The Adverse Effects of Polypharmacy in Traumatic Brain Injury: A Case Report

Shelby Halsey

Case Description: A 64-year-old gentleman sustained a traumatic brain injury (TBI) after an attack by an inmate while he was working as a prison guard, where he hit his head on a brick wall resulting in loss of consciousness (LOC). He then developed paroxysmal spells characterized by sudden falls with resultant LOC. Electroencephalograms (EEG) were negative for seizure activity. He sustained a subsequent head injury when he had a syncopal episode and fell backward, resulting in acute subdural hemorrhage (SDH). He was started on various medications after the initial injury to treat the neurobehavioral and medical sequelae of his TBI, including olanzapine, imipramine, clarithromycin, levetiracetam, lamotrigine, gabapentin, modafinil, and zolpidem on admission to the inpatient rehabilitation hospital. After both injuries, he was taken to a skilled nursing facility (SNF) instead of acute inpatient rehabilitation. He continued to suffer from multiple falls related to an unsteady gait and a progressive decline in mentation. He was admitted to a tertiary hospital on two separate occasions for restlessness, confusion, and refusal to eat or take medications. The patient was admitted to the Brain Injury Program in an acute inpatient rehabilitation facility (IRF) approximately six months post-injury, after he was admitted to acute care for pneumonia. Upon admission to the IRF, he was initially paranoid, delusional, and had developed trismus and rigidity, contributing to his falls; he was unsafe to walk, confabulatory and perseverative, with severe memory deficits and cognitive rigidity. Throughout his inpatient rehabilitation admission, all of the medications listed above were discontinued with the exception of clarithromycin and lamotrigine.

Setting: Acute Inpatient Rehabilitation Facility

Results: After discontinuation of multiple medications, he improved rapidly with physical, occupational, and speech therapy. In particular, the patient’s cognitive status, as indicated by comprehensive formal neuropsychiatric testing, rapidly improved, and he was noted to have significant improvement in overall arousal/alertness, following commands, complex yes/no questions, verbal fluency, convergent naming, and orientation.

Discussion: Sequelae from acquired brain injury, including cognitive impairments, are often targeted with pharmacologic interventions prior to admission to inpatient rehabilitation, leading to an increased potential of drug-drug and drug-disease interactions from polypharmacy. This case illustrates how discontinuation of various medications, particularly psychotropic, used to treat TBI sequelae may improve functional recovery and cognitive status.

Conclusion: Polypharmacy should be addressed immediately upon admission to inpatient rehabilitation, if not in the acute care setting, as adverse events and drug-drug interactions could have deleterious effects on a patient’s rehabilitation potential, both physically and cognitively. Improved awareness of polypharmacy in the setting of TBI may

Level of Evidence: Level V
Application of Automated Vowel Space Area Analysis to Predict Concussion Status

Russell Banks1, Meisam Khalil Arjmandi1, Hamzeh Ghasemzadeh1, Mark Berardi1
1Michigan State University - Voice Biomechanics and Acoustics, East Lansing, United States

Recent research has indicated that the percentage of the adult population with a neurologic disorder in the United States has risen to 6.75%. Included in this population are those with Alzheimer’s disease, Amyotrophic Lateral Sclerosis (ALS or Lou Gehrig’s disease), brain tumors, epilepsy, Huntington’s, Multiple Sclerosis (MS), Parkinson’s Disease (PD), stroke, and traumatic brain injury (TBI). This population is often only identified after months or even years of dealing with symptoms which they do not associate with neurologic disorders, thus delaying treatment which may improve their quality of life. For this reason, better means of identifying individuals in the early and mild stages of these diseases is necessary. We propose the use of automated vowel space analysis as a means of identifying individuals with a form of mild brain injury: concussion.

Due to the lack of research in this area, we propose further examination of various aspects of voice including vowel space analysis and machine learning techniques be applied to the large database of concussed speakers obtained through collaboration with another institution. These efforts will require the development of automated vowel extraction tools in Matlab, Python, and Praat softwares. Measures of vowel space dispersion and area of vowel space (convex hall) will be used to train various machine learning classifiers in separating disordered speech from normal ones. This study allows us to evaluate the ability of vowel space-based acoustic features in separation of speech of individuals with neurological disorders from normal speech.

Most machine learning techniques rely on a set of features for representing different target classes. In order to tackle this, manually extracted vowels are analyzed in both temporal and spectral domains with the aid of wavelet and short time Fourier transform and their structures are identified. This information then is used to extract powerful features for training a support vector machine (SVM) which would implement the automated vowel space analysis tool. Additionally, those vowel space analysis currently being used will require transitional work in order to obtain automated output. Current methods of vowel space analysis use manual identification of vowel formant frequencies to obtain a reliable measure of vowel space. This process requires large amounts of time in both the training of the manual formant extractors and the actual extraction of the formants.

It is anticipated that our analysis will be more efficient and as accurate as manual formant extraction techniques. It is also anticipated that our analysis will be sensitive enough to identify normal versus disorders speech when applied to the voice of several neurological diseases highly prevalent throughout the state of Michigan.

Differences in vowel space area between non-disordered and concussed individuals are examined and discussed in this study.
Subcortical Exam Findings Across the Developmental Spectrum in mTBI Patients

Tony Doran¹, Robert Graw¹, Dan Pokrifka¹
¹Headfirst, Annapolis, United States

This research project examined the similarities and differences of cranial nerve functioning of subjects from age 6 to 70. Examining a convenience sample of 280 consecutive patients to a community-based concussion clinic were examined. Sample groupings were: under 10 (n=22); 11 – 19 (n=107); 20 to 29 (n=110); 40 to 59 (n=41); and 60+ (n=19). Cranial nerve functioning was assessed examining – smell, hearing, pupils, ocular-motor functioning, ataxia, and balance. Overall eye pain and balance difficulties were present in 60% of mTBI’s. Developmental differences were observed. Subtle cranial nerve abnormalities can assist clinicians in identifying, recommending treatments, and monitoring recovery of patients diagnosed with a mTBI.
Identification of Clinician Expertise in the Evaluation, Diagnosis and Treatment of mTBI

Tony Doran¹, Dan Pokrifka¹
¹Headfirst, Millersville, United States

Clinical proficiency was examined in an outpatient concussion clinic. 85 staff members were reviewed.

Methodology: Peer review documentation of medical records; presentations to senior clinicians were used to rate clinical proficiency; total number of mTBI seen were used to complete rating evaluations.

Results: Clinicians who had seen less than 50 mTBI’s were typically rated as novices requiring continued supervision; clinicians who had seen 200 or more mTBI’s were rated as competent fluidly completed exams and documentation and were comfortable with diagnosis and recommendations; clinicians who had seen 1000 or more mTBI’s were rated as concussion specialists – these clinicians knew how to integrate subtle differences in history, subcortical exam, and neurocognitive functioning to assist with treatment planning and monitoring of patients.

Discussion: Generally greater exposure to evaluating, diagnosing and treating mTBI lead to greater expertise in clinical management.
Formant Dynamics in Vowel Pronunciation as Acoustic Correlates of Concussed Speech

Russell Banks\textsuperscript{1}, Meisam Khalil Arjmandi\textsuperscript{1}, Hamzeh Ghasemzadeh\textsuperscript{1}, Mark Berardi\textsuperscript{1}

\textsuperscript{1}Michigan State University, East Lansing, United States

Human voice carries various indexical, linguistic, and pathologic information. Concussion is a traumatic brain injury (TBI) which may impact individual’s normal voicing behaviors through disruption of upper or lower motor neuron neural pathways involved in speech production. Early diagnosis of this neurological disorder through acoustic analysis of speech signal provides a low-cost, non-invasive and valuable mean for effective intervention and treatment of this neurologic disorder. Individuals with concussed brain are very likely to experience impaired neural intervention to muscles and tissues responsible for articulatory movement during speech. Evidence of deviation from normal articulatory movements can be captured by tracking formant changes as acoustic measures of the natural resonances of the vocal cavity (i.e., vocal tract) during sound articulation. This study investigates the informativeness of first (F1) and second formant (F2) dynamics during sustained /a/ vowel phonation in prediction of concussed speech. Vowel pronunciation of 103 participants were recorded before and right after concussion diagnosis. F1 and F2 values were extracted for 103 subjects (13 Females and 90 Males) at consecutive analysis frames with 10 ms length through the duration of the sustained vowels. The formant parameters were adjusted for male (maximum formant = 5 KHz) and female (maximum formant = 5.5 KHz) participants to assure the accuracy of formant estimation. Temporal variation of formant trajectories before and after concussion revealed that the articulatory movements in individuals who diagnosed with concussion contain wider range of variability with deviated tongue position after diagnosis compared to normal condition. Machine learning of temporally dynamic cues of F1-F2 formant trajectories revealed the distinctive clusters of formant trajectories distribution for the vowel sounds pronounced before and after concussion. The findings from this study suggest that neural and functional impairments caused by concussion negatively affect individuals’ ability to preserve normal movements of articulatory organs including tongue, mouth and jaw. This deviation from normal pronunciation of vowel sounds is detectable by tracking temporal variation of F1-F2 formant values as biomarkers of concussed speech.
Written Narrative Language Deficits Following Concussion

Melissa Stockbridge¹,², Rochelle Newman¹
¹University of Maryland, College Park, United States, ²Johns Hopkins School of Medicine, Baltimore, United States

Purpose: The purpose of this research is to examine typed, written narratives in order to better understand the kinds of cognitive and language deficits that adolescents and adults experience immediately following a concussion.

Method: Participants aged 12-40 years old who had either a recent concussion or no history of brain injury responded to an online survey by writing both a familiar and a novel narrative. They also completed multiple tasks targeting word-level and domain-general cognitive skills, so performance could be interpreted across these dimensions.

Results: Participants with a recent concussion demonstrated difficulties in letter fluency, story grammar, and cohesion, but not common measures of syntactic complexity. Evidence of word finding errors at the prose level was mixed. This suggested that deficits in narrative language, though likely influenced by problems in word-finding, memory, and attention, also existed beyond what could be explained by those deficits alone.

Conclusions: These findings support a multidimensional explanation of narrative deficits observed in writing.
Managing Anxiety and Depression after Severe Traumatic Brain Injury

Deana Adams¹
¹Hope After Brain Injury, Arlington, United States

Objective: The research aimed to answer, "What are the coping strategies utilized by survivors and primary caregivers to manage the effects of associated with severe traumatic brain injury?" The purpose was to explore the coping strategies of adult severe traumatic brain injury (TBI) survivors and primary caregivers and with this knowledge add to the development of theory related to rehabilitation and counseling. Specifically, how to manage the propensity of depression and anxiety that accompanies brain injury for survivors as well as caregivers.

Participants: This study included fourteen individuals, eight participants with severe traumatic brain injury and six primary caregivers, who participated in a series of semi-structured interviews aimed at identifying the coping strategies utilized in dealing with the effects of severe brain injury.

Method: The study design was a qualitative phenomenological method.

Results: The study identified the prevalence of anxiety and depression after severe brain injury. Participants offered suggestions for mental health professionals addressing how to more effectively work with brain injury survivors and their primary caregivers.

Conclusion: Coping strategies determine the effectiveness in managing anxiety and depression after severe brain injury. The findings indicated problem focused, emotion focused, and avoidant coping were utilized to some degree throughout the rehabilitation process. Results also supported research addressing effective management of depression and anxiety in the brain injured and their caregivers.
Background: Traumatic brain injury often have major consequences for the individual affected, since severe traumatic brain injury often leads to long-term physical, cognitive, social and behavioral deficits. These impairments affect the patient's participation in the decision-making process during the admission to a rehabilitation department and relatives become important participants as a proxy to advocate for patients. However, studies have shown that this is complex because of differing understandings of the meaning of involvement as well as diverse needs to be involved.

Aims and Objective: We explored the experience of the rehabilitation process from the perspectives of relatives of patients with a severe traumatic brain injury. The aim of the study was to identify relatives’ strategies and practices in the rehabilitation process as seen in their meetings with providers.

Design: A longitudinal study with a qualitative approach, drawing on the theory of Pierre Bourdieu.

Methods: Data were generated using participant observation and semi-structured interviews. Participants were eleven relatives of patients with a severe traumatic brain injury, followed through in-patient rehabilitation varying from nine to twelve weeks. Analysis was undertaken using both an inductive and deductive approach.

Findings: Drawing on Bourdieu’s concept of strategy, three relative positions were identified, the warrior, the observer and the hesitant. These positions illustrate how different positions and related dispositions of relatives influence their strategies. Differences were evident in how relatives act, participate and relate to both the patient and the providers during rehabilitation.

Conclusions: It is of utmost importance that providers are able to differentiate relatives’ need for information, support and involvement. Knowledge about the three related positions offers a way of thinking that can help clinicians reflect on their own practice.
Concussion and Vision: Managing the Four “S’s”

Neera Kapoor

NYU School of Medicine, New York, United States

This course provides an overview of why vision may be impacted following mild traumatic brain injury (mTBI)/ concussion along with basic ophthalmic terminology. Illustrated with a case, four aspects of an evidence-based high-yield primary vision evaluation of typical residual vision problems will be presented, along the underlying neurology, primary associated symptom, and generalized treatment approach for the typical vision conditions evident following mTBI / concussion.
Impact of Weekend Admission and Medical Comorbidities on Inpatient Intracranial Hemorrhage Mortality

Neveda Murugesan1, Tim Wong1, Ali Seifi2
1University of Health Science Center Long School of Medicine, San Antonio, United States, 2University of Texas Health at San Antonio, San Antonio, United States

Primary intracerebral hemorrhage (ICH) causes up to 15% of strokes, with about 50% mortality within 30 days. We aimed to identify if the "weekend effect" on mortality was present or not for patients with ICH admitted to United States hospitals between 2006 and 2014. We also sought to identify medical comorbidities that had significant impact on inpatient ICH mortality in this period.

Retrospective cohort study examining 146,587 inpatients with ICH diagnosis in US hospitals from 2006-2014 with data from the National Inpatient Sample, the largest US all-payer inpatient healthcare database. Primary outcome measure was all-cause in-patient mortality, defined as deaths on the day of admission, during hospitalization, or on the discharge date, provided the length of stay was ≤ 30 days. Univariate odds ratios, confidence intervals, and p-values were obtained from mixed effects linear models with adjustment for clustering within hospitals. A multivariate logistic model of in-hospital mortality in terms of age, gender, race, teaching status of hospitals, income quartile by zip code, and comorbidities was fit without model reduction and the model was validated on data collected in 2014. Mortality rates for weekend admissions were compared between urban teaching and urban non-teaching hospitals using a logistic regression of odds ratios to calculate a chi-squared value.

Weekend admission alone was a prognostic factor for mortality when compared to weekday admission in both teaching and non-teaching hospitals (p<.001). Teaching hospitals showed a lower mortality rate for weekend admissions compared to non-teaching hospitals (p<.001). Coagulopathy was the strongest mortality risk factor for all ICH admissions among medical comorbidities in the study (OR 1.90). Comorbidities associated with decreased mortality for all ICH admissions included complicated diabetes mellitus (OR 0.76), obesity (OR 0.81), and hypertension (OR 0.83).

Our study suggests greater mortality for weekend ICH admissions compared to weekday ICH admission, but to a lesser extent in teaching hospitals. Certain comorbidities including coagulopathy, HIV/AIDS and renal failure increased inpatient mortality for ICH, while diabetes mellitus, obesity and HTN surprisingly were associated with decreased mortality.
Evidence Synthesis on Traumatic Brain Injury as a Precursor for Neurodegeneration, Cognitive Decline, and Development of Alzheimer’s Disease

Tatyana Mollayeva1,2,4, Shirin Mollayeva1,2, Nicole Pacheco1,3, Andrea D'Souza1,2, Angela Colantonio1,2,3

1Toronto Rehabilitation Institute-University Health Network, Toronto, Canada, 2Rehabilitation Sciences Institute University of Toronto, Toronto, Canada, 3McMaster University, Hamilton, Canada, 4Occupational Science and Occupational Therapy University of Toronto, Toronto, Canada

Despite indications that traumatic brain injury (TBI) may be a precursor for cognitive decline and subsequent development of Alzheimer’s disease (AD), little is known about the time course of this relationship and the factors that contribute to synaptic dysfunction and neurodegeneration. We summarized the current evidence on the course and prognostic factors of cognitive outcomes in adults with TBI. Our results highlighted that as time since injury progresses, performance of measures of recent memory, executive function, language, and information processing speed tend to improve or remain stable from baseline in non-sports-related mild TBI samples and mixed severity TBI samples, indicating potential neurogenesis or practice effect. Severe injury results also depict mostly improvements or stability with respect to cognitive performance, however, as last follow up time progresses it appears that improvements are abated and reports of no change dominate. Although several mechanisms were found to modulate the risk of cognitive decline in persons with TBI, the evidence in the longitudinal studies published to date suggests the ability of the brain to compensate and naturally recover after injury is associated with genetic makeup, injury severity and count, age, and sex. The evidence taken together, however, is not strong and, as such, not convincing of the presence and strength of a relationship between TBI and cognitive decline, and subsequent risk for development of neurodegenerative disorders. Some of the issues in the studies published to date are attributable to the limited information present on evaluative properties of the outcome measures used to assess cognition, unknown sensitivity to changes over time and practice effect. Future work must apply these considerations in their design process and execution to circumvent issues present in current studies, providing a more concrete understanding of the relationship in question and factors that modulate it.
Sequels and clinical profile of traumatic brain injury in motorcycle drivers in the metropolitan area of Medellin, Colombia

Isabel Cristina Rojas-Gallego1, Maria Tieck1, Yessica Giraldo1, Liliana Alvarán1, Santiago Vasquez-Builes1, Clara Escorcia1, Esteban Calle1, Laura Montoya1

1Ces University, Medellin, Colombia

Traumatic brain injury (TBI) is the leading cause of death among individuals under the age of 44 in industrialized countries. In Colombia, 70% of the emergency department visits are due to trauma, 51% of which are road traffic incidents. Around 43.9% of the events were motorbike accidents. The disability caused by this kind of accidents is not well documented. We performed a two-phase transversal study to characterize the neurological profile of motorcycle drivers at the moment of the accident (phase I) and 6 months after suffering a TBI (phase II) between 2014-2016 in clinics from the metropolitan area of Medellin, Colombia. During phase I, 645 patients' histories were evaluated using the Glasgow coma scale to assess TBI severity. In phase II, 102 patients that met the inclusion criteria were neurologically evaluated in the clinic 6 months after the accident. The primary outcome measures were the presence of sequels immediately after the accident and 6 months later. We determined the factors that modulated TBI severity with a logistic regression. A conjoint analysis was made to establish the factors associated with sequels. We found in phase one that female sex was a protective factor against severe TBI, while any open TBI, the presence of more than one hematoma and loss of consciousness were classified as risk factors for severe TBI. The phase II study showed the highest amount of sequels in patients classified as severe TBI, followed by mild TBI, and then moderate TBI. Patients at highest risk of developing sequels were male, motorcycle drivers with frontal trauma, closed trauma, without loss of consciousness, mild TBI and receiving care at a high complexity institution. 68% of all patients presented with some sequels. The most common sequels were headaches and equilibrium disturbances. The Glasgow coma scale did not correlate with a worse prognosis or the occurrence of sequels, which questions the usefulness of the scale when assessing TBI severity.
The Effects of Physical Exercise on Depression for Individuals with TBI: A Comparison with Non-TBI Severe Central Nervous System Injury

James Dolbow¹, Kenneth Troxclair¹, David Dolbow², Bizu Gelaye³, Daniel Credeur⁵, Lee Stoner⁴

¹Lincoln Memorial University-Debusk College Of Osteopathic Medicine, Speedwell, United States, ²William Carey University, Hattiesburg, United States, ³Department of Epidemiology, Harvard T.H. Chan School of Public Health, Boston, United States, ⁴Department of Exercise and Sport Science, University of North Carolina, Chapel Hill, United States, ⁵School of Kinesiology, University of Southern Mississippi, Hattiesburg, United States

Depression is a serious comorbidity of Traumatic Brain Injury (TBI) with 53% of these patients meeting the Diagnostic and Statistic Manual of Mental Disorders criteria for major depressive disorder. This is in contrast to 11.4% of patients with spinal cord injury (SCI) who meet these criteria. Previous studies examining the utilization of exercise and community integration has been widely shown to improve symptoms of depressive of able-bodied adults, however the effects of exercise on depression in patients with severe central neurologic disability has yet to be determined. The purpose of this review and analysis is to investigate the effects of exercise on depression for those with TBI and SCI as well as consider ways to improve the current standard of care accordingly. The analyzed studies suggest no improvement in depression could be consistently found with increases in activity level in individuals with TBI. Conversely, increases in overall physical activity level may be effective in improving the mental health and depression of patients with SCI. More research is needed before cause and effect relationships can be stated with confidence. Given the consistent improvements in depression found as a result of cognitive behavioral therapy and other psychiatric-specific therapies in patients with TBI, consideration should be paid into the implementation of these therapies as standard of rehabilitative care.
Differences Between Men and Women in Concussion/Mild Traumatic Brain Injury: Psychosocial Profiles and Community Integration

Tatyana Mollayeva\(^1\), Shirin Mollayeva\(^1,2,3\), Angela Colantonio\(^1,2,3\)

\(^1\)ABI & Society Research, Toronto Rehab-UHN, Toronto, Canada, \(^2\)Rehabilitation Sciences Institute University of Toronto, Toronto, Canada, \(^3\)ABI Research Lab University of Toronto, Toronto, Canada

Differences between men and women in the clinical manifestations and community integration outcomes of concussion/mild traumatic brain injury (mTBI) have been recognized, and it has become apparent that these differences cannot be explained solely by biological differences.

We aimed to elucidate differences in experiences according to sex in patients with concussion/mTBI and the relevance of these differences to a patient-reported outcome, community integration. A cross-sectional study was conducted on 94 patients diagnosed with concussion/mTBI based on multidisciplinary assessment at a neurology clinic at the largest rehabilitation research-teaching hospital utilizing neuroimaging, clinical, and functional assessments. Chi-square and t-tests were used to examine the relationship between psychosocial profiles and outcomes between men and women. Stepwise multivariable linear regression models were used to evaluate the associations for observed differences in community integration. Fifty-eight men and 36 women, 45.20±9.94 years old at 197 days [interquartile range 139-416] post-injury were studied. The male to female ratio was 1.6:1. There were no differences between men and women with respect to age or time since injury, presence of prior head injuries, acute injury markers such as loss of consciousness or post-traumatic amnesia, or structural brain abnormalities recorded on magnetic resonance imaging results (all \(p> 0.1\)). Men were more likely to work night shifts at the time of their injury compared to women (\(\chi^2= 4.1, \text{ all } p=0.03\)). Mechanism of injury differed between men and women, with men more likely to sustain their injury by being struck by an object (\(\chi^2=4.71, \text{ all } p=0.03\)) and women as a result of an assault (\(\chi^2=4.76, \text{ all } p=0.02\)). Work disability status at the time of investigation was comparable for both sexes (\(\chi^2=1.32, \text{ all } p=0.25\)). Living alone, reporting family difficulties, and lower level of education were more common for men than for women (\(\chi^2=6.97, \chi^2=3.74, \chi^2=5.04, \text{ all } p< 0.05\)). Women were more likely to be diagnosed with somatoform disorder (\(\chi^2=11.16, \text{ p}<0.001\)) or malingering (\(\chi^2=7.64, \text{ p}<0.01\)) compared with men. Living alone was associated with better community integration (\(\beta = 2.087, \text{ p} <.05\)) and a diagnosis of possible/probable malingering was associated with poorer community integration (\(\beta = -4.923, \text{ p} <.001\)) in a multivariate linear regression model adjusted for sex, education, mechanism of injury and time since injury.

Our results suggest that among patients who have been diagnosed with concussion/mTBI, there is evidence that women may be more inclined to be seen as producing exaggerated physical or psychological symptoms than men; and men more may be more vulnerable to family pressure or pressure for community reintegration because they live alone. Our results support the need for increased gender-delineated psychosocial profile assessment and consideration of potential differences between men and women in the management of concussion/mTBI.
Return-to-Learn after Traumatic Brain Injury: The Impact of Hospital and School Collaboration in School Re-Entry

Anne Crylen

1Eastern Michigan University, West Olive, United States

Over a half million children with head injuries pass through U.S. emergency rooms each year. According to the Center for Disease Control, Traumatic Brain Injury (TBI) is the leading cause of disability in children in the United States (Schilling & Getch, 2012). Although TBI is listed as a disability eligible for services under the Individuals with Disabilities Education Act (IDEA), educators receiving information through mass trade publications may be most familiar with the hot topic of sports-related concussion rather than TBI. Concussion is a mild form of TBI; the vast spectrum of TBI makes it a complex disability, which may involve intensive physical rehabilitation and cognitive therapy.

The purpose of this qualitative case study was to understand the process of reintegration from hospital to school for students with TBI from the perspective of the educational leaders supporting a student with TBI. This study is not a policy analysis; rather an effort to uncover the meaning of education needs and support for students and their families and to explain the student’s academic and socio-emotional success.
Rate of Readmissions in Patients with Intracranial Injuries in the United States

Chelsea Mendonca1, Kenneth James1, Mouhamed Nashawi1, Ali Seifi1

1UT Health at San Antonio Long School of Medicine, San Antonio, United States

Introduction: Intracranial injury (ICI) is one of the leading causes of death and comorbidity in healthcare. Readmissions carry a heavy cost on the healthcare system and indicate a failure. We aim to determine the rate and common causes of readmissions in ICI patients.

Methods: Data from the Agency for Healthcare Research and Quality’s National Inpatient Sample was queried from 2009-2014 for admissions and readmissions of ICI patients. Z-tests were performed to assess for significant differences.

Results: During the study period, the NIS reported a total of 1,223,883 ICI which increased from 193,696 to 200,405 (p=0.577). The mean age for this population increased from 53.21 to 58.3 years old (p=0.000). The average LOS in this population decreased from 6.2 days to 6.1 days (p=0.574); however, the number of mortalities increased from 15,792 to 17,090 (p=0.279).

Over these 6 years, the 7-day readmission rate for any cause increased from 4.9% to 5.0% (p=0.668). The 30-day readmission rate for any cause increased from 11.0% to 11.3% (p=0.462). The average 7-day readmission rate for any cause is 4.9% while the three most common reasons for readmission are intracranial injury, epilepsy, and septicemia. The average 30-day readmission rate for any cause is 11.2%. The three most common reasons for readmission in 30-days are intracranial injury, acute cerebrovascular disease, and septicemia.

Discussion: Our data shows that readmission for ICI is relatively common in the United States; however, there has been no significant change in the rate of readmissions in this population from 2009 to 2014.
The Efficacy and Harms of Pharmacological Interventions for Neurobehavioral Symptoms in Post Traumatic Amnesia after Traumatic Brain Injury – Systematic Review

Amelia Hicks\(^1\), Fiona Clay\(^2\), Malcolm Hopwood\(^{1,3}\), Amelia James\(^1\), Mahesh Jayaram\(^2\), Rachel Batty\(^2\), Jennie Ponsford\(^1\)

\(^1\)Monash-Epworth Rehabilitation Research Centre, Monash Institute of Cognitive and Clinical Neurosciences, School of Psychological Sciences, Monash University, Melbourne, Australia, \(^2\)Department of Psychiatry, University of Melbourne, Melbourne, Australia, \(^3\)Professorial Psychiatry Unit Albert Road Clinic, Department of Psychiatry, University of Melbourne, Melbourne, Australia

Background and Aims: Many individuals in the post-traumatic amnesia (PTA) period following traumatic brain injury (TBI) experience significant neurobehavioral symptoms (NBS), including agitation, aggression and disorientation. These symptoms are often associated with increased length of stay and low engagement in rehabilitation, self-inflicted harm and risks of physical violence. The aim of this systematic review was to critically evaluate the evidence on pharmacological interventions for NBS in PTA following TBI in adults.

Methods: We reviewed studies in English, published before December 2017. MEDLINE, PubMed, CINAHL, EMBASE, PsycINFO and CENTRAL databases were searched, with additional hand searching of key journals, clinical trials registries and international drug regulators. The primary outcomes of interest were reduction in the severity of NBS in PTA and occurrence of harms. The secondary outcomes of interest were duration of PTA, length of stay, functional outcome, and cognitive function. Evidence quality was assessed using the Joanna Briggs Institute Critical Appraisal Instruments.

Results: Thirteen studies were identified, including three randomized controlled trials (RCTs), three cohort studies, and seven case series. Pharmacological interventions were complex and varied, and often lacked detailed descriptions of dose, frequency and duration of the pharmacological intervention. The quality assessment revealed methodological problems with the majority of studies.

The three RCTs examined the efficacy of rosuvastatin, sertraline and amantadine. Neither amantadine nor sertraline had an effect on NBS. Less rigorous studies reported reduced NBS in patients administered haloperidol, ziprasidone, carbamazepine, amitriptyline, desipramine, and varied neuroleptics. With respect to harms and adverse events, there was an increase in creatinine for one patient administered rosuvastatin, and no adverse events for patients receiving amantadine. From the case series, there were no adverse events recorded for use of carbamazepine, ziprasidone, or the polypharmacy intervention of amantadine, trazadone, and either Ritalin or Dexedrine. In contrast, haloperidol use was associated with one oculogyric crisis, there was an increase in agitation noted for one participant administered amitriptyline.

With respect to the secondary outcomes of interest, neither sertraline nor amantadine had an effect on PTA duration, and the effects of rosuvastatin were unclear. Administration of amantadine was associated with better functional outcome and cognition. Patients administered rosuvastatin had worse functional outcome at discharge; however, this was no longer significant after 3 months.

Conclusions: There is a paucity of well-designed, adequately powered and controlled studies of pharmacological interventions for NBS in PTA. More research is needed to provide evidence-based treatment recommendations and improve care.
Traumatic Brain Injury as a Risk Factor for Dementia and Alzheimer’s Disease: Critical Review of Study Methodologies

**Amelia Hicks**, Amelia James, Gershon Spitz, Jennie Ponsford

1Monash-Epworth Rehabilitation Research Centre, Monash Institute of Cognitive & Clinical Neurosciences, Monash University, Clayton, Australia

**Objectives:** Despite much previous research stating that traumatic brain injury (TBI) has been confirmed as a risk factor for dementia and Alzheimer’s disease (AD), findings from observational studies are mixed and are of low methodological quality. This review aimed to critically evaluate the methodologies used in previous studies examining the relationship between TBI with dementia and AD.

**Methods:** The search strategy involved reviewing reference lists for previous systematic and narrative reviews examining an association between head injury and dementia or Alzheimer’s disease, or risk factors for dementia or Alzheimer’s disease more broadly. The reference list and citations for all primary studies identified were reviewed. Formal database searches were completed in June and July 2018 to supplement the initial snowballing approach in MEDLINE (OVID SP interface) and PsycInfo (OVID SP interface). Key word searches were completed in Google Scholar and Research Gate in August 2018. All English language studies, regardless of publication status, published before August 2018 were eligible for inclusion.

**Results:** Sixty-eight identified reports, published between 1982 and 2018, met inclusion criteria. There were 12 prospective cohort studies, 13 retrospective cohort studies, 38 retrospective case-control studies, 3 case series and 2 pooled analyses. Common methodological weaknesses included reliance on self-reported TBI; poor case definition of TBI; low prevalence of TBI in samples reducing power; failure to account for number of TBIs; reverse causality whereby the dementia is likely to have manifested prior to the TBI; failure to assess for dementia or AD in the control group; failure to match cases with controls or adjust analyses; failure to correctly interpret effect sizes. Risk of bias across studies was generally high.

**Conclusions:** This critical review identified several key areas of methodological weakness across studies. These limitations significantly impede the conclusions that can be drawn from the research. Identifying common methodological issues within this evidence base provides an opportunity to address these weaknesses in future studies and produce methodologically rigorous research that has the potential to progress knowledge in this area. This is of critical importance in answering the long-debated question of whether a TBI is indeed a risk factor for dementia and AD.
Pharmacotherapy for the Pseudobulbar Affect in Individuals Who Have Sustained A Traumatic Brain Injury: A Systematic Review

Amelia Hicks¹, Fiona Clay²,³, Jennie Ponsford¹, Luke Perry², Mahesh Jayaram², Rachel Batty², Malcolm Hopwood²,³

¹Monash-Epworth Rehabilitation Research Centre, Monash Institute of Cognitive and Clinical Neurosciences, School of Psychological Sciences, Monash University, Clayton, Australia, ²Department of Psychiatry, University of Melbourne, Melbourne, Australia, ³Professorial Psychiatry Unit, Albert Road Clinic, Department of Psychiatry, University of Melbourne, Melbourne, Australia

Background: Pseudobulbar affect (PBA) is a debilitating condition that significantly reduces quality of life for many individuals following traumatic brain injury (TBI). It is characterized by embarrassing and often uncontrollable episodes of crying or laughter. The aim of this systematic review was to evaluate the effectiveness of pharmacotherapy as compared to all other comparators for the management of PBA in adults who have sustained a TBI.

Methods: Six databases were searched, with additional hand searching of journals, clinical trials registries and international drug regulators to identify published and unpublished studies in English up to June 2018. Studies were eligible for this review if they included adults who had sustained a medically confirmed TBI and presented with PBA. All pharmacotherapy and comparator interventions were considered for inclusion, and study design was not limited to randomised controlled trials. The primary outcomes of interest were changes in the symptoms of PBA and occurrence of harms. The secondary outcomes of interest were health related quality of life and change in symptoms of depression. Evidence quality was assessed using Joanna Briggs Institute Critical Appraisal Instruments.

Findings: Two quasi-experimental studies examining the effectiveness of dextrometamorphan/quinidine (DM/Q) were identified. These studies reported that DM/Q was effective in reducing symptoms of PBA and had a positive safety profile, over follow-up periods of 3 months (n=87) and 12 months (n=23). One study also found a significant reduction in the impact of PBA episodes on global subjective well-being, and a decline in the severity of neurobehavioural symptoms including depression and aggression. However, both studies were limited by lack of a control group and a high dropout rate.

The findings of twelve case reports examining the effectiveness of DM/Q (n=6) and anti-depressants (n=6) are also discussed. All six cases prescribed anti-depressant medication reported improvement in PBA symptoms, with four cases showing complete remission within 3 months. The findings from the DM/Q intervention were more complex, with some cases displaying divergent effects for symptoms of crying and laughing. Only seven case series considered adverse events, for which no harms were reported for administration of DM/Q (n = 6) or fluoxetine (SSRI; n = 1). Five of the six cases prescribed DM/Q reported changes in other neuropsychiatric sequelae, including improvements in aggression and rage, anxiety and symptoms of panic. All case reports were assigned a moderate to high risk of bias.

Conclusions: The studies in this review do not provide clear evidence for a specific pharmacological intervention for PBA following TBI. Direct comparator trials of DM/Q with anti-depressant medications in large randomized trials are needed, with consideration given to side effect profiles and financial costs of medication. This represents a critical first step towards producing recommendations for PBA following TBI.
Trajectory of Post-Concussive Symptoms 12-Months Post-Deployment in Soldiers with and without Mild Traumatic Brain Injury - Warrior STRONG Study

Hamid Ferdosi1
1Defense and Veterans Brain Injury Center - George Washington University, Silver Spring, United States

Background: While it is believed that symptoms related to deployment-related mild traumatic brain injuries (mTBI) will improve within a few days or weeks in most cases, some service members may continue to experience troubling residual symptoms. We have previously reported on the prevalence of neurobehavioral symptoms in a cohort of soldiers evaluated shortly after returning from deployment and again at three months. In the present study, we report on symptom prevalence and trajectories extended to one-year follow-up.

Objective: To determine the predictors and trajectories of neurobehavioral symptoms in a cohort of OEF and OIF service members with and without mTBI who were assessed within several days of their return from deployments and 3, 6, and 12 months post-deployment.

Design: Longitudinal Cohort Study (Warrior Strong Study)

Setting: Two US Army military bases (Fort Bragg and Fort Carson)

Exposure: Mild Traumatic Brain Injury incurred in OEF and OIF

Methods: This prospective, longitudinal study enrolled active duty Service Members returning from OEF and OIF who were screened for mTBI within a few days of return. Differences in post concussive symptoms between those with deployment related mTBI (n=557) and without mTBI (n=1010) were assessed using the Neurobehavioral Symptom Inventory. Mixed effects models using a missing at random (MAR) approach for missing data were used to evaluate the role of mTBI and other factors on the trajectory of symptoms.

Results: A total of 1567 soldiers participated in baseline interviews between 2009 and 2014, of whom 1162 completed at least one follow-up interview. Severe/Very severe symptoms were reported by 48% of mTBI cases and 21% of controls at baseline. Overall, at all time-points, TBI cases were almost twice as likely to report symptoms (adjusted OR=1.7, 95%CI 1.51-1.93, p <0.0001) compared to controls. Three of the four most prevalent baseline symptoms remained associated with mTBI at all time points (sleep problems: OR=2.19; forgetfulness: OR=2.56; and irritability: OR=2.73). Headache was more common in cases than controls at baseline (OR=3.44) although this OR decreased with time due primarily to increasing prevalence of headaches in controls.

Conclusion: In this cohort of recently deployed service members, the majority of those who had sustained an mTBI during deployment reported clinically relevant neurobehavioral symptoms over one-year follow-up. Symptoms also were reported by a large minority of those who did not sustain a mTBI.
Group-Based Trajectory Analysis in Mild Traumatic Brain Injury

Hamid Ferdosi¹

¹Defense and Veterans Brain Injury Center - The George Washington University, Silver Spring, United States

Background: Across the general population, approximately 15-25% of individuals who receive mild traumatic brain injury (mTBI) fail to experience a rapid and complete recovery, evidencing persistent symptoms at one-year post injury. Continued presence of symptoms beyond three months post injury has been labeled persistent post concussive syndrome (PPCS) and is commonly coded as post-concussion syndrome in ICD-10-CM. The rate of PPCS appears to be elevated among active duty service members and Veterans. According to a recent study, almost half of military service members recently deployed to combat theatres of operation in Iraq and Afghanistan who screened positive for mTBI reported severe or very severe post concussive symptoms at 3 months follow-up. Of note, individuals without mTBI also report the presence of post-concussive type symptoms, although at significantly lower rates than those with mTBI. In the Schwab et al 2017 study, 25% of recently deployed service members who screened negative for mTBI reported severe or very severe symptoms at the three-month follow-up, compared to 47% of those with mTBI. Research indicates variation in the trajectory of PPCS following injury, but researchers have assumed homogeneity.

Objective: To identify distinct differential trajectories of PPCS among individuals

Design: Longitudinal Cohort Study (Warrior Strong Study)

Setting: Two US Army military bases (Fort Bragg and Fort Carson)

Exposure: Mild Traumatic Brain Injury incurred in OEF and OIF

Methods: Data were from Warrior STRONG, a longitudinal study that enrolled active duty Service Members returning from OEF and OIF screened for mTBI within a few days of return. Group-based trajectory models provide a flexible and easily applied approach to identify distinct clusters of individual trajectories within this population. Using SAS Proc Traj longitudinal data were modeled as a discrete mixture of two or more latent trajectories via maximum likelihood estimation. Separated analyses were performed on; (1) all individuals and (2) those with mTBI only.

Results: Using all individuals, group-based trajectory modeling identified two distinct PPCS trajectories: low PPCS (65.5%) and high PPCS (34.5%). Individuals identified as non-white, female, lower rank, and have a combat MOS were associated with trajectory characterized by higher PPCS. Using only individuals with mTBI, group-based trajectory modeling identified two distinct PPCS trajectories: start low group with slowly rising through the first 6 months with slow decline afterwards (83.7%) and start high group with rapid decline by 6 months then rapid increase after 6 months (16.3%). Only lower rank was associated with start high group.

Conclusion: Data showed that there are two distinct trajectories of PPCS for those with mTBI that were only associated with lower military rank. Methods that account for heterogeneity in individual responses are essential to better understand and facilitate future research on symptom recovery over time.
Can Therapeutic Hypothermia Diminish the Impact of Traumatic Brain Injury and Prevent Chronic Traumatic Encephalopathy?

Shan Lateef1, Jennifer James1, Aubrie Holman1, Jessica Carpenter2

1Thomas Jefferson High School for Science and Techn, Alexandria, United States, 2Childrens National Health System and George Washington University School of Medicine, Washington, United States

Background/Main Objectives: No effective strategy exists to treat the well-recognized, devastating impact of Traumatic Brain Injury (TBI) and Chronic Traumatic Encephalopathy (CTE) which is the brain degeneration likely caused by repeated head trauma. The goals of this project were: 1) To study the effects of single and recurrent TBI (rTBI) on Drosophila melanogaster’s: a) Life span b) Response to sedatives and c) Behavioral responses to light and gravity; 2) To determine whether therapeutic hypothermia or the intentional lowering of body temperature can mitigate the deleterious effects of TBI.

Methods: Five experimental groups were created: 1) Control; 2) Single TBI or concussion; 3) Concussion+hypothermia; 4) Recurrent TBI; 5) Recurrent TBI + hypothermia. A “high-impact trauma” (HIT) device was built, which used a spring-based mechanism to propel flies against the wall of a vial, causing mechanical damage to the brain. Hypothermia groups were cooled to 150 C for 3 minutes. Group differences were analyzed with chi-square tests for the categorical variables and with ANOVA tests for the continuous variables.

Results: Survival curve analysis showed that recurrent TBI can decrease Drosophila lifespan and hypothermia diminished this impact. Average sedation time for Control vs. Concussion vs. Concussion+hypothermia was 78 vs. 52 vs. 61 seconds (P<.0001). Similarly, rTBI vs. rTBI/hypothermia groups took 43 vs. 59 seconds (P<.0001). Concussed flies preferred dark environments compared with control flies (Risk Ratio 3.3, P<.01) while flies who were concussed and cooled had a Risk Ratio of 2.7 (P<.01). Flies with rTBI were almost 4 times likely to prefer the dark environment but only 3 times as likely if they were cooled, compared to controls. Geotaxis was significantly affected by rTBI only and yet less so if rTBI flies were cooled.

Conclusions: Hypothermia successfully mitigated many deleterious effects of TBI in Drosophila and may represent a promising breakthrough in the treatment of human TBI and may even represent a strategy to prevent progression of TBI to CTE.

Traumatic Brain Injury and Cannabis Use: A Primer for Clinicians

Shree Bhalerao¹, Fallon Ponnambalam¹, David Lee¹, Karl Grenier¹

¹St. Michael's Hospital, Toronto, Canada

Clinical experience at a brain injury clinic suggests that numerous patients with Traumatic Brain Injury are using Cannabis both prior to and after their brain injury. It is quite common for this patient population to inquire about the evidence of using Cannabis post head injury for the neurosensory (pain, headaches), neurocognitive (overwhelmed while multi-tasking) and neuropsychiatric (depression, anxiety, sleep and to avoid opioid addiction) sequelae. Our paper provides the essential background to understanding the background and evidence that is presently available to help clinicians guide the psychoeducation requested by patients with TBI. It is apparent that case reports and the level of evidence for the use of Cannabis amongst TBI patients is sparse and we feel this paper can serve as a stepping stone for future studies that explore the impact of Cannabis after its legalization.
Amantadine as an Awakening Agent

Paul Kaylor¹, Fallon Ponnambalam¹, Shree Bhalerao¹
¹St. Michael's Hospital, Toronto, Canada

A case study of a 35 year old male demonstrates the use of amantadine as a neurostimulator in patients with decreased level of consciousness post brain injury. The patient was initially given other drugs to treat his brain injury with no improvement in his recovery. However, improvement in level of consciousness was noted with the addition of amantadine. The patient continued to improve with higher doses of amantadine. Amantadine is a known dopamine agonist and NMDA antagonist, but the mechanism of action in recovery from decreased consciousness is not yet evident. Literature review also supports our case study, in that amantadine can be used as a neurostimulatory agent in patients with low level of consciousness.
Repetitive Transcranial Magnetic Stimulation for Cerebellar Ataxia: Case Reports

Vivek Sharma

Purpose: Repetitive transcranial magnetic stimulation (rTMS) is a non-invasive technique to stimulate the cortical areas of the brain. The cerebellum has been considered as a potential stimulation site for rTMS for enhancing recovery from ataxia. We present findings of two ataxic clients following the rTMS intervention.

Methods: The rTMS parameters used for each client were 1-Hz frequency at 100% resting motor potential with 30 trains of 30 pulses each and with 5 sec interval between each train, applied for 5 days. The coil was on the ipsilesional cerebellar hemisphere. Both the clients were assessed on the 9-hole peg test and Scale for the Assessment and Rating of Ataxia (SARA).

Results: In our study, both the clients showed some improvement on 9-hole peg test and SARA. No statistical test was used owing to small sample size.

Conclusion: rTMS can be used as an adjunct in the management of ataxia. There is a need for larger randomized controlled trials to further explore the effects of cerebellar rTMS.

Key Words: rTMS, cerebellar stimulation, ataxia
The Effects of Early, Mild Traumatic Brain Injury on Theory of Mind 30 Months Post-Injury

Dominique Dupont, Frédérick Morasse, Jenny Bellerose, Annie Bernier, Jocelyn Gravel, Miriam Beauchamp

1Université of Montréal, Montreal, Canada, 2Centre Hospitalier Universitaire Sainte-Justine, Montreal, Canada

Objective: The prevalence of mild traumatic brain injury (mTBI) in preschoolers (0-5 years) is high and its effects are understudied. Childhood is an important time for brain and functional development and acquiring a brain insult during this period could be detrimental. Studies conducted to date indicate that early TBI may have adverse cognitive, behavioral and social consequences. One study by our group found that preschool children with mTBI had poorer performance on theory of mind (ToM) tasks 6-months post-injury compared to children with orthopedic injuries (OI) and to typically developing children (TDC), suggesting a brain-injury-specific effect. These differences were found to persist up to 18 months post-injury and to correlate with social competence. The objectives of the current analyses were to establish if differences in ToM persist at 30 months post-injury and if reduced ToM is associated with changes in global social competence.

Methods: Children with mTBI and OI between 18 and 60 months of age were recruited at the emergency department of a tertiary care pediatric hospital and were followed-up at 6-, 18- and 30-months post-injury. 64 children (mean (M) age= 69.6, SD= 11.2 months, 26 boys) with mTBI participated in the 30-month follow-up and their performance was compared to 38 children with OI (M age=65.4, SD=11.7 months, 15 boys) and 56 children (M age=68.3, SD=11.7 months, 29 boys) recruited from the community (TDC). At 30 months post-injury they completed a battery of cognitive and social tasks including measures of ToM: False Belief Stories and Content to Self and to Others. Their parents completed the Social subscale of the Adaptive Behavior Assessment System (ABAS Social) as an indicator of social competence.

Results: The mTBI group did not significantly differ from the OI or TDC groups on any of the ToM tasks: False Belief Stories: F(2,146)= 1,05, p=.35, Content to Self: F(2,140)= 2,12, p=.13; Content to Others: F(2,138)= 0,92, p=.40. Hierarchical regression analysis indicated that sex, SES and age significantly contributed to global social competence at 30 months post-injury (F(1,55) =9.94, p=.0001), but the inclusion of ToM abilities did not explain any additional variance in social competence at 30 months post-injury (F change (1,54)= .11, p=.74).

Conclusion: The findings indicate that post-mTBI differences in ToM that were present at 6- and 18-months post-injury resolved at 30 months post-injury. The data suggest that it may take up to 30 months for young children who sustain mTBI to return to typical age-related levels of social cognition, as measured by ToM. Encouragingly, reduced social cognition (ToM) observed in the first year and a half post-injury does not seem to affect social competence in the very long term.
Traumatic Brain Injury and Workers' Compensation Claim

Vincent Quatrini¹, Adam Quatrini¹
¹QuatriniRafferty Law Firm, Greensburg, United States

One of the principal purposes of a state workers' compensation statute is to provide an injured employee with a speedy remedy – replacement of lost wages, and payment of medical expenses and vocational rehabilitation – when an unforeseen mishap befalls the worker. History has demonstrated that the traditional tort system does not provide adequate financial protection to an injured worker. Therefore, a no-fault system of adjudication was created. In exchange for the employee relinquishing the common law right to sue, the employee is entitled to lost wage and medical coverage, irrespective of fault. And, in recognition of the financial burden upon an employee, as well as the employer's immunity from suit, is the notion that this social legislation must be tilted, ever so slightly, in favor of the worker.

This paper lays out this unique setting and provides a big picture and detailed analysis of the proofs necessary for an injured worker to obtain an award for a traumatic brain injury.

Here are some highlights:
• Risk factors for suffering a TBI in the workplace
• Prerequisites of a TBI WC claim
• Assessment of a TBI injury
• Identifying the critical medical disciplines: Neuropsychologist, Neuroradiologist, Neuropathologist, Physiatrist, Vocational Psychologist, Vestibular/Vision/Cognitive Provider
• Utilizing the Medical Experts; Identifying the “captain” of the Medical Ship.
• Assessing the Medical Expert
• The Challenge of proving TBI in the absence of objective sequelae; Utilizing Before and After Videos/Pictures, Testimonials (Family, Co-Worker, Clergy, Employer)
• The Role of Post-concussive Syndrome
• Cross-examination of the Medical Experts (Employer/Employee)
• Cross-examination of the Injured Worker
• Model Interrogatories
• Model Medical Report

Conclusion: The TBI in the workplace presents unique challenges to the workers' compensation practitioner – Plaintiff and Defendant. The litigation toolbox is filled with medical terminology, the medical diagnoses, multiple medical disciplines which are not typical for the vast majority of workplace injuries. The practitioner must possess a heightened emotional sensitivity to properly manage the client and the witnesses as well as a knack for translating complicated medical concepts thru the medical experts so as to present a cogent legal argument to the fact finder.
Examining the Use of an Intensive Physical Exertion Test as a Final Return to Play Measure in Concussed Athletes

Cameron Marshall¹, Nicole Chan², Pauline Tran², Carol DeMatteo²

¹Complete Concussion Management Inc, Oakville, Canada, ²School of Rehabilitation Sciences, Faculty of Health Sciences, McMaster University, Institute of Applied Health Sciences, Hamilton, Canada

Objectives: To examine the utility of the Gapski-Goodman Test (GGT), as a final return to play (RTP) clearance test in youth and young adult athletes, and to determine the relationship between participant and test variables on RTP within asymptomatic athletes diagnosed with concussion.

Study Design: Prospective cohort

Subjects: 759 athletes (450 male, 309 female), ages 13 to 25 with a recent concussion who had symptomatically recovered, completed all return to school protocols, had completed preliminary physical exertion testing, all return to play steps, and were attempting to be cleared for a full return to sport.

Intervention: As part of usual patient care, concussed athletes underwent the GGT, at partnered Complete Concussion Management Inc. (CCMI) clinics once asymptomatic as part of RTP decision making. The GGT is an intensive physical exertion test designed to mimic the demands of a sporting environment and challenge the cardiovascular, vestibular, visual, and proprioceptive systems with the purpose of identifying lingering concussion-related issues.

Outcome Measures: Main outcome was pass or fail of the GGT based upon self-reported symptom provocation during or closely after completion of the test. Prospective data was collected electronically by trained CCMI clinicians utilizing the Complete Concussion Management database. A de-identified chart review was conducted to examine data collected between January 2016 and February 2017. Participant and test variables were analyzed to determine relationships with pass/fail rate of the GGT.

Results: Although all asymptomatic, 14.6% of concussed athletes failed the GGT while attempting to achieve RTP clearance. Statistically significant relationships were found between failure of the GGT and symptom severity score on initial presentation, and self-reported history of pre-morbid anxiety. When taken together, sex, age, and pre-morbid anxiety significantly predicted length of time between injury and RTP clearance.

Conclusion: The GGT may identify individuals who are not ready to RTP, despite a self-reported asymptomatic status. These results illustrate that RTP clearance decisions based on self-reported asymptomatic status at rest are inadequate. Instead, monitored, intensive, sport-specific, physical exertion testing should be utilized to inform clinical RTP decisions.
IMPACT - Intervention for Metacognition and Social Participation: An Acquired Cognitive-communication Disorder Treatment. Treatment Development and Preliminary Findings

Anna Copley1, Emma Finch1,2, Jenny Fleming1, Petrea Cornwell3
1The University of Queensland, St Lucia, Australia, 2Centre for Functioning and Health Research Metro South Health, Brisbane, Australia, 3Griffith University, Brisbane, Australia

Objectives: Cognitive-communication disorders (CCDs) can have devastating lifelong impacts on individuals with acquired brain injury. Because of the interplay between cognition and communication, metacognitive approaches incorporating functional tasks have been recommended as the most appropriate treatments for this population. Yet few studies have been completed investigating the use of metacognition as a treatment for CCDs. In consideration of the important role of metacognition in cognitive-communication disorders, the authors of this paper developed an intervention called IMPACT (Intervention for Metacognition and Social Participation: An Acquired Cognitive-communication Disorder Treatment).

Method: To ensure a systematic approach to intervention development and implementation, the guidelines outlined by the Medical Research Council framework for the development of complex interventions (Craig et al., 2013) were followed throughout the first two phases of development and feasibility testing. During the development phase, literature describing the management of cognitive-communication disorders was reviewed and informed publication of a systematic review of social communication interventions in ABI (see Finch, Copley, Cornwell, Kelly, 2015). In addition, theories of change that may underpin the success of the intervention including adult learning theory (Knowles, Holton, Swanson, 2011), self-efficacy theory (Bandura, 1997) and theories of behaviour change (Prochaska & Clemente, 1982) were considered in developing the intervention methods and procedures.

Results: The intervention was then tested for feasibility in two small pilot studies (n=8 per pilot study) which indicated that it may be efficacious in improving receptive language and pragmatic language skills for individuals with CCDs (Copley, Smith, Savill, & Finch, 2016; Finch, Cornwall, Copley, Doig, & Fleming, 2017). Findings from these studies resulted in some changes to the intervention to make it more easily implemented into clinical practice and appropriate for SLPs and clients (for example updated training materials, adapted session frequency). Currently, IMPACT is a 6-week intervention that is preceded by a pre-assessment session and a goal setting session. Each intervention week includes 1 face-to-face individual session and 1 group session.

Conclusions: The aim of IMPACT is to explicitly train goal setting, self-regulation, and task analysis for functional communication activities. Findings from the feasibility testing suggesting that IMPACT successfully meets these aims. However, further larger scale research evaluating the effectiveness of IMPACT for individuals with CCDs is required.
Monitoring Goal Attainment with HRV in Therapeutic and Pharmacological Interventions in PSH Patients

Soren Sondergaard1, Helene Honoré2, Kathrine Eggertsen1

1Department of Intensive Care and Neurointensive Stepdown Unit, Elective Surgery Centre, Silkeborg Regional Hospital, Silkeborg, Denmark, 2Hammel Neurorehabilitation Centre and University Research Clinic, Hammel, Denmark

Background: Paroxystic Sympathetic Hyperactivity (PSH) is a calamitous companion to severe acquired brain injury (ABI). The syndrome presents a challenge diagnostically as well as therapeutically while adding to the physiological burden and subjective suffering of ABI. A method for real time monitoring of severity and effects of remediating interventions may be of value.

Aim: To investigate whether heart rate variability (HRV) spectral parameters mirror the effects of therapeutic and pharmacological interventions in a consecutive cohort of ABI patients developing PSH admitted to a neurointensive stepdown unit.

Methods: Patients were included if they presented with sinus rhythm and scored >8 in the Baguley PSH Clinical Feature Scale (CFS) and Diagnostic Likelihood Tool (DLT)[1]. ECG was recorded at 300 Hz for 30 minutes in two therapeutic scenarios: before/after (B/A) occupational or physiotherapeutical and before/after pharmacologic interventions. Therapeutic interventions were scored in the goal attainment scale (GAS)[2]. ECGs of eight patients were analysed off-line in Kubios Premium ver. 3.0.0 in their spectral characteristics low, high frequency (LF, HF) and the ratio LF/HF during a minimum of five minutes. LF conventionally represents a mixture of sympathetic and parasympathetic activity (SNS, PNS), HF represents predominantly PNS activity. The ratio LF/HF is considered to typify sympathovagal balance or to reflect SNS modulations [3].

Results: Therapeutic interventions (e.g. mobilisation, topological changes, sensory stimulation and guided activities) significantly changed the relative distribution of LF and HF in the direction of HF predominance. The diminished SNS activity was demonstrated in a significantly lowered LF/HF post intervention. The GAS scoring showed a tendency of lowered LF and increased HF the higher the GAS score: the better the goal of intervention was attained, the greater the influence on SNS and PNS. Pharmacologic interventions (e.g. intrathecal administration of baclofen, intravenous injection of dextomethidine, propranolol, opioid) showed significant increase in HF and decrease in LF/HF.

Perspective: In this pragmatic study of a small cohort we were able to demonstrate an effect of occupational/physiotherapeutical and pharmacologic therapies on the composition of frequency aspects of HRV to the effect that sympathetic influence diminished and parasympathetic increased. This invites to the development of a real time monitoring of therapeutic interventions to further characterise choice and content and monitor the enriched environment, specifically the social interaction with next-of-kin, in ABI patients with PSH.

Driving Concussion Education into Action: The Role of Infographics as a Knowledge Translation Strategy

Christine Provvidenza1,3, Laura Hartman1,3, Jason Carmichael1, Nick Reed1,2,3

1Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, 2Department of Occupational Science and Occupational Therapy, University of Toronto, Toronto, Canada, 3Bloorview Research Institute, Toronto, Canada

Background and Objective: There is a knowledge gap regarding how to best educate youth on concussion, and what strategies are considered to be effective in distilling and sharing concussion knowledge. Knowledge translation (KT) plays a critical role in how information is organized and shared. The objective of this study was to assess the impact of infographics created by a pediatric concussion centre on enhancing concussion knowledge and their value as a concussion KT strategy.

Methods and Analyses: Six infographics were created to provide information about concussion that is easily accessed and understood by youth and families. A prospective, post-test study design using a self-developed survey was conducted to gather information about the value and utility of the infographics and to determine additional concussion knowledge needs. Frequency distributions were calculated for the closed ended questions to assess infographic use and knowledge acquisition. An inductive content analysis was conducted of the open-ended questions to provide insight on participant feedback regarding the infographics. Data was collected from 166 participants, of which 47% were youth and 53% were adults, representing athletes, students, teachers, healthcare trainees and healthcare professionals.

Results: Ninety-one percent of participants identified that the infographics met their knowledge needs, and 87% of participants indicated that the infographics provided them with new knowledge. Participants indicated that they intend to use the infographics to build their knowledge (91%) and educate others (52%) about concussion. In terms of the structure and format of the infographics, participants identified that the content was well organized and that there was a good balance between information and graphics. Opportunities for enhancement included incorporating graphics to appeal to different target audiences and creating infographics that share the lived experiences of individuals who have a concussion.

Conclusion: Infographics are a valuable KT strategy that meet the knowledge needs of and appeal to many audiences. Study results indicate that infographics are a useful strategy for sharing and building knowledge. Furthermore, individuals intend to use these infographics to minimize knowledge gaps, educate others about concussion, help others cope with concussion and inform concussion clinical care. Concussion recovery and management and return to school and play were other content areas that participants felt could be shared through infographics. Outcomes of this study highlight the importance of knowing the target audience and their knowledge needs to create effective and meaningful concussion education initiatives and knowledge translation strategies.
Mild Traumatic Brain Injury and Emerging Psychopathology in Adolescence: Evidence from the Project on Human Development in Chicago Neighborhoods

Brandon McCormick, Eric Connolly, David Nelson

1Sam Houston State University, Huntsville, United States

Purpose: Emerging scientific evidence and media accounts document an association between early-life mild traumatic brain injury (mTBI) and deleterious mental health outcomes. While findings from this growing body of literature report strong associations between mTBI and a range of adverse developmental outcomes, the extent to which mTBI is associated with subsequent increases in risk for these outcomes during adolescence remains unknown. A notable impediment to addressing this question is selection bias, as some adolescents may be more likely to develop symptoms of internalizing and externalizing psychopathology regardless of whether they have experienced an mTBI. For example, adolescents with aggressive tendencies who engage in high levels of delinquent behavior may seek out unsafe environments that increase their risk of experiencing an mTBI, thus confounding the direct relationship between mTBI on the emergence of future externalizing problems. There is also reason to suspect that internalizing problems, such as anxiety or depression, increase the likelihood that youth experiment with hard drug use to cope with symptoms, which in turn increases the risk for falls or motor vehicle accidents. To date, the bulk of the literature has failed to control for prior symptoms or other potentially important risk factors. This study attempts to rectify this state of affairs in an exploration of the relation between mTBI and psychopathology in a sample of adolescent youth.

Methods: Longitudinal data regarding adolescent youth aged 10-18 (n = 1,824) from the Project on Human Development in Chicago Neighborhoods were analyzed. Primary outcome measures were comprised of parent reports of their adolescents’ behavior on the multidimensional Achenbach Child Behavior Checklist/4-18.

Results: Multivariate longitudinal Poisson regression analyses found that adolescents with a history of mTBI at Time 1 were significantly more likely to have parent reports of symptoms of aggressive behavior, anxiety/depression, attention problems, somatic symptoms, and delinquency at Time 2, while controlling for levels of parent-child conflict, victimization, verbal IQ, neighborhood SES, age, sex, and race, as well as prior levels of psychopathology.

Conclusions: Mild traumatic brain injury appears to be an important, distinct, environmental risk factor for psychopathology during adolescence. Health professionals should consider screening children for mTBI to better address the influence of this type of risk factor on the emergence of symptoms for internalizing and externalizing problems during adolescence.
Adaptation and Implementation of a Decision Support Tool for Patient Prioritization Following Mild Traumatic Brain Injury: A Study Protocol

Julien Dery¹,², Elaine de Guise³,⁴, Marie-Eve Lamontagne¹,²

¹Université Laval, Québec, Canada, ²Centre interdisciplinaire de recherche en réadaptation et intégration sociale (CIRRIS), Québec, Canada, ³Université de Montréal, Montréal, Canada, ⁴Centre de recherche interdisciplinaire en réadaptation du Montréal métropolitain (CRIRM), Montréal, Canada

Mild traumatic brain injuries (mTBI) represent 70% to 90% of all TBI cases and their incidence has more than doubled in the past few years. Patients who suffered a mTBI can experience persistent symptoms for a few weeks up to over a year post-injury, which could result in functional disabilities. In Quebec, three months post-injury, patients at risk of chronic symptoms are referred to rehabilitation centers so they can receive specialized services by a multidisciplinary team. However, long waiting lists are common and often make timely access to rehabilitation services impossible. Waiting lists management and patient prioritization are not standardized practice and are often based on opinion of one person. Optimizing waiting list management for rehabilitation services is crucial for mTBI patients and an adapted decision support tool (DST) for patient prioritization could be an interesting solution to help waiting lists management for those patients. The aim of this project is to implement a prioritization DST for mTBI patients in three Quebec trauma rehabilitation programs. To achieve this goal, a survey of stakeholders (patients, clinicians, decision-makers and researchers) will be conducted using the Delphi method until a consensual list of prioritization criteria is obtained. These criteria will be included in the DST-mTBI to facilitate and standardize the assessment of patients’ needs. Based on this evaluation, patients will be assigned to a dynamic list according to the consensus-based criteria. The DST-mTBI will then be implemented in three rehabilitation settings in the province of Quebec. Changes induced by this DST-mTBI will be measured on patients (TBI symptoms, anxiety, depression, satisfaction with services) and clinicians (attitudes and sense of clinical utility) using a pre/post design. This project proposes a significant paradigm shift in waiting list management from a time-focused approach to a standardized approach based on potential impacts on individuals.
Developing an Early Intervention for Cognitive-Communication Reading Comprehension Deficits After ABI: Preliminary Results

Kerrin Watter¹,²,³, Anna Copley¹, Emma Finch¹,²,⁴
¹School of Health and Rehabilitation, University of Queensland, Brisbane, Australia, ²Speech Pathology Department, Princess Alexandra Hospital, Metro South Health, Brisbane, Australia, ³ABI Transitional Rehabilitation Service, Division of Rehabilitation, Princess Alexandra Hospital, Metro South Health, Brisbane, Australia, ⁴Centre for Functioning and Health Research, Princess Alexandra Hospital, Metro South Health, Brisbane, Australia

Introduction: Cognitive-communication reading comprehension (CCRC) deficits occur in adults with acquired and traumatic brain injury (ABI and TBI) and impact comprehension of discourse-level text. These deficits can impact a person’s participation in rehabilitation, independence on hospital discharge and return to premorbid roles. Early rehabilitation of CCRC deficits may influence these factors and enhance the rehabilitation potential for people with ABI or TBI.

Method: An emergent multi-phase mixed-methods study was used to investigate and design an evidence-based contextual intervention for the early rehabilitation of CCRC deficits post brain injury. This involved investigating and identifying: the evidence base, including completing a systematic review; clinical practice for CCRC management in early rehabilitation; contextual and service delivery factors in subacute speech pathology rehabilitation; and consumer and client factors for early rehabilitation.

The intervention was investigated via an experimental single-case-study (multiple-baseline) design for 3 participants (P) with brain injury in early rehabilitation, i.e., <3 months post injury (ABI: P1; TBI: P2, P3).

Results: A multiple-strategy intervention was developed, involving cognitive (content), visual and metacognitive strategies; which were delivered within a hierarchical mastery-based treatment in early rehabilitation. Positive changes in reading comprehension pre-post intervention were found for all participants on the Gray Oral Reading Test; reading comprehension age was maintained at follow-up for two participants (P1, P2). Examination of multiple-baseline data showed a treatment effect during treatment for two participants (P1, P3). Additional cognitive-communication assessment results regarding clients’ perceived communicative ability pre-post intervention (via the Latrobe Communication Questionnaire) will also be presented.

Conclusions: The CCRC intervention shows promise as an early intervention for reading comprehension for adults with brain injury, and further evaluation with larger participant numbers is required.
Examining the Role of Menstrual Irregularity on Physical and Emotional Functioning in the Moderate-Severe Traumatic Brain Injury Population

Ondrea McKay

1Rutgers-NJMS/Kessler Institute for Rehabilitation, Newark, United States

Introduction: Hormonal imbalance and the resultant menstrual irregularity it can cause still remain relatively understudied in the brain injury population. Although the mechanism is not always understood it is known that fluctuations in reproductive hormones may interactively affect neuroendocrine, neurotransmitter and circadian systems. Menstrual irregularity could have many cognitive and physical side effects that impede recovery, although it is a treatable condition. Once identified it may help physicians provide better care and possibly improve outcomes. The goal of this exploratory pilot project is to examine menstrual irregularity in the moderate to severe traumatic brain injury population.

Methods: The research project followed an exploratory pilot project design due to the paucity of research on the topic. The study was conducted using telephone based or in person interview, each interview took approximately 45 minutes to complete. The interview questions were compiled from the CDC reproductive health questionnaire as well as previous similar research studies then reviewed with a reproductive health specialist. Preliminary results were analyzed using descriptive statistics.

Results: N=8 , but actively enrolling
•General trend did show that more severe had greater change in menstrual cycle (average change in cycle length by 3 days) and functionally had lowest FIM scores.
•1 patient with severe brain injury started birth control pills within 2 months of her injury to regulate her cycle and endorsed little change post injury with the use of OCPs.
•1 patient did not experience amenorrhea post injury after having had a hormonal IUD placed two weeks prior to injury, she did endorse change in cycle length(shorter) which is likely attributed to IUD. Performed best on functional measures.
•1 patient still has not received her menstrual cycle 10 months after injury.
•3 patients endorsed significant anxiety and fear regarding reproductive health, childbearing ability and child care abilities.

Conclusion: The participants in our study that were using hormonal contraceptive methods at or near injury, overall performed better across all measures. Further research is needed to determine the impact hormonal dysregulation and hormonal contraception methods may have on recovery. One important finding with this study is that it brought awareness to the amount of emotional stress that menstrual irregularity caused for these women and the lack of physician counseling on the matter. Reproductive health is often overlooked in the treatment of female brain injured patients although it could be a significant source of emotional distress during the recovery process. Identifying issues in reproductive health could help physicians provide better care and possibly impact patient outcomes.
Strategies for Living with TBI - Simple not Easy

Nancy Bauser

Trauma Recovery Expert, LLC, Bloomfield Hills, United States

Have you ever thought about how you would feel if you woke up one day and could not remember why you were wherever you were? I’m not talking about waking up after abusing a substance or forgetting where you slept. Those of us who are brain injured all get betrayed by our memories. Today, I’m speaking of a state of being that is far more frightening.

Suddenly, you find that you are unable to do what you remember you could do. Your life terrifies you, you trust no one and you can’t recall needing the assistance that you now require.

How do you continue? What do you have to do differently now and in the future? Is doing all that you can worth the struggle? Why should you listen to me? What’s in it for you?

You might consider what I have to say because I’ve been, where many of the people who seek your help are. Almost 48 years ago, when I was in undergraduate school at the University of Michigan, I was a passenger in a small sports car that crashed into a large vehicle and I sustained a severe closed head injury. For nearly five decades, I’ve worked at recovering. From being a patient on life-support, in the neurosurgery intensive care unit at University Hospital in Ann Arbor, to the Rehabilitation Institute in Detroit Michigan, I have continued to crawl out from some horrendous circumstances, one step at a time.

Immediately after my trauma, I had to relearn how to walk, talk, think and take care of my most basic needs. If I considered the magnitude of what I had to accomplish, I would have given up. But I didn’t think that way. I chose to concentrate on things that I could accomplish immediately. I built one success upon another. To this day, I have continued to gently push myself forward.

Upon returning to college, I began to learn how to reintegrate into the mainstream. Because I wasn’t aware of what rehabilitation professionals might say I couldn’t do, I did.

After an injury, an illness or an addiction, life becomes an uphill battle in all situations. Whether it’s dealing with doctors, drug companies, medical professionals or any other support staff, living as a self-sufficient person is simply no longer possible. Adjustments, accommodations and modifications must be made to be certain that a quality life will be realized.

Absolute independence is no longer possible and total dependence on anything is undesirable. A mixture of both, self-sufficiency or getting assistance when it is needed, becomes the new normal. When brain injury is the disease, learning how to live is the cure.
Decreased Evoked Slow-Activity After tDCS in Patients with Severe Brain Injuries and Altered State of Consciousness

Armand Mensen¹, Aurore Thibaut¹,², Olivier Bodart¹,², Sarah Wannez¹, Steven Laureys¹,², Olivia Gosseries¹,²
¹GIGA-Consciousness, GIGA Research, University of Liege, Liege, Belgium, ²Coma Science Group, Neurology Department, University Hospital of Liege, Liege, Belgium

Background: Due to life-saving medical advances, the diagnosis and treatment of disorders of consciousness (DOC) has become a common clinical issue. One recently developed intervention option has been noninvasive transcranial direct current stimulation.

Objective: Here we investigate the mechanism behind the tDCS intervention using a combination of transcranial magnetic stimulation and electroencephalography (TMS-EEG).

Methods: We examined the neural response both before and after tDCS was applied to the dorsolateral prefrontal cortex in 7 DOC patients. Analysis focused on two key measures of bistability in the TMS-EEG response: slow wave activity, and high-frequency suppression.

Results: We found that the overall evoked slow activity was reduced following tDCS intervention. We also found a positive correlation between the strength of the slow activity and the amount of high-frequency suppression. However, there was no significant pre-post tDCS difference in high-frequencies. In the resting state EEG, we observed that both the incidence of slow waves and the positive slope of the wave were affected by tDCS. None of the seven patients showed a relevant behavioural change after tDCS.

Conclusions: These results suggest that the tDCS intervention can reduce the slow wave activity component of bistability but this may not directly affect high-frequency activity. We hypothesise that while reduced slow activity may be necessary for recovery of neural function, especially consciousness, this alone is insufficient.
Gender Specific Relationship Between Cortisol Stress Reduction, Hormonal Fluctuations and PCS symptoms in Post-concussion Patients

Kelly Armstrong¹
¹The Center for Pain and Stress Research, Jacksonville, United States

Literature now supports that concussions and head traumas activate sympathetic stress levels.

The sympathetic system is designed for short term survival; however, it is “upregulation” or persistent tone in this system, commonly called stress, that is believed to be related to PCS symptomology and decreased neuroplasticity. [4-6]

It is now theorized the current management of Post-concussion syndrome has produced unsatisfactory patient outcomes in neuro-rehabilitation due to the inability to reduce these sympathetic stress levels.

Emerging evidence also supports passively applied tCDS (trans-cranial Direct Current Stimulation) as modulating stress imbalances to reduce PCS symptomology.

This lecture will report the gender specific scientific influence of actively applied tCDS (tCMPS) has on cortisol stress levels, HPA-endocrine, PCS symptomology, and cognitive functioning when applied to a n=35 sample Post-Concussion Syndrome (PCS) patients.

Session Summary: Science equals truth. There is no evidenced based science documenting endocrine and cognitive changes that occur in post-concussion patients after sympathetic stress reduction.

This lecture will introduce the concepts of gender specific stress and HPA-endocrine and explore the cognitive changes post stress reduction in n=35 severely concussed patients.
Improving Well-Being after Traumatic Brain Injury through Volunteering: A Randomized Controlled Trial

Clare Morey¹, Lisa Payne¹, Lenore Hawley¹, Jessica Ketchum¹, Angie Philippus¹, Cynthia Harrison-Felix¹, Ed Diener²

¹Craig Hospital, Englewood, United States, ²Psychology Department, University of Utah, Salt Lake City, United States

Objective: To evaluate the efficacy of a novel intervention facilitating altruistic volunteer activity to improve well-being in individuals with traumatic brain injury (TBI).

Design: Randomized two-arm controlled trial, with a wait-list control condition.

Setting: Community based setting.

Participants: 74 community-dwelling individuals at least one-year post TBI, who had completed inpatient or outpatient TBI rehabilitation.

Interventions: A novel intervention, HOPE – Helping Others through Purpose and Engagement, involving orientation/training and a 3-month volunteer placement for the participant, along with training for community agencies regarding TBI.

Main Outcome Measure(s): The Satisfaction With Life Scale (SWLS), the Flourishing Scale (FS), the Brief Symptom Inventory-18 (BSI-18); Scale of Positive and Negative Experience (SPANE); Purpose in Life subscale (is one of six in the Ryff Scale of Psychological Well-Being - 54 item version).

Results: There were significantly greater improvements in life satisfaction (SWLS) and self-perceived success (FS) in the intervention group compared to the control group. Treatment effects on the additional secondary measures of well-being were not significant, although they trended in a positive direction. This study provides evidence that volunteering leads to improvements in well-being after TBI. The authors recommend assisting and facilitating volunteer placement for individuals living with TBI in the community, to improve psychological well-being.
A Biphasic Material Characterization of Brain at High Strain Rates

Mariusz Ziejewski, Mohammed Hosseini, Ghodrat Karami

North Dakota State University, Fargo, United States

A rigorous mechanical characterization of brain tissue is crucial for biomechanical studies of traumatic brain injury (TBI). Recent experimental studies have postulated that strain rate is one of the most influential biomechanical parameters to be measured in TBI diagnosis. In this paper a poro-hyper viscoelastic constitutive model will be introduced to demystify more phenomenological behaviors of this tissue that could not otherwise be perceived with established, single-phasic approaches. In this regard, brain tissue was defined as a biphasic material consisting of a compressible solid matrix and fully saturated with an incompressible interstitial fluid. The model was calibrated for the experimental results of bovine brain tissue and tested under high rates (10, 100, 1000 mm/sec). A finite element computational scheme used to model the brain with extracted material parameters showed a relatively good prediction of tissue response under other loading rates. The detailed mechanical responses for solid and fluid phases, and their contributions to general behavior of this biological tissue, were successfully provided by this phenomenological, two-phasic model. These identified poro-hyper viscoelastic parameters were found to be sufficient for biomechanical analysis of brain injury mechanism and predict the behavior of each phase under high kinematical motions.
Utilizing a Token Economy to Increase Physical Activity in An Individual with An Acquired Brain Injury

John Davis¹, Danielle Hawthorne²

¹Mohawk College, Hamilton, Canada, ²Hamilton Health Sciences, Hamilton, Canada

The treatment program involved the utilization of a token economy to increase the physical activity in an individual with an acquired brain injury in an in-patient unit. Physical activity was measured through the use of a recumbent cross training machine. Tokens were earned through the step rate calculated on the cross-training machine. Tokens were redeemed for excursions to local historic sites. A changing criterion design was implemented to systematically increase the step goal. The client successfully reached each step goal. As well as engaging in the token economy, the individual was also receiving cognitive behaviour therapy and acceptance and commitment therapy. After the cessation of the token economy, the individual expressed interest in engaging in other forms of physical activity as well as feeling ready to return home and engage in meaningful occupations with her family.
Which Facial Movements are Pain indicators of patients with Traumatic Brain Injury?

Roghieh Nazari, Hamid SharifNia, Saeed Pahlevan Sharif, Kelly Allen, Ameneh Yaghoobzadeh

Amol Faculty of Nursing and Midwifery, Mazandaran University of Medical Sciences, Sari, Iran, Taylor’s Business School, Taylor’s University Malaysia, Subang Jaya, Malaysia, The Melbourne Graduate School of Education, The University of Melbourne, Melbourne, Australia, Department of geriatric nursing, Tehran University of Medical Sciences, Tehran, Iran

Background and Aim: Although self-reporting of pain considered as the gold standard in evaluation of this sign, many of Traumatic Brain Injury (TBI) patients with variable levels of consciousness are not able to express their pain verbally. This point is an important and basic problem for caregivers and researchers. Therefore, this study was conducted to evaluate the behavioral pain indicators in patients with different levels of consciousness due to TBI.

Method: Thirty-five TBI patients with different consciousness level were selected by convenience sampling method in 2016. Data were collected through observation of patient's behavior in two painful and non-painful situations. The results of the observation were recorded in a checklist containing 16 facial pain-related behaviors. It was completed through direct observation by the researcher focusing on the patient's face and examining the films recorded from the patient at various directions.

Results: The findings showed that facial expression changes observed more than other behaviors during the painful procedure. These facial expression changes were levator contraction (65.7%), frowning (31.4%), and sudden eye opening (34.3%), and lip changes (31.4%).

Conclusion: The findings of this study indicate that pain behaviors in TBI patients with different levels of consciousness are untypical. Also, changing in facial expressions can be helpful in the pain assessment in these patients. Therefore, it is suggested that specific behavioral tools should be designed and tested to evaluate the pain of TBI patients.
Associations of Traumatic Brain Injury, Depression and Childhood Adverse Experience in Disadvantaged Canadians

Daniel Zhang¹, Hajer Nakua¹, Stanley Zhang¹, Rowan Jing², Michael Cusimano¹³
¹Division of Neurosurgery, St. Michael's Hospital, Toronto, Canada, ²Canadian Institute for Health Information, Toronto, Canada, ³Faculty of Medicine and the Dalla Lana School of Public Health, Toronto, Canada

Introduction: Homelessness is an international problem and Canada is not immune to it as there are approximately 200,000 individuals experience one or more episodes of homelessness in a given year. This vulnerable population and adolescents in foster care are disadvantaged people who are prone to traumatic brain injury (TBI). However, little is known about the associations between TBI, depression, and childhood adverse experience in these disadvantaged individuals.

Objective: The objective of the study was to determine the associations between TBI, depression, and childhood adverse experience in a cohort of disadvantaged Canadians.

Methods: The Adverse Childhood Experiences (ACE) and the Center for Epidemiological Studies – Depression (CESD) questionnaires were administered in 51 homeless adults and 63 foster adolescents who self-reported to have a history of TBI (n=74) or no TBI (n=26). In addition, 57 controls (30 adults and 27 adolescents) were included in the study.

Results: ANOVA analysis showed that the ACE scores of the disadvantaged group were significantly higher than those of the controls: verbal abuse (p<0.001), physical abuse (p<0.001), sexual abuse (p=0.003), neglect (p<0.001). X2 analysis showed that a significantly higher proportion of the disadvantaged individuals answered yes to each of the ACE question and there was no significant difference between males and females in verbal (p=0.5) or physical abuse (p=0.2), but female disadvantaged people had significantly higher proportion than their male counterparts to suffer sexual abuse (p=0.003). Further, the disadvantaged group had significantly higher CESD scores (mean =26.3 for adult, mean=22.9 for adolescent) than controls (mean=13.9 for adult, mean=14.1 for adolescent, p<0.01). They also had a significantly higher proportion (60.7% for adult, 62.5% for adolescent) of suffering a major depression (CESD score >=21) than controls (10% for adult, 11.5% for adolescent).

Within the disadvantaged group, those with a history of TBI had significantly higher ACE scores than those without (p<0.01). Additionally, TBI was associated with sexual abuse (X2=4.76, p=0.03) and mental illness in the family (X2=9.07, p=0.003). For the disadvantaged adolescents, TBI was also associated with criminal offense in the family (X2=4.21, p=0.04).

Conclusions: The disadvantaged Canadians have higher risks to have experienced depression and adverse events in their childhood. Such childhood adverse experiences are associated with a positive history of TBI. The findings will further our understanding of the risks associated with this vulnerable population.
Estimated Life Time Savings from Specialist Rehabilitation Following Hypoxic Brain Injury: A Large Multi-Centre Cohort Analysis From the UK

Lynne Turner-Stokes1,2, Alan Bill2, Heather Williams2, Keith Sephton2
1Department of Palliative Care, Policy and Rehabilitation, King’s College London, London, United Kingdom, 2UK Rehabilitation Outcomes Collaborative, Northwick Park Hospital, Harrow, United Kingdom

Objectives: To evaluate the cost-efficiency of specialist in-patient neurorehabilitation following hypoxic brain injury (BI), through estimated life-time savings in ongoing care-costs.

Methods: The UK Rehabilitation Outcomes Collaborative (UKROC) national clinical database collates episode data for all specialist in-patient rehabilitation services in England. Recorded on admission and discharge, the Northwick Park Dependency Scale and Care Needs Assessment (NPDS/NPCNA) estimates the savings in ongoing care-costs in the community. The Functional Independence Measure (FIM) is recorded within the UK Functional Assessment Measure.

In the absence of specific mortality data for hypoxic BI, life expectancy adjusted for brain injury was calculated using US mortality figures for traumatic BI computed in five functional groups defined by FIM scores at discharge: ‘Persistent vegetative state’, ‘Walks well alone’, ‘Some walking ability’ and “Unable to walk: self-feeds or fed by others’ (Shavelle 2007, Brooks 2015).

• US figures for percentage reduction life expectancy were applied to national UK projected life expectancy data, to derive the BI-adjusted remaining life expectancy.
• Net life-time savings were then individually calculated as ‘(annual savings in ongoing care costs x BI-adjusted remaining years of life expectancy) minus the rehabilitation episode cost’.

Between 2010-2018, 1094 admissions for rehabilitation in 67 centres had complete NPCNA and FIM data. The remaining life expectancy and mean net lifetime savings in care costs were analysed for the whole sample and grouped by dependency (high, medium and low), based on admission NPDS scores.

Results: For the whole sample, the mean age was 50.5 (±SD 15) years; mean length of stay 106 (±73) days. The mean reduction in care costs was £19746 (95%CI £17204, £22270) per year. The mean remaining life expectancy was 19.5 (18.8, 20.2) years. Estimated net life savings in ongoing care costs (after deduction of the cost of rehabilitation) were £433020 (£366358, £502271) per patient, totaling over £474 million for the analysed population (n=1094).

When broken down by dependency:
• The remaining life expectancy was shortest in the high-dependency group (17.1 (±11.2) years, compared with 25.2 (±13.1) and 26.9 (±11.9) in the medium- and low dependency groups respectively.
• But the mean annual savings in ongoing care costs were greatest in the high-dependency group £22,569 (£19447, £25729), compared with £19096 (£13963, £23614) in the medium- and £3230 (£1918, £7828) in the low-dependency groups.
• Mean net life-time savings were greatest in the medium- and high dependency groups: £529667 (£378839, £670946) and £468886 (385977, 558643) respectively, compared with the £48571 (£91897, £198249) in the low dependency group.
Conclusions: Whilst outcomes from hypoxic BI are generally less favourable than other forms of BI (e.g., trauma/stroke), even severely dependent patients can make functional gains from specialist rehabilitation, leading to substantial savings in ongoing care costs when computed over a life-time.
Comparison of Alternative Scoring Paradigms of Rest-Activity Consolidation to Inform A Biomarker of Circadian Disruption after TBI

Risa Nakase-Richardson1,2, Marc Silva3, Daniel Schwartz1,2, Karel Calero2, Jamie Zeitzer3,4
1James A. Haley Veterans Hospital, Tampa, United States, 2Morsani College of Medicine, Sleep and Pulmonary Division, University of South Florida, Tampa, United States, 3Psychiatry and Behavioral Sciences, Stanford Center for Sleep, Stanford University, Palo Alto, United States, 4Mental Illness, Research, Education, and Clinical Center, VA Palo Alto Health Care System, Palo Alto, United States

Background: Sleep disruption and disorders are prevalent following traumatic brain injury (TBI), which may negatively impact the restorative role sleep plays in facilitating mechanisms of neural repair. Monitoring longitudinal changes in sleep amounts and patterns is typically accomplished through use of actigraphy (wrist-worn accelerometry). We have demonstrated that actigraphy is a valid proxy of the criterion standard of sleep (EEG-based polysomnography) in TBI patients during rehabilitation. Guideline-recommended scoring of actigraphy is not feasible in cognitively-impaired populations who are unable to reliably provide daily sleep logs. Alternatives include examination of actigraphy indices across the 24-hour period that are independent of known in-bed timing. A recent study highlighted that one such index, rest-activity consolidation (RAC), was associated with cognitive status (Rancho Scale) during acute care hospitalization for TBI. No study has examined RAC during inpatient rehabilitation or compared different methods of determining RAC normality. We compared two aggregate measures of RAC abnormality to operationalize an evidence-based biomarker of circadian disruption and inform treatment.

Methods: Consecutive VA TBI Model System participants from a single Polytrauma Center from 2013-2016 (N=70) were examined. Participants were primarily male (92%), middle age (median age=32), with severe injury (median indices: Glasgow Coma Scale/GCS=6, time to follow commands=11 days, Post-Traumatic Amnesia/PTA duration=41 days). All admissions received a minimum of 3 days of actigraphy monitoring (median=56 days post-TBI) and outcomes (PTA duration, Functional Independence Measurement/FIM, Disability Rating Scale/DRS) were recorded. Daily RAC was computed using previously reported metrics (daytime activity/24-hour activity; daytime interval defined as 0600-2200). Two criteria for determining RAC normalcy were compared: mean RAC across three days (Mean Method) and presence of RAC<80% on any of the three days (Fluctuation Method).

Results: Greater than 80% of the cohort showed normal RAC (≥80%) each day; however, the participants moved in and out of the normal/abnormal group across the three days. A greater proportion of the sample was abnormal using the Fluctuation Method (31%) compared to the Mean Method (19%). Across both methods, the abnormal and normal groups were comparable on time elapsed since injury to actigraphy assessment and injury severity indices (emergency department GCS, and time to follow commands). Participants with abnormal RAC using the Fluctuation Method had longer duration of PTA (p=.008) and worse outcomes on rehabilitation admission FIM (cognitive [p=.027], motor [p=.011]) and DRS (p=.037). Participants with abnormal RAC using the mean method only differed on the motor FIM (p=.011).

Conclusions: A greater proportion of the sample had abnormal RAC when examining consistency (>80% activity in daytime hours) across a 72-hour interval and showed worse neurologic recovery when compared to mean RAC scores. Findings inform development of an objective biomarker of circadian disruption during acute neurologic recovery and a precision medicine approach to sleep management in TBI.
Getting My Life Reset: Living with An Acquired Brain Injury: The Irish Experience

Grainne Mcgettrick, Orla Muldoon, Stephen Walsh, Mariah Curtin, Elaine Kinsella

Introduction: The ‘Getting my life reset’ research project aimed to elevate the voice of people with ABI to allow for a greater understanding of the lived experience of acquired brain injury (ABI). Following their ABI, many people cannot return to their pre-injury roles and face a very different life-course.

Method: The research reports on a series of interviews that aimed to capture the impact and experience of brain injury. 15 people with ABI were interviewed using a semi-structured format using a loose structure to explore topics of interest. The data was recorded and analysed.

Findings: Five themes are exposed in the data. These relate to:
1) the role of the families in supporting those affected by ABI, particularly because of their often-reduced social worlds;
2) the difficulties encountered by those affected by ABI in navigating and securing support services;
3) evidence of the particularly complex needs of those affected by brain injury;
4) the role of group activity as a means of social engagement and meaningful doing; and
5) adaptation and resilience of those living with brain injury.

Analysis: The analysis seeks to present an overview of the main issues that arise for those living with ABI. These issues are illuminated and evidenced throughout the report by the first-person quotes. In synthesising the shared experience of participants, this research shines a light on the difficulties experienced by those living with this chronically challenging condition.

Conclusion: The research, and its conclusions and recommendations, contribute to a greater understanding of the conditions among key stakeholders including service providers, policy makers and wider society.
Chronic Electrical Stimulation Promotes the Excitability and Plasticity of ESC-derived Neurons following Glutamate-induced Inhibition In vitro

Latchoumane Charles¹, LaDonya Jackson¹, Mohammad Eslampanah Sendi², Kayvan Tehrani³, Luke Mortensen¹, Steven Stice¹, Maysam Gohvanloo², Lohitash Karumbaiah¹

¹The University of Georgia, Athens, United States, ²Georgia Institute of Technology, Atlanta, United States

Functional electrical stimulation (FES) is rapidly gaining traction as a therapeutic tool for mediating the repair and recovery of the injured central nervous system (CNS). However, the underlying mechanisms and impact of these stimulation paradigms at a molecular, cellular and network level remain largely unknown. In this study, we used embryonic stem cell (ESC)-derived neuron and glial co-cultures to investigate network maturation following acute administration of L-glutamate, which is a known mediator of excitotoxicity following CNS injury. We then modulated network maturation using chronic low frequency stimulation (LFS) and direct current stimulation (DCS) protocols. We demonstrated that L-glutamate impaired the rate of maturation of ESC-derived neurons and glia immediately and over a week following acute treatment. The administration of chronic LFS and DCS protocols individually following L-glutamate infusion significantly promoted the excitability of neurons as well as network synchrony, while the combination of LFS/DCS did not. qRT-PCR analysis revealed that LFS and DCS alone significantly up-regulated the expression of excitability and plasticity-related transcripts encoding N-methyl-D-aspartate (NMDA) receptor subunit (NR2A), brain-derived neurotrophic factor (BDNF) and Ras-related protein (RAB3A). In contrast, the simultaneous administration of LFS/DCS down-regulated BDNF and RAB3A expression. Our results demonstrate that LFS and DCS stimulation can modulate network maturation excitability and synchrony following the acute administration of an inhibitory dose of L-glutamate, and upregulate NR2A, BDNF and RAB3A gene expression. Our study also provides a novel framework for investigating the effects of electrical stimulation on neuronal responses and network formation and repair after traumatic brain injury.
Personalized stimuli in the Assessment of Consciousness Using the Coma Recovery Scale-Revised (CRS-R) in the Motor and Communication Subscales

Carmen Krewer, Inara Makhkamova, Annette Boettcher, Klaus Jahn, Friedemann Müller

Schoen Klinik Bad Aibling, Bad Aibling, Germany; Ludwig-Maximilians-Universität, Munich, Germany

Background: Behavioral assessment with the Coma Recovery Scale-Revised (CRS-R) is regarded as the gold standard for diagnosis of disorders of consciousness (DOC). Some patients diagnosed with the unresponsive wakefulness syndrome (UWS) based on CRS-R assessments, however, were shown to have signs of higher-level consciousness using electrophysiological and neuroimaging methods (Kondziella et al., 2016). This discrepancy could be due to the use of standard non-personalized stimuli in the key items of the scale. The benefits of including personalized stimuli in the CRS-R were shown in two recently published studies, one focusing on the assessment of auditory and visual items in UWS patients (Sternberg et al., 2018), and the other on a motor item in minimally conscious state (MCS) patients (Sun et al., 2018).

Objective: We investigated whether personalized stimuli evoke better responses in DOC patients than standard CRS-R stimuli in the motor (object manipulation) and communication (non-functional: intentional) subscales.

Methods: All DOC patients admitted to a neurorehabilitation hospital (Schoen Clinic Bad Aibling, Germany) between January and August 2018 (N=98) were assessed by experienced assessors every second week for the duration of their stay. Responses to personalized versus non-personalized stimuli were analyzed. Motor function subscale items were assessed by using personally relevant (e.g., pen, hair brush) and standard (tennis ball) objects during the same testing. Non-functional communication was assessed by asking patient-related (e.g., “Is your birthday in winter?”) vs. the standard (e.g., “Am I touching my nose right now?”) questions.

Results: 39 patients scored 4 or 5 (object manipulation possible but still MCS) on the motor subscale with personalized stimuli (mean age 60.3 ± 20.8 years; 20 men; 79 % non-traumatic and 21 % traumatic etiology). 46.2 % of these patients showed consistently a better response in object manipulation with personalized compared to non-personalized stimuli, whereas 38.5 % achieved consistently the same score. A consistent finding means the same response was found in each of the patient’s assessments. 15.3 % showed an inconsistent response. Similarly, 36 patients scored 1 (non-functional: intentional) on the communication subscale (mean age 56.9 ± 19.7 years; 16 men; 83 % non-traumatic and 17 % traumatic etiology). For the communication subscale, 77.8 % of patients obtained consistently a better score with personalized questions compared to non-personalized questions, and 11.1 % showed consistently no difference in performance. Mean number of assessments analyzed per patient was 6.4 ± 6.1 and 4.2 ± 3.9 in the motor and communication subscale, respectively.

Conclusion: Our results show that more responses can be consistently evoked with personalized than standard CRS-R stimuli. This difference was observed more frequently in the communication subscale. As data generated in clinical routine were analyzed in this study, we stress the need for further controlled experimental designs.
Brain Injury and Impact Characteristics

Parisa Department

1Manhattan College, Riverdale, United States

Almost all studies of traumatic brain injuries (TBI) have only focused on the maximum acceleration associated with the impact. However, it has been noted that other impact characteristics should also be considered. This study has examined the effect on brain damage (maximum strain) of changing three characteristics of an isosceles trapezoid acceleration profile: initial slope (jerk), maximum acceleration, and impact energy (maximum velocity squared). This involved using a preexisting finite element model of the brain and applying the trapezoidal acceleration impact to the center of the forehead.

The results showed a strong direct relationship between maximum acceleration and brain damage, and impact energy and brain damage. However, it was found that with respect to jerk there was a value associated with minimum brain damage, which was approximately 2.7% below the maximum value. Larger amounts of damage were therefore associated with the extreme trapezoidal profiles: an isosceles triangular profile and a boxcar acceleration profile. This comports with a shock spectrum analysis of a simple multiple degree of freedom system exposed to different trapezoidal impulses.
Critical Fetal Systemic Air Embolism after CT-Guided Lung Biopsy: Case Report

Kai-Hung Ho¹, Hsing-Lin Lin¹, Yi-Pin Chou¹
¹Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan

Introduction: Systemic air embolism (SAE) is a rare complication which may occur during CT guided lung biopsy. It happens very fast and often causes prompt collapse of the patient. Acute myocardial infarction and brain infarction caused by the SAE can lead to sudden death of patient. There’s no existing guideline or consensus on treating such condition. This case report aimed to share our experience of successfully rescuing a patient from life threatening systemic air embolism during CT guided biopsy of a lung nodule.

Case Presentation: A 70-year-old man who underwent CT guided lung biopsy for a nodule located at Right lower lobe, encountered a cough induced systemic air embolism during biopsy procedure. He progressed into cerebral and myocardial infarction in short time. He was intubated at scene, resuscitated initially and admitted to our ICU for further management. Then, he received hyperbaric oxygen (HBO) treatment after stabilization. We arranged emergent hyperbaric Oxygen (HBO) therapy with set pressure of 3 ATA at around 24 hours after the event. Cardiac enzymes and function returned normal first and near full recovery of neurologic function was observed with the sequela of reduced fine motor control.

Conclusion: HBO therapy is essential to the treatment of SAE and can benefit in air absorption and symptom improvement. There was no consensus in treatment pressure, time and course, further study should be done to setup proper protocol for these patients.
Back to Social Participation – A Group Intervention for TBI Patients

Marjaana Raukola-Lindblom¹, Riitta Vartiainen²

¹University of Turku, Turku, Finland, ²Specialized Speech and Language Services Riitta Vartiainen Ltd, Helsinki, Finland

Background: Understanding cognitive-communicative disorders is an essential component of goal setting and therapy planning in group interventions. It is important to identify social communication skills problems associated with community integration and satisfaction with life. La Trobe Communication Questionnaire can be used to evaluate communicative abilities and gather the information of individual experiences with real life social situations. A follow up study of the perceived communication skills after TBI was carried out in Finland during 2004-2007. The results show that communicative abilities were severely impaired after TBI, seemed to be persistent and were perceived very similarly by the patients themselves and their close-others. Therefore, we came to the conclusion that the following intervention is essential.

Intervention: The main goal in our group interventions is to support the participation and social integration. Since 2007 we have carried out several group intervention periods with 10-20 group meetings including few individual meetings for guidance. These group meetings can also be multidisciplinary with speech-language pathologist and neuropsychologist. They include education, reflection and practicing. The aspects of nonverbal communication, peer discussions and finding compensation skills for challenging social situations are also important to include in intervention. Cognitive-communication disorders of the participants have varied from mild to moderate.

Conclusions: According to clinical observations the main remarks after the intervention are: increased quantity of turn taking and comments, increased coherence in discussion, increased relation to the topic, better identification and understanding the aspects of nonverbal communication. The patients themselves report increased encouragement, more positive relation to social participation, new activities and compensation skills, and decreased loneliness. It seems that group intervention is an important link between cognitive-communication rehabilitation and real life.

Correspondence: Raukola-Lindblom, Marjaana: marjaana.raukola-lindblom@utu.fi
Postoperative Residue Pneumocephalus After Tumor Removal Observation for 9 Years: Leave It Alone or Repair Immediately

Wei-Chuan Liao¹, Tung-Ho Wu¹, Hsing-Lin Lin¹
1Veterans General Hospital- Kaohsiung, Taiwan, Kaohsiung, 台灣

Introduction: Brain tissue loss caused by post-operation with a residue cavity is usually filled with air or fluid. Management of this kind of brain damage still remains controversial. Herein, we present a patient with residue pneumocephalus without symptoms.

Case presentation: A 37-year-old female who underwent surgical removal of right vestibular schwannoma, pneumocephalus was also found after obtaining follow-up MRI. The pneumocephalus was found and observed for 9 years without progression. However, she started to experience vertigo and vomiting. The brain computed tomography revealed a tension pneumocephalus with compression of cerebellar vermis and in left cerebellar hemisphere. The patient later received skull base repair to close the defect. She was discharged after improvement of her symptoms.

Discussion: If a patent has complications of CSF leakage, meningitis, or tension pneumocephalus, surgical repair of the defect should be considered. But in patients with residual pneumocephalus, close observations could be adopted for a while and repair if symptoms get worse.
Meeting the Needs of Families After Pediatric ABI – Do You Know What You Don’t Know?

Caron Gan¹, Christine Provvidenza¹, Ashleigh Townley², Virginia Wright¹
¹Bloorview Research Institute, Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, ²Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada

Background/Rationale: Pediatric acquired brain injury (ABI) can have immediate and long-term effects on a child’s development and persisting impact on families. Studies on family needs after pediatric ABI have shown the importance of information, ABI education, practical support, and sibling/family support from the time of injury to their child’s return home and beyond. In spite of this recognized need for family support, there has been no systematic way to assess the extent to which needs are met after pediatric ABI. We collaborated with family caregivers and front-line clinicians to adapt the validated adult Family Needs Questionnaire (with author’s permission) so it would be suitable for families of children with ABI. The Pediatric Family Needs Questionnaire [FNQ-P] was created and validated with partners from Sweden, United Kingdom, Lithuania, and Sweden.

Objective: To pilot the implementation of the FNQ-P into clinical care and assess its clinical utility from the perspective of clinicians and family caregivers.

Methods: The Knowledge to Action (KTA) cycle was the framework used to inform the pilot implementation of the FNQ-P with families of children in an ABI inpatient rehabilitation program. Pre-implementation planning included: sharing a Knowledge Translation (KT) video with program staff to highlight the voices of families and clinicians about the importance of family needs and heighten awareness of the FNQ-P, inviting clinical and family champions to help drive the FNQ-P into practice, identifying enablers and barriers to using the FNQ-P in clinical care, and co-creating an implementation pathway. Pilot-implementation strategies used to move the FNQ-P into practice included providing education on the FNQ-P, developing a supplementary education binder, co-creating simulations for FNQ-P administration with family champions, and digitizing the scoring of the FNQ-P to connect the information across disciplines.

Results: Pilot-implementation occurred over a five-month period, involving 11 clinical champions and 15 families. Overall mean FNQ-P and category scores, areas of need that were most met, and the areas of greatest unmet need will be reported. Key themes from qualitative interviews with family participants (n=8) were: “Not knowing my needs”, “It’s about my child”, and “Gaining new insights”. Key themes from clinician interviews (n=6) highlighted how the FNQ-P “empowers and validates families”, “plants seeds”, and “helps us know what’s important.”

Conclusions: The pilot implementation demonstrated the clinical utility of the FNQ-P in identifying needs that families and clinicians had not considered or did not know were important. Identification of needs that are most met, and areas of greatest unmet need can also be used for long-term monitoring of family needs or for program planning. This work highlights the importance of co-creating an implementation strategy with key stakeholders and using evidence-informed (research, experiential and contextual) strategies to optimize the transfer of new tools into clinical practice.
Traditionally, the right hemisphere has been considered as non-dominant because of absence of significant alterations in cognitive functioning after lesions. Recent studies have shown that right hemisphere plays an active role in cognitive processes, such as spatial global analysis, recognition and evocation of auditory patterns, motor sequences, recognition of faces and emotions. The goals of the present study consist of presentation of the content of program for neuropsychological rehabilitation of young adult with traumatic brain injury in right hemisphere. Before the work with the program of rehabilitation, qualitative neuropsychological assessment with posterior analysis of the clinic syndrome was provided. A case report is referred to masculine patient of 23 years old with brain damage in right frontotemporal region due to an automobile accident. The neuropsychological assessment evaluation was carried out through qualitative protocols for Spanish speaking patients. Neurological analysis detected adequate functioning of motor, visual and kinesthetic primary and secondary zones. Tomography showed hypodensity in the frontotemporal region of the right cerebral hemisphere. EEG data obtained by bipolar and monopolar montage and visual qualitative analyses has shown local abnormal patterns of groups of theta oscillations (4-7 Hz) in frontal, central and temporal sectors of the right hemisphere, indicating dysfunctional stage of cortical zone of right hemisphere. analysis of the results of neuropsychological assessment together with assessment of intellectual activity pointed out severe disturbance of global perception and involuntary retention of diverse types of information. Mild difficulties with regulation and direction of actions to objectives with conservation of selective control of activity were identified. The patient was always critical and orientated in time and person. He could understand that he had committed mistakes but was unable to correct them independently. A pretest-posttest research design was used in order to describe the effects of the program of neuropsychological rehabilitation. Results describe positive effects of the program of neuropsychological rehabilitation on intellectual activity and emotional sphere. Final assessment pointed out important improvement in the process of intellectual activity on perceptive and verbal levels. The patient managed to return to university studies. Our results show that it is possible to define the mechanisms, which underline the clinical syndrome in cases brain injury in right hemisphere. Predominant difficulties consisted in loss of involuntary regulation and mild difficulties with global perception of information on perceptive and verbal level. These difficulties were reflected in all kinds of complex intellectual activity, which became milder after the work with the program for rehabilitation. The patient has shone high level of cognitive and affective motivation during the work with the program. We conclude that qualitative approach in neuropsychological rehabilitation should take into account the sphere of personality of patients with brain damage during creation and application of sessions of rehabilitation.
A Computational Framework to Detect Subdural Haematoma Onset and Bridging Veins Rupture

Ricardo Alves de Sousa\textsuperscript{1}, Mariusz Ptak\textsuperscript{2}, Fabio Fernandes\textsuperscript{1}, Gonçalo Migueis\textsuperscript{1}, Monika Ratajczak\textsuperscript{3}

\textsuperscript{1}Universidade De Aveiro, Aveiro, Portugal, \textsuperscript{2}Wroclaw University of Science and Technology, Wroclaw, Poland, \textsuperscript{3}University of Zielona Gora, Zielona Gora, Poland

The human head is one of the most important part of the human body, since it includes the brain, a vital organ to the human life. Given its importance, the head injuries can be quite serious, leading to a long-term incapacity or even to death.

To better understand the mechanisms that trigger them or to develop prevention and detection mechanisms, many finite element head models (FEHM) have been developed. The YEAHM (YEt Another Head Model) is one of these models, and its first version was composed by brain, skull and a volume that groups falx, tectorium, meninges and the cerebrospinal fluid (CSF). This version of YEAHM was validated through simulations of two different tests on cadavers. The first one aims at validating the models by assessing the pressure gradient originated in the model when a projectile contact the skull. The second one aims at validating the head models through the movement of the brain originated by the application of rotational and tangential acceleration to the head.

However, this version of the YEAHM does not enable the detection of subdural hematomas, one of the types of head injuries that causes more sequelae in humans and which has a considerable mortality rate. In this work, a geometry was developed for the bridging veins, in order to overcome this limitation. This new version of the model, which already includes the bridging veins, was also tested with two different tests: the first one, to verify the influence of the presence of the veins on the overall behaviour of the skull/brain kinematics, and a second one with the objective of evaluating the rupture onset of the bridging veins and the validation of the damage model implemented.
Benefits of Rehabilitation Late After Stroke: A Multi-Centre Cohort Analysis from the UK Rehabilitation Outcomes Collaborative (UKROC) Database

Lynne Turner-Stokes\textsuperscript{1,2}, Annabel Cardona\textsuperscript{2}, Ejessie Alfonso\textsuperscript{2}
\textsuperscript{1}Department of Palliative Care, Policy and Rehabilitation, King's College London, London, United Kingdom, \textsuperscript{2}Regional Hyper-acute Rehabilitation Unit, Northwick Park Hospital, London, Harrow, United Kingdom

Background and Objectives: Whilst rehabilitation professionals acknowledge the benefits of rehabilitation late after stroke, received wisdom in the literature still suggests that the best outcomes follow early rehabilitation and that most patients make little functional gain beyond 3 months.

The objectives of this study were to evaluate functional gain and cost-efficiency of specialist inpatient rehabilitation in patients with severe stroke admitted more than 3 months after stroke, in the context of real-life clinical practice.

Methods: Design subjects and setting:
The UK Rehabilitation Outcomes Collaborative (UKROC) database collates data on needs, inputs and outcomes for all episodes of specialist inpatient rehabilitation in England. This was a retrospective analysis of prospectively-collected routine clinical data from the UKROC database.

Data were extracted for all registered episodes of patients with severe stroke (n=2174), admitted for inpatient rehabilitation between 2010-2017 in a Level 1 or 2 specialist rehabilitation service (76 centres in all), for whom the time since onset was over 90 days at the time of admission.

Main Outcomes: Recorded on admission and discharge, the UK FIM+FAM measures change in motor and cognitive function. The Northwick Park Dependency and Care Needs Assessment (NPDS/NPCNA) calculates cost efficiency as the time for savings in ongoing care costs in the community to offset the initial costs of rehabilitation.

Data were analysed in three groups of dependency based on NPDS scores on admission: ‘High’ (NPDS>25); ‘Medium’ (NPDS=10-25); Low (NPDS<10).

Summary statistics are reported using median (IQR) for ordinal data or mean (95%CI) for interval data, with bootstrapped samples of 1000 to account for skewed data.

Results: The sample comprised 58% Males, mean age 55.2 years (95%CI 54.6, 55.8) and mean length of stay 112 (109, 115) days. Stroke aetiology was infarct (35%), haemorrhagic (36%), sub-arachnoid haemorrhage (19%). Left/ right hemisphere stokes were equally represented.

The mean time since onset of stroke at admission was 403 days (95%CI 365, 450) or median 140 days (IQR 108-232).

The Median total UK FIM+FAM score on admission was 86 (IQR 57-125): median change score from admission to discharge 24 (IQR 9-42).

The mean episode cost was £38,546 (95%CI £36,333, 40,894) with mean reduction in care costs/week of £334 (95%CI £250, £376) or £16,328 per annum. The cost of rehabilitation was offset in 28 months.
When analysed in groups of dependency, the time to offset the initial costs of rehabilitation was shortest in the high-dependency group (27 months) compared with the medium (46 months) and low groups (101 months).

Conclusions: This analysis of real-life data collected in routine clinical practice demonstrates that some patients continue to make functional gains from specialist rehabilitation even more than one year after stroke. Moreover, this intervention was highly cost-efficient, especially for the most dependent patients.
Rates of Pediatric Mild Traumatic Brain Injuries in Quebec, 2003 to 2016

Glenn Keays¹, Debbie Friedman¹, Isabelle Gagnon¹
¹Chirpp, Montreal Children's Hospital Trauma, Montreal, Canada

Objective: Increases in mild traumatic brain injuries over the past decade have been reported in the United States and Ontario. The main objective of this study is to see if the same phenomenon occurred in Quebec by A) calculate rates of mild traumatic brain injury in Quebec and B) compare them with those in Ontario.

Design: Retrospective data.

Setting: Provincial Health Data.

Patients (or Participants): Patients from 0 to 17.99 years old who consulted for a for mild traumatic brain injuries in Quebec between 2003 and 2016.

Main Outcome Measures: Yearly rates, per age group and sex, for concussions and minor head injuries.

Results: In Quebec, there were significant increases in rates of mild traumatic brain injuries (concussions and minor head injuries) in older children: a 2.0-fold increase for those 13 -17.99, and 1.4 for those 9 -12.99. For the first time, females (13-17.99) had more concussions than males as of 2015. The fold increase in concussion rates was significantly higher in Ontario than in Quebec: 4.4 vs. 2.2.

Conclusions: The recent increase in rates of mild traumatic brain injuries reported in the scientific literature has also been observed in Quebec. The public health paradigm of males having more injuries than females is no longer true, at least for concussions. The fact that the rate of mild traumatic brain injury consultation, per person, remained the same from 2003 to 2016 indicate that the increase is not a result of patients/parents see.
Amelioration of Hyperacusis Impacts Vestibular Symptoms and Binocular Vision Dysfunction Symptoms in Patients with Traumatic Brain Injury

Debby Feinberg¹, Mark Rosner¹,²
¹NeuroVisual Medicine Institute, Bloomfield Hills, United States, ²St. Joseph Mercy Hospital, Ann Arbor, United States

Purpose: Patients with binocular vision dysfunction (BVD) have vestibular symptoms (dizziness, nausea, gait abnormalities) as well as headache/head pressure, neck pain, anxiety and unclear vision. Treatment of BVD with glasses containing micro-prism lenses usually significantly reduces these symptoms. One cohort of patients with traumatic brain injury (TBI) did not improve as expected, and all admitted to hyperacusis. This study’s purpose is to demonstrate reduction of residual symptoms with noise cancelling devices.

Methods: This retrospective study includes 23 patients with TBI presenting for annual vision examination, previously diagnosed with BVD and treated with glasses containing micro-prism lenses for >1 year, who had residual vestibular and BVD symptoms and who admitted to hyperacusis. Baseline data included completion of the modified Khalfa questionnaire, and subjective 0-10 scoring of headache, neck pain, dizziness, unsteadiness walking, nausea, anxiety and light sensitivity. Sound cancelling earbuds or headphones (Bose QC 30 earbuds or QC 25 headphones) were placed upon the patient and subjective symptom scoring was repeated. Then the vision examination was performed with the patient wearing the sound cancelling device. Post-examination, subjective symptom scoring was repeated with both the updated vision prescription and sound cancelling device in place.

Results: 65% of patients had moderate to severe hyperacusis. All subjective symptom scores decreased markedly including dizziness (58.4%), nausea (63.3%), and unsteady walking (76.6%). Over 90% of symptom reduction was due to sound cancellation, with <10% due to micro-prism lenses.

Conclusions: In patients with TBI previously diagnosed with BVD and previously treated with glasses containing micro-prism lenses, who had residual vestibular and BVD symptoms and who admitted to hyperacusis, amelioration of the hyperacusis using sound cancelling devices resulted in marked reduction of the residual symptoms.
Behavioral Markers of Recovery of Consciousness After Severe Brain Injury

Géraldine Martens¹², Yelena Bodien¹³, Joseph Giacino¹

¹Department of Physical Medicine and Rehabilitation, Spaulding Rehabilitation Hospital, Harvard Medical School, Boston, United States, ²Laboratory for Neuroimaging in Coma and Consciousness, Massachusetts General Hospital, Boston, United States, ³Coma Science Group - GIGA-Consciousness & Neurology Department, University and University Hospital of Liege, Liege, Belgium

Patients with an altered state of consciousness (i.e., coma, unresponsive wakefulness syndrome/vegetative state [UWS/VS], minimally conscious state [MCS] and emergence from the MCS [eMCS]) following severe brain injury are highly exposed to the risk of misdiagnosis. Detecting the transition from an unconscious to conscious state is critically important to clinical management, disposition planning and family counseling.

This retrospective observational study aimed at determining which behaviors signal recovery of consciousness after severe traumatic and non-traumatic brain injury and the time course to recovery of consciousness using the Coma Recovery Scale-Revised (CRS-R) in an inpatient rehabilitation hospital with a specialized disorders of consciousness (DoC) program.

Seventy-nine patients who transitioned from coma or UWS/VS to MCS or eMCS during inpatient rehabilitation were included (51 males; median age [IQR]= 48 [25.5 – 61]; TBI = 34; median time since injury at admission [IQR]: 26 [20 – 36] days). Visual pursuit was the most frequently observed behavioral sign marking recovery of consciousness (present in 37% of patients), followed by reproducible movement to command (23%) and automatic movements (22%). Ten other behaviors signaled return of conscious awareness, but these signs were first to emerge in less than 15% of cases. In 72% of the sample, the transition to conscious awareness was marked by a single behavior: visual pursuit. When two behavioral markers of consciousness emerged concurrently at time of transition (17%), visual and motor signs were most prevalent. The median time to recovery of consciousness was 44 [33 – 59] days post injury.

The transition from an unconscious to conscious state is usually marked by the emergence of a single behavioral sign of consciousness. Visual pursuit, reproducible command-following and automatic movements are the most common markers of recovery of consciousness. Clinicians should utilize assessment methods that are particularly sensitive to these behaviors to avoid early misdiagnosis and inappropriate treatment recommendations.
Challenges of Neurorehabilitation and the Prosthetic Prescription for a Patient with an Anoxic Brain Injury: Understanding how Neuropsychological Changes Affect Functional Rehabilitation

Justin Weppner¹, Jenna Meriggi¹, Gary Galang¹
¹University of Pittsburgh Medical Center, Pittsburgh, United States

Objectives: Prosthetic devices are a vital part of an amputee’s life, improving function and independence. Rejection and non-functional use of prostheses can be high, especially in upper extremity amputees. Regardless of technological advances, motor learning is a fundamental principle of prosthetic integration that must be considered in the brain injured population. This case study identifies four factors that must be considered in the comprehensive rehabilitation of a brain injured upper extremity amputee: (1) executive function; (2) functional performance; (3) physical and mental health; (4) acceptance of adult functional role and capacity of independent use.

Methods: A healthy 26-year-old male patient was electrocuted while working on a roof suffering a 20-foot fall and severe electrical burns to bilateral hands and forearms. Initially found in cardiac arrest, he was resuscitated by emergency medical services. Computed tomography imaging revealed bilateral loss of gray-white matter differentiation at the parieto-occipital regions and basal ganglia with progressive cerebral edema. Brain magnetic resonance imaging showed symmetric T2/FLAIR hyperintensity involving the right occipital regions and deep gray structures with associated diffusion restriction consistent with anoxic injury. Due to extent of burns, he underwent bilateral below elbow amputations with skin grafting. He was fitted for bilateral body powered upper limb prostheses that he was unable to use. He was referred to the Brain Injury Medicine (BIM) service for cognitive evaluation.

Results: The patient was admitted to acute inpatient rehabilitation for prosthetic training. Four barriers were identified. Based on neuropsychological battery, executive functioning was impaired, contributing to the challenge of applying procedural knowledge during complex tasks. While the patient’s strength and coordination were preserved during individual therapy sessions, carry-over between sessions was poor limiting his functional performance. He was started on donepezil and combined with task specific training he demonstrated improvements with procedural memory and functional performance using his prostheses. The patient’s physical and mental health profoundly affected his rehabilitation course with frequent debilitating anxiety, post-traumatic stress, and agitation. In addition to psychological therapy the patient continued venlafaxine and was prescribed divalproex sodium and propranolol for mood stabilization. The patient was also started on gabapentin for neuropathic residual limb pain. Improvements in pain, mood, and anxiety facilitated participation in rehabilitation. Over the course of the patient’s injury, he developed an over-reliance on others to complete tasks, limiting both his acceptance of his new prostheses and capacity to carry out tasks independently. Within the safe construct of the inpatient rehabilitation unit, we encouraged independence from family during therapy sessions.

Conclusions: Prosthetic prescription should be considered within the context of a larger plan to address patient’s health and disability. Neuropsychologic testing and early BIM consultation to medically optimize the patient using our four measures should be considered prior to prosthetic prescription.
Prevalence of Depression after TBI in a Large Prospective Cohort; The SHEFBIT Study

Rajiv Singh1,2, Suzanne Mason2, Fiona Lecky2, Jeremy Dawson3

1Sheffield Teaching Hospitals/University of Sheffield, Sheffield, United Kingdom, 2School of Health and Related Research (ScHARR), University of Sheffield, Sheffield, United Kingdom, 3Institute of Work Psychology, Sheffield University Management School, Sheffield, United Kingdom

Objectives: Assess the prevalence of post-TBI depression and its changes over 1 year.

Background: Depression is common after traumatic brain injury (TBI) and associated with worse functional and psychosocial outcomes. However, there remains considerable uncertainty over the exact prevalence of the condition.

Methods: a prospective cohort of TBI admissions to a teaching hospital emergency department over two years. Minimal exclusions were applied in order to recruit a representative TBI population who were then assessed at ten weeks and one-year post. Depression was recorded with a HADS (Hospital Anxiety and Depression Scale) Demographic and injury features were also examined for association with depression

Results: 774 individuals were recruited of whom 690 attended one-year follow-up and 38 had died. Only 6% of the cohort was lost to follow-up after one year. The prevalence of depression at ten weeks was 56.3% [95% CI 52.8-59.8] and at one year 41.2% [95% CI 37.6-44.9]. A multivariable analysis identified the independent predictors of depression; at ten weeks these were TBI severity, abnormal CT scan, past psychiatric history, alcohol intoxication, female gender and non-white ethnicity. At one year, predictors were; abnormal CT scan, past psychiatric history, alcohol intoxication and female gender. TBI severity was no longer significant. Injury aetiology, social isolation, age, length of stay and medical comorbidity were not associated with depression risk.

Conclusions: The prevalence of depression remains high at 1 year. Features related to the injury itself, such as TBI severity, may become less significant in the long-term outcome. It is possible that psychosocial features e.g. personality and coping mechanisms are more important in determining long term outcome than injury features such as severity and aetiology.
What is the Global Outcome after TBI? Experience with a Large Prospective Cohort

Rajiv Singh1,2, Suzanne Mason2, Fiona Lecky2, Jeremy Dawson3
1 Sheffield Teaching Hospitals, Sheffield, United Kingdom, 2 School of Health and Related Research (ScHARR) University of Sheffield, Sheffield, United Kingdom, 3 Institute of Work Psychology, Sheffield University Management School, Sheffield, United Kingdom

Objectives: to assess the global outcome and return to work after TBI in a large, unselected TBI cohort admitted to hospital and any relationships with other TBI and demographic features.

Background: Global outcome studies after Traumatic Brain Injury (TBI) differ widely in terms of findings. This is mainly due to differences in outcome measure, attrition to follow-up and selection bias. Information on long-term outcome would help to inform patients, families and develop services.

Design, Subjects and Setting: 1322 consecutive TBI admissions over 5 years, assessed within a specialist regional neurorehabilitation clinic at a University hospital (Sheffield Brain Injury after Trauma cohort)

Methods: All patients assessed at 10 weeks and 1 year. Main outcomes were Extended Glasgow Outcome Scale (GOSE), return to work, Rivermead Head Injury Follow-up Questionnaire, Rivermead Post-Concussion Symptoms and the Hospital Anxiety and Depression Score.

Results: 1194 (90.2%) of the cohort had follow-up data at 1 year. Mean age was 46.9(SD17.3) and median length of stay 2days (1-154) reflecting the preponderance of mild TBI (49.2% mild, 33.9%moderate and 16.9%severe). At 10 weeks only 24.6% made a good recovery with 5.2% and 22.7% in moderate and severe disability. This improved at one year to 38.8% good but only 22.6% were in the good upper or best grouping. For return to work, only 28.1% of individuals returned to normal pre-morbid level of work at 10 weeks, improving to 39.2% at 1 year. However, 31.0% at 1 year were unable to make any return to work or study and 24.7% had a partial return.

Conclusions: In a truly representative TBI population including MTBI, there is still considerable disability at 1 year and many individuals are unable to make any return to pre-morbid vocation. Further analysis will be presented.
The Leg Activity Measure (LegA), A Measure of Passive and Active Function and Impact on Quality of Life in Acquired Brain Injury for Outcome Evaluation in Leg Spasticity

Stephen Ashford¹, Richard Siegert², Heather Williams¹, Ajoy Nair⁴, Samantha Orridge⁵, Lynne Turner-Stokes¹

¹London North West Healthcare NHS Trust & King’s College London, London, United Kingdom, ²Department of Palliative Care, Policy and Rehabilitation, Faculty of Nursing, Midwifery and Palliative Care, King’s College London, London, United Kingdom, ³AUT University, Department of Psychology, Faculty of Health and Environmental Sciences, Auckland, New Zealand, Auckland, New Zealand, ⁴Alderbourne Rehabilitation Unit, Hillingdon Hospital, London, United Kingdom, London, United Kingdom, ⁵Kings College Hospital, London, United Kingdom, London, United Kingdom

Background and Aims: Following stroke or other brain injury people have reduced control of their limbs, and may also have spasticity, which further prevents normal activity. The importance of measuring the impact of treatments from the perspective of patients and caregivers has been emphasised (Department of Health 2009). We identified no comprehensive instrument to measure function of the spastic leg (Ashford et al. 2015). We therefore developed, the Leg Activity measure (LegA), with clinicians, patients and caregivers. We then subsequently evaluated the properties of the LegA measure according to COSMIN (COnsensus-based Standards for the selection of health Measurement INstruments) (Mokkink et al. 2010; Mokkink L B et al. 2012).

The main purpose of this study was to demonstrate the application of the Leg Activity measure (LegA) - a new measure of passive and active function and impact on quality of life, for application in focal post-stroke spasticity intervention. LegA was also used to identify areas of limited performance to support goal setting.

Methods: An open label prospective cohort study conducted within a three-centre specialist spasticity management program. Outcome measures used were the Leg Activity Measure (LegA), the Modified Ashworth Scale (MAS) and Goal Attainment Scaling – light (GAS Light). Measurement was undertaken at baseline, 6 and 12 weeks.

Participants with acquired brain injury (n=64) presenting for treatment of leg spasticity were included and their mean age was 51 years, ranging from 18 to 84 years, half (n=32) were men.

Results: Significant changes were demonstrated over the 12 week period in MAS (Xr² =35.4; p<0.001), the LegA passive function scale (Xr² =32.2; p<0.001) (e.g. improved ease of dressing, hygiene) and LegA impact on quality of life scale (Xr² =32.2; p<0.001). No change was identified in the LegA active function scale and reflected a lack of change in this domain. Goal attainment was demonstrated at 6 weeks and further improved at 12 weeks (Xr² =65.7; p<0.001) and was associated with change in the relevant LegA sub-scale (passive function or quality of life in this sample).

Discussion: Significant gains in passive function and quality of life were recorded by the LegA scales at 6 weeks and maintained or improved at 12 weeks post-injection in the context of on-going physical treatment.
Transitions of Care after Severe Brain Injury: How to Attain the Best & Most Appropriate Rehabilitation for your Patient/Client

Mary Tanis¹, Elizabeth Lock¹
¹Hope Network Neuro Rehabilitation, Grand Rapids, United States

This poster is a learning opportunity for those who work with individuals who have suffered a severe neurologic injury and are in need of physical and/or cognitive rehabilitation. The goal is to obtain a working knowledge of the different levels of care available for this patient type, as well as resources to advocate for residential brain injury rehabilitation and for the funding of these services.

Three Educational Learning Objectives:
• Identify the different phases of brain injury care and rehabilitation, including the admission/discharge criteria for each phase
• Understand funding implications with brain injury rehabilitation, especially post-acute care
• List several ways to advocate for residential brain injury rehabilitation for a patient/client
Wayfinding and Storytelling in Individuals with TBI

Nicole Cruse¹, Michael Belousov¹, Akhila Kuchibhotla¹, Carl Coelho¹

¹University of Connecticut, Hebron, United States

Navigation and discourse are both areas that can be adversely affected by traumatic brain injury (TBI). Individuals with TBI often struggle to maintain coherent discourse. These same individuals may also have difficulty navigating between two locations in everyday environments. It has been proposed that deficits in spatial navigation and discourse, both stem from executive dysfunction. The goal of this study was two-fold: 1) to investigate deficits in planning, monitoring, and task maintenance during spatial navigation and storytelling tasks in individuals with mild TBI, and 2) to examine the relationship between performance on a standardized cognitive assessment battery and performance on the behavioral tasks. The NIH Toolkit was administered to assess general cognitive functioning in 20 participants, 10 non-brain-injured (NBI) and 10 with TBI. Behavioral tasks included a virtual course-plottling activity that required participants to navigate an avatar through a town, stopping at appointed locations, as well as a story re-telling task. Preliminary results suggested that the TBI group had more difficulty than the NBI group on two of the three assessments, although not all were significantly different. Overall, the TBI group took longer to plan and execute three of the four navigation tasks, stopping more times and making more errors than the NBI group. The story re-telling task revealed more difficulty with story completeness and accuracy within the TBI group than the NBI group. Despite performance differences on the behavioral tasks, the NIH Toolkit identified no statistically significant differences between the two groups. The findings of this pilot study are interpreted cautiously due to the small group sizes, the fact that the TBI group consisted primarily of participants with mild TBI, and the challenge of matching task difficulty across domains (spatial navigation and story retelling).
Assessment of Fatigue Following Acquired Brain Injury: Overlaps in Fatigue and Depression Among Young Patients with Acquired Brain Injury

Frederik Dornonville de la Cour\textsuperscript{1,2}, Birgitte Forchhammer\textsuperscript{2}, Jesper Mogensen\textsuperscript{3}, Anne Norup\textsuperscript{2}

\textsuperscript{1}Brain Injury Center Bomi, Roskilde, Denmark, \textsuperscript{2}National Study of Young Brain Injury Survivors, Department of Neurology, Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark, \textsuperscript{3}The Unit for Cognitive Neuroscience (UCN), Department of Psychology, University of Copenhagen, Copenhagen, Denmark

Introduction: Fatigue is a common and debilitating complaint following acquired brain injury (ABI) with detrimental effects on vocational capabilities and quality of life. Fatigue is often associated with depression, but the nature of this relationship is unclear. Further, the multifaceted and subjective nature of the concept poses challenges to the definition and assessment of fatigue. The objectives of the present study were (1) to investigate levels of fatigue and depression in young survivors of ABI and (2) to determine the relations between different dimensions of fatigue and symptoms of depression.

Method: This cross-sectional study was conducted using data from patients (15 to 30-year-olds) at a regional outpatient clinic established as part of the National Study of Young Brain Injury Survivors in Denmark. Healthy controls were recruited using an online survey. Fatigue was assessed in five dimensions using the Multidimensional Fatigue Inventory (MFI-20): General Fatigue, Physical Fatigue, Mental Fatigue, Reduced Motivation, and Reduced Activity. Symptoms of depression were assessed with the Major Depression Inventory (MDI). Mann-Whitney U-tests were used to compare fatigue and depression between groups. Associations between fatigue and depression were analyzed in the ABI group using Spearman’s correlation analyses and multiple regression analyses, adjusting for shared variations in MFI-20 subscales, sex, age, and time since injury.

Results: The ABI group (n=105; M=23.7 years old; SD=4.2) was assessed 31 months post-injury on average (SD=61). Internal consistency of MFI-20 subscales was adequate, except for Reduced Motivation (α=.55). The ABI group had higher scores on MFI-20 and MDI than healthy controls (n=160), all p’s<.001. Each MFI-20 subscale was correlated with MDI, all p’s<.01. In multivariate analyses, General Fatigue, Mental Fatigue, and Reduced Motivation were independently associated with MDI, all p’s<.01, while the subscales Physical Fatigue and Reduced Activity were not.

Conclusions and Perspectives: Fatigue and depression were elevated and associated symptoms among adolescents and young adults with ABI. Further, symptoms of depression overlapped with specific aspects of fatigue, namely General Fatigue, Mental Fatigue, and Reduced Motivation.

Motivation: Consequently, depression may be likely to inflate fatigue measures such as MFI-20. Future perspectives within the area of fatigue includes validating a fatigue scale developed for ABI specifically, and no scale has so far proved robust psychometric properties for use in neurological populations. The Dutch Multifactor Fatigue Scale (DMFS) was recently developed to assess the nature and impact of fatigue following ABI, specifically, in addition to how well patients cope with fatigue. DMFS is currently being validated in Denmark to address the lack of appropriate assessment scales and has potential to be a valuable tool in targeting treatment to patients’ individual needs by addressing the multifaceted nature of fatigue following ABI.

Grant Support: The work was supported by the Danish Ministry of Health.
Improving Responsiveness to Non-Invasive Brain Stimulation in Minimally Conscious State Patients: A Closed-Loop Approach

Géraldine Martens¹, Alice Barra¹, Manon Carrière¹, Aureli Soria-Frisch², Giulio Ruffini², David Ibáñez², Andrés Rojas², Steven Laureys¹, Aurore Thibaut¹

¹Coma Science Group - GIGA Consciousness, University and University Hospital of Liege, Liege, Belgium, ²Starlab Barcelona, Barcelona, Spain

Transcranial direct current stimulation (tDCS) applied on the left dorsolateral prefrontal cortex has already been shown to efficiently promote the recovery of conscious awareness in patients with disorders of consciousness following severe brain injury, especially those in minimally conscious state (MCS)1. However, one potential barrier to clinically respond to tDCS is accounting for the timing of the stimulation with regard to the fluctuations of vigilance that characterize this population2. Indeed, the vigilance of MCS patients has periodic average cycles of 70 minutes (range 57-80 minutes)3, potentially preventing them to be in an optimal neural state to benefit from tDCS when applied at random moments. To tackle this issue, we propose a new protocol to optimize the application of tDCS by selectively stimulating at high vigilance and low vigilance states, as measured by real-time spectral entropy (as a marker of vigilance3) and based on pre-identified individual thresholds, in a closed-loop fashion. We will conduct a clinical trial on 36 patients in MCS who will undergo a 4-hour EEG recording beforehand to set individual vigilance thresholds. The patients will then be randomized in three groups based on the moment of tDCS application: high vigilance, low vigilance and sham. These EEG-tDCS sessions will last for 6 hours with a maximum of two tDCS sessions of 20 min at 2 mA. Behavioral effects will be assessed using the Coma Recovery Scale-Revised4 at baseline, after 3 and 6 hours. The device used will be provided by Starlab and enable real-time analysis of EEG dynamics and spectral entropy as well as control of the tDCS stimulator (a customized version of Neuroelectrics’ Startsim 8). This unique and novel approach will provide new insights for the identification of tDCS responders and provide treatment options for the challenging population of patients with disorders of consciousness.

Using an Integrated Knowledge Translation (IKT) Approach to Optimize a Protocol for a Pilot Randomized Controlled Trial of a Peer Support Program for Individuals with Traumatic Brain Injury

Sarah Munce1,3, Dorothy Luong1, Shane Sweet2, Nancy Salbach1,3, Susan Jaglal3, Monika Kastner4, Michelle Nelson5, Carla Thoms6, Ruth Wilcock6, John Shepherd3, Mark Bayley1,3

1Toronto Rehabilitation Institute-University Health Network, Toronto, Canada, 2McGill University, Montreal, Canada, 3University of Toronto, Toronto, Canada, 4North York General Hospital, Toronto, Canada, 5Sinai Health System, Toronto, Canada, 6Ontario Brain Injury Association, Thorold, Canada

Objective: An integrated knowledge translation (IKT) approach can provide important information to understanding and optimizing strategies for participating in peer support and peer support research. IKT is defined as an ongoing relationship between researchers and decision makers for the purpose of engaging in a mutually beneficial study or research program to facilitate decision-making. The purpose of this study was to gain insight from key informants to refine the processes for a randomized controlled trial evaluating a peer support program for individuals with moderate to severe traumatic brain injury, prior to implementation.

Methods: A qualitative descriptive approach was used. Semi-structured, one-on-one telephone interviews were conducted with key informants, including individuals with moderate to severe traumatic brain injury and caregivers who have received peer support, peer support program mentors, staff members working in peer support programs, and researchers and clinicians with expertise in peer support and/or traumatic brain injuries. Interviews focused on enablers and barriers to participating in peer support programs and research. Transcripts were analyzed using an inductive thematic approach. A subset of interviews were double coded, and researchers met throughout the development of the analysis to discuss and refine emerging themes and descriptions.

Results: Twenty-two key informant interviews were completed: 8 mentors (3 who had previously been recipients of peer support themselves), 4 individuals with traumatic brain injury who have received peer support, 3 caregivers (1 who was a provider of peer support and 2 who were recipients of peer support), 4 individuals with experience working in peer support programs, and 3 clinicians and/or researchers with expertise in peer support and/or traumatic brain injuries.

Results: Contextual considerations of individuals with traumatic brain injuries are critical to optimizing strategies around recruitment, adherence, and retention related to participating in peer support programs and research. Four specific themes emerged from the data related to: knowledge, awareness and communication of programs and research; logistics of participating in programs and research; readiness and motivation to participate; and clear expectations of what peer support and/or research is, as well as what being a participant involves. Appropriate matching was also identified as key for successful participation in peer support programs, but not for participating in research.

Conclusions: This study provided specific information from key informants on the protocol for a randomized controlled trial evaluating a peer support program for individuals with moderate to severe traumatic brain injury. Results were used to modify the protocol and offer considerations for future planning related to recruitment, adherence, and retention of brain injury participants in both peer support programs and research.
Implementing Interdisciplinary Goal Attainment Scaling in Clinical Practice

Kerrin Watter1,2, Mandy Nielsen1,2, Areti Kennedy1,2
1ABI TRS, Division of Rehabilitation, P.A. Hospital, Metro South Health, Woolloongabba, Brisbane, Australia, 2The Hopkins Centre, Brisbane, Australia

Background and Objectives: A new rehabilitation service model for adults with brain injury has been implemented in Queensland, Australia. The acquired brain injury transitional rehabilitation service (ABI-TRS) commenced clinical service in January 2017. The ABI-TRS provides time-limited (12 weeks) interdisciplinary team community rehabilitation for adults with ABI, in the transitional phase of hospital to home. Traditionally, Queensland’s ABI rehabilitation services have been provided using a multi-disciplinary approach, with goal setting occurring at a multi- and single-discipline level. Establishing and maintaining new clinical practices, including interdisciplinary team practice and interdisciplinary goal setting, can be challenging for teams. The ABI-TRS implemented IDT goal setting practices including interdisciplinary goal-attainment scaling (GAS-light) as standard care.

Method: A change management process was used to facilitate and maintain clinical change for interdisciplinary goal processes, including GAS-light goals. This occurred via strategically planning service change, involving stakeholders, implementing change strategies and establishing an evaluation and review process. Specifically, this included identifying clinicians’ skill, knowledge and experience; providing training and education; and implementing supported goal setting. An expert review process involved experienced researchers providing feedback on interdisciplinary GAS-light goals. Team evaluation of processes also occurred; clinicians provided qualitative information regarding interdisciplinary goal setting, experience and confidence, and barriers and facilitators. Supported goal setting and ongoing review processes were implemented to maintain new practices.

Results: Interdisciplinary GAS-light goal-setting was successfully implemented within ABI-TRS, providing a consistent measure of goal attainment within an interdisciplinary service. This occurred following two specific cycles of change within the team. The implementation and change management process, barriers and facilitators identified by the team and interdisciplinary GAS-light goal examples will be presented.

Conclusion: Interdisciplinary GAS-light goals are feasible in early ABI rehabilitation. Establishing and maintaining team change is enhanced by planned change management and support processes.

Correspondence: Kerrin Watter; Kerrin.Watter@health.qld.gov.au
Measuring Neurobehavioral Deficits among Severe Brain Injury Survivors: Reports of Survivors and Proxies in the Chronic Phase

Pernille Langer Soendergaard\textsuperscript{1}, Lars Siert\textsuperscript{2}, Ingrid Poulsen\textsuperscript{2}, Rodger Ll. Wood\textsuperscript{3}, Anne Norup\textsuperscript{1}
\textsuperscript{1}Department of Neurology, Rigshospitalet, Copenhagen University Hospital, Glostrup, Denmark, \textsuperscript{2}Department of Neurorehabilitation, TBI Unit, Rigshospitalet, Hvidovre, Denmark, \textsuperscript{3}Swansea University, Institute of Life Sciences, College of Medicine, Swansea, United Kingdom

Background: Neurobehavioral disability (NBD) is a term used to describe neuropsychological and neurological deficits in behavior amongst patients surviving acquired brain injury (ABI). NBD comprises deficits in attention control, reduced self-awareness, executive dysfunction, lack of insight, problems in social judgements, labile mood, reduced ability to control impulses, and personality changes. NBD has major influence on long-term psychosocial outcome and daily life, as it affects not only the patient, but the whole family.

Objectives: The aim of the study was to investigate 1) the frequency of NBD among survivors of severe ABI measured by the Danish version of the St Andrew's-Swansea Neurobehavioural Outcome Scale (SASNOS), and 2) concordance between reports of NBD completed by survivors and proxies.

Methods: SASNOS was administered in an outpatient unit as a part of a follow-up assessment after discharge from intensive neurorehabilitation. SASNOS consists of five factors: Interpersonal Behaviour, Cognition, Aggression, Inhibition and Communication, and was completed by both the patient and a proxy. Patients were included if they met the following criteria: 1) severe ABI; 2) ≥18years; 3) ≥1year since time of injury; 4) intact ability to read; 5) ≥7 on the Rancho Los Amigos Scale indicating resolution of post-traumatic amnesia or similar state of confusion. Proxies had to be close family members above 18 years. A total of 32 patients and 31 proxies completed the questionnaire. Most patients were male (68.8%), and most proxies were female (58.1%). Most patients had traumatic brain injury (68.8%), and mean time since injury was 19.4 months (10.0 SD).

Results: Raw scores were transformed to T-scores, and scores outside the normal range (>1 SD below mean, cut-off of T-score <40) were calculated. In the ABI-group, 25% rated themselves as below cut-off on the Interpersonal Behaviour domain, whereas proxies only rated 12.8% patients below on the same domain. On the Cognition domain, 25% of the patients rated themselves below cut-off, and proxies rated 32.2% patients below. Differences between ratings completed by proxies and patients were found on Cognition (t=2.33, df=30, p=0.027), Aggression (t=-3.22, df=30, p=0.003), and Communication (t=-3.60, df=30, p=0.001).

Conclusion: This study is the first to report results using the Danish version of SASNOS. A fourth of the ABI-group reported themselves as below normal range on the major domains Interpersonal Behaviour and Cognition. Significant differences were found between patient and proxy ratings. In relation to the domains Aggression and Communication, relatives rated the patient higher, indicating less deficits, whereas the opposite pattern was found on the Cognition domain. The ABI-group still experienced NBDs more than one year after injury. Thus, it is of clinical relevance to address NBD long-term and be aware of changes in disabilities over time, as NBDs have devastating consequences for social functioning and daily living.
The Prevalence of Neuropsychiatric Symptoms and Psychotropic Drug Use in Patients with Acquired Brain Injury in Long-Term Care: A Systematic Review

**Roy Kohnen**¹², Debby Gerritsen², Odile Smals¹², Jan Lavrijsen², Raymond Koopmans²³

¹Vivent, Mariaoord, Rosmalen, The Netherlands, ²Department of Primary and Community Care, Radboud University Medical Centre, Nijmegen, Netherlands, ³De Waalboog, Centre for Specialized Geriatric Care “Joachim en Anna”, Nijmegen, Netherlands

**Background:** Little is known about the prevalence of neuropsychiatric symptoms (NPS) and psychotropic drug use (PDU) in patients below the age of 65 years in the chronic phase of acquired brain injury (ABI). NPS put a high burden on patients and their environment in long-term care facilities. These NPS are often treated with psychotropic drugs, which can cause severe side effects. The objective of this study was to review the literature about the prevalence of NPS and PDU.

**Methods:** A systematic literature search of English, Dutch, and German articles in Pubmed, EMBASE, PsycINFO and CINAHL was performed with the use of MeSH and free-text terms for place of residence, cause of ABI, NPS, and PDU.

Inclusion criteria were patients with a mean/median age up to 65 years and in the chronic phase of nonprogressive ABI such as traumatic brain injury, stroke, anoxia, and cerebral infections. Exclusion criteria were patients with an age of 65 years or older, patients in the community, patients with disorders of consciousness, patients in hospitals and rehabilitation centres, degenerative forms of ABI, and Korsakoff’s Syndrome.

Two reviewers independently assessed eligibility of studies using the inclusion criteria mentioned above and evaluated the methodological quality of the included articles using the Guideline for evaluating prevalence research. With this guideline, the methodological quality of prevalence studies can be assessed with the use of eight criteria.

**Results:** A total of 828 studies were screened on title and abstract and 750 studies were excluded. From the remaining 78 records, the full text article was retrieved for assessing eligibility. Six articles met the inclusion criteria. The place of residence was mainly a nursing home and most studies were conducted in a population of patients with traumatic brain injury. Sample sizes varied from 40 to 26,472 residents and NPS were assessed with different assessment instruments, which made comparison difficult. Depressive symptoms were the most common NPS with a prevalence ranging from 13.9% to 39.3%. Two studies reported PDU in which tranquilizers (59%) were the most prevalent psychotropic drugs followed by anticonvulsants (35%) and antidepressants (26-34%).

**Conclusions:** In the few prevalence studies found regarding patients below the age of 65 years in the chronic phase of ABI in long-term care facilities, the most common NPS were depressive symptoms. Tranquilizers were the most prevalent psychotropic drugs. These patients experience lifelong consequences, regardless the cause of ABI, that have a high impact on them and their surroundings. More insight into the magnitude of NPS and PDU, through prevalence studies, is necessary to achieve suitable provision of care for these patients.
Correlation of Novel Blood Biomarkers with Traumatic Findings on CT After Traumatic Brain Injury

**Jussi Posti**, Riikka Takala, Linnéa Lagerstedt, Alex Dickens, Iftakher Hossain, Mehrbod Mohammadian, Henna Ala-Seppälä, Janek Frantzén, Mark van Gils, Peter Hutchinson, Ari Katila, Henna-Riikka Maanpää, David Menon, Virginia Newcombe, Jussi Tallus, Kevin Hrusovsky, David Wilson, Jessica Gill, Jean-Charles Sanchez, Olli Tenovuo, Henrik Zetterberg, Kaj Blennow

**Objective:** To study the ability of eight protein biomarkers and their combinations in discriminating CT-negative and CT-positive patients with TBI, utilizing highly sensitive immunoassays in a well-characterized cohort.

**Methods:** Blood samples were obtained from 160 patients with acute TBI within 24h from admission. Levels of β-amyloid isoforms 1-40 (Aβ40) and 1-42 (Aβ42), glial fibrillary acidic protein (GFAP), heart fatty-acid binding protein (H-FABP), interleukin 10 (IL-10), neurofilament light (NF-L), S100 calcium-binding protein B (S100B) and tau were measured. Patients were divided into CT-negative and CT-positive, and analyses were conducted separately for TBIs of all severities (Glasgow Coma Score 3-15) and mild TBIs (mTBI, Glasgow Coma Score 13-15).

**Results:** NF-L, GFAP, and tau were the best in discriminating CT-negative and CT-positive patients, both in patients with mTBI and with all severities. In patients with all severities, area under the curve (AUC) was 82.2%, 81.7%, and 78.1% for GFAP, NF-L and tau, respectively. In patients with mTBI, AUC was 72.0%, 68.9% and 67.6%, for GFAP, tau and NF-L, respectively. The best panel of three biomarkers for discriminating CT-negative and CT-positive patients in the group of all severities was a combination of GFAP+H-FABP+IL-10, with a sensitivity of 100% and specificity of 38.5%. In patients with mTBI, the best panel of three biomarkers was H-FABP+S100B+tau, with a sensitivity of 100% and specificity of 46.4%.

**Conclusions:** Panels of biomarkers outperform individual biomarkers in separating CT-negative and CT-positive patients. Panels consisted of mainly different biomarkers than those, which performed best as an individual biomarker.
Fatal Traumatic Brain Injuries During 13 Years of Successive Alcohol Tax Increases in Finland – A Nationwide Population-Based Registry Study

Jussi Posti1,2, Matti Sankinen2,3, Jussi Sipilä3,4,5, Jori Ruuskanen2,4, Jaakko Rinne2,3, Päivi Rautava6, Ville Kytö7

1Turku Brain Injury Centre and Turku University Hospital, Turku, Finland, 2University of Turku, Turku, Finland, 3Department of Neurosurgery, Turku University Hospital, Turku, Finland, 4Department of Neurology, Turku University Hospital, Turku, Finland, 5Department of Neurology, Siun sote, North Karelia Central Hospital, Joensuu, Finland, 6Clinical Research Center, Turku University Hospital, Turku, Finland, 7Heart Center, Turku University Hospital, Turku, Finland

Background: Up to half of the patients who sustain traumatic brain injury (TBI) are intoxicated with ethanol at the time of injury. In Finland, the excise tax on alcoholic beverages was reduced markedly and alcoholic beverage prices declined by 33% with the most pronounced relative price reduction in strong alcoholic beverages in 2004. This led to a 10% increase in overall alcohol consumption. To reduce health hazards, swift increases in alcohol taxes were subsequently undertaken. We sought to investigate how increases in alcohol taxation and changes in alcohol consumption were associated with the incidence of fatal traumatic brain injuries (TBIs) in Finland during the years 2004-2016.

Methods: The nationwide, mandatory cause-of-death database covering all deaths of subjects 16 years of age and older in Finland was searched for deaths related to TBIs (ICD-10: S06.X) during 2004-2016. Data for alcohol consumption were obtained from the National Institute for Health and Welfare and for alcohol taxation from the Ministry of Finance. Occurrence rates were standardized to the Euro 2013 standard population.

Results: There were 28,657,870 person-years and 325,514 deaths of which 12,110 were TBI-related. The standardized incidence of TBI-related deaths was 22.0 (95% CI 21.61-22.38) per 100,000 person-years. Overall alcohol consumption decreased, on average, by 1.2% annually. Concurrently, the overall incidence of fatal TBIs decreased by 4.1% annually (4.3% males and 2.4% females). There was an association between overall alcohol consumption and TBI-related mortality rate (p<0.001). Tax-rate increases of all beverage types were associated with a decreased incidence of TBI-related deaths in males (p<0.001), females (p<0.036), and overall (p<0.001).

Conclusions: During 13 years of successive alcohol tax increases, overall alcohol consumption has decreased in parallel with a reduction in the incidence of fatal TBIs in Finland.
Treatment of Post-TBI Fatigue with Light Exposure

Kristen Dams-O'Connor¹,², Wayne Gordon³, Alex Landau¹, Lisa Spielman¹, Eric Watson⁴
¹Icahn School of Medicine at Mount Sinai, New York, United States, ²Department of Neurology, Icahn School of Medicine and Mount Sinai, New York, United States

Objective: Fatigue is a common problem after TBI that is related to but distinct from sleepiness, sleep difficulties, and depressed mood. It affects up to 80% of individuals with Traumatic Brain Injury (TBI) and is relatively stable and persistent after the first-year post-injury. Behavioral management techniques, such as cognitive behavioral therapy, seek to reduce the effects of fatigue through use of compensatory strategies, economizing energy use, and improving sleep hygiene. Regular exposure to bright white light (BWL) is a new potential treatment for Post-TBI Fatigue (PTBIF) as it has been shown effective in treating seasonal and non-seasonal depression, circadian rhythm disturbances, and other sleep-related disorders. The current study evaluated the efficacy of BWL in reducing PTBIF.

Participants and Methods: Participants were 88 community-dwelling adults living with a medically documented TBI who were randomly assigned to 4 weeks of self-administered daily BWL or dim red light (DRL) exposure. Objective neurocognitive data were obtained using the CNS Vital Signs computerized assessment tool and self-report measures assessing fatigue (Multidimensional Assessment of Fatigue), sleep disturbance, anxiety, and depression (subscales from the TBI-QoL).

Results: Treatment groups (BWL vs DRL) were statistically equivalent at baseline. Analysis of covariance revealed significant changes from pre-treatment to post-treatment for PTBIF (p<.001). Random-effects modeling confirmed significant differences in self-reported PTBIF over time but not between treatment groups. Additional random-effects models included demographic variables (e.g., age, sex, education) as well as symptoms of depression, anxiety, and cognitive performance.

Conclusions: Findings suggest that phototherapy (either BWL or DRL) confers benefits for individuals with PTBIF. Subgroup response to BWL can inform patient stratification to maximize treatment efficacy.
Concussion Assessment and Treatment with Visual Training and Computer Based Programs

Philip Palmer
1
1Genesis Rehabilitation, Physiotherapy & Sports Injury Clinic, Toronto, Canada

Outlining current medical objective testing for concussion. Diffusion Tensor Imaging (DTI), Functional Magnetic Resonance Imaging (fMRI), Magnetic Resonance Spectroscopy (MRS), Positron Emission Tomography (PET).

The imaging modalities discussed demonstrate that substantial abnormalities in cerebral physiology may occur after concussion in a brain that appears anatomically normal.

Effects of concussion on brain function, vision and the specific neurologic pathways affected. (Smooth pursuit, Saccades-reflexive & scanning, Vergence, VOR).

The vestibulo-ocular reflex: The vestibulo-ocular reflex involves a 3-neuron arc, consisting of the oculomotor nuclei, vestibular nuclei, and vestibular ganglion, sometimes referred to as Scarpa’s ganglia (which is the location of the cell bodies of the vestibular nerves). Discussion on effects of this pathway on vision and balance control at the neuromuscular level.

Computerised Assessment of Gait: Brain injury patients demonstrate less proficiency at coordinating movement, patient will see greater variations in contact times, step lengths and phases of gait.

Asymmetrical deficiencies from compensating for poor neuromuscular control.

Deficiencies highlighted when adding cognitive function/executive decision-making tasks.

Objectively addressing the issue of subjective symptoms retracting but identifying alterations in speed of processing and physical functioning (the patient is still suffering from concussive symptoms that are not otherwise described or quantified.)

Rehabilitation Focus: Train the ability of each eye to aim, track and focus. At the same time train the two eyes to work as equal partners. Addition of movement, neck rotation and instability

Training gait, while training executive function will improve both components as opposed to training in isolation.

Reviewing Tabara Study: Test subjects who were unable to balance on one leg for 20 seconds were at risk of blood vessel damage and reduced cognitive function in otherwise healthy patients with no clinical symptoms. Indicative of increased microbleeds and lacunar infarctions with reduced balance times as confirmed with MRI. Prevalent finding in concussion.

Post-concussion/ brain injury patients may feel symptoms have resolved, however without expanded objective testing, dysfunction may be overlooked.
Disordered Sleep as a Modifiable Risk Factor for Post-Traumatic Neurodegeneration

Danielle Shpigel¹, Eric Watson¹, Kristen Dams-O'Connor¹,²
¹Icahn School of Medicine at Mount Sinai, New York, United States, ²Department of Neurology, Icahn School of Medicine at Mt. Sinai, New York, United States

Traumatic brain injury (TBI) is a growing public health concern due to its prevalence and the prolonged morbidity and early mortality of TBI survivors. As rates of TBI exceed population growth in older adults, there is an urgent need to identify modifiable risk factors that contribute to post-traumatic health and functional decline. In recent years, TBI researchers have begun to appreciate the high prevalence and negative consequences of sleep disturbance following TBI. TBI initiates a cascade of physiological changes that impact both homeostatic and circadian processes, resulting in disordered sleep and consequent sleep deprivation. Growing evidence suggests that immune and inflammatory responses to sleep disturbance can impede neural repair in the acute stages of recovery; oxidative stress and intermittent hypoxia together with brain aging can contribute to cognitive decline in chronic stages of TBI. Parallel to this line of work, dementia researchers have been investigating the role of sleep disturbance in cognitive decline and Alzheimer’s disease (AD). Investigators have identified associations between frequent nighttime waking and levels of amyloid beta 42 and phosphorylated tau (key factors in AD pathogenesis) in cerebrospinal fluid of older adults, as well as strong links between sleep apnea-related hemodynamic changes/sleep fragmentation and amyloid burden/cognitive decline. Large epidemiologic studies demonstrate that persons with sleep apnea have an increased risk of developing dementia compared to age and gender-matched controls. Despite the fact that TBI is a widely recognized risk factor for dementia, to date these two parallel lines of inquiry have not been integrated. The goal of this talk is to highlight intersecting evidence across TBI research and dementia research that implicate a role for disordered sleep in post-traumatic neurodegeneration. We will also present emerging evidence that implicates sleep disruption in post-TBI functional decline.
Comparative Effectiveness Study of Sleep Apnea Screening and Diagnostic Tools

Risa Nakase-Richardson¹
¹MHBS, James A. Haley Veterans Hospital and Morsani College of Medicine, Sleep and Pulmonary Division, University of South Florida, Tampa, United States

Objective: Recent meta-analyses found sleep apnea to be 12 times higher among TBI survivors than in large community-based non-TBI samples. Sleep is critical for early recovery and disordered sleep may play a role in cognitive decline after TBI. No study has prospectively examined the relationship between sleep apnea and its potential effect on long-term functioning in persons with TBI. This is particularly important because sleep apnea represents a treatable condition that may alter outcome. The nocturnal hypoxemia of untreated apnea is a secondary neurologic insult. Successful intervention for sleep apnea may serve as a method for enhancing acute and post-acute recovery processes and preventing cognitive decline in the chronic stages of TBI. Therefore, the purpose of this study is to describe the incidence of sleep apnea among persons with moderate to severe TBI receiving acute inpatient rehabilitation. Data are collected from participants in an ongoing PCORI-funded six-center clinical trial comparing the efficacy of different sleep apnea screening and diagnostic tools during acute neurologic recovery within the TBI Model System clinical trial network. Secondary data analysis of long-term outcomes using data from the current study merged with the longitudinal TBI Model System data upon study completion will also be discussed.

Participants and Methods: After 14 months of data collection, N=258 participants (81% male, 68% white) with moderate to severe TBI have been consented with 249 meeting eligibility and N=190 completing diagnostic polysomnography.

Results: Of the N=182 studies scored at the time of this submission, sleep apnea is prevalent (65%, obstructive; 4%, central; 1% mixed).

Conclusions: Identification and successful treatment may improve neurologic recovery including cognitive outcomes during a time of critical neural repair.
TWILIGHT: RCT of Phototherapy

Jeanne Hoffman

University of Washington, Seattle, United States

Objective: Examine the impact of bright white light (BWL) vs. red light on sleep and cognitive function during acute inpatient rehabilitation for moderate to severe traumatic brain injury (TBI).

Participants: One hundred thirty-one subjects with TBI and clinician-reported difficulty with sleep were enrolled at three TBI Model System centers.

Methods: Randomized controlled trial of BWL vs. red light for 30 minutes daily up to 10 days.

Results: Subjects were mostly male (69%), white (71%), unmarried (61%), involved in vehicular crashes (53%) and had a mean age of 41 years. 86% of subjects received light therapy but received only 8 days on average of light therapy due to short lengths of stay. No differences were found on sleep time or number of awakenings between groups. Results suggest some reduction in fatigue for those who received BWL, but no other differences in affect, therapy participation, or cognitive function (Symbol Digit Modalities Test).

Conclusions: This is the first randomized trial of light therapy for sleep disturbance during inpatient rehabilitation. Light therapy was well accepted by patients and nursing staff. Some evidence that fatigue was improved for those who received BWL. However, no significant change in sleep or cognition with the dosage used in the current study. Further study is needed to determine whether increased dosage could impact sleep and cognitive function.
Development of a Measure of Nociception and Pain for Patients with Severe Brain Injury

John Whyte1, Ingrid Poulsen2,3, Pengsheng Ni4, Marianne Eskildsen2, Rikke Guldager2,5
1Moss Rehabilitation Research Institute, Elkins Park, United States, 2Department of Neurorehabilitation, Traumatic Brain Injury Unit, The University Hospital of Copenhagen, Copenhagen, Denmark, 3Section of Nursing Science, Health, Aarhus University, Aarhus, Denmark, 4Department of Health Law, Policy & Management, Boston University School of Public Health, Boston, United States, 5Department of Neurosurgery, The University Hospital of Copenhagen, Copenhagen, Denmark

Severe traumatic brain injury may be accompanied by a range of painful comorbidities, such as fractures and surgical procedures, while patients may also display concurrent disorders of consciousness (DOC) or communication impairments, that limit the ability to provide self-reports of pain through pain diagrams or visual analog scales. Accurate assessment of nociception and pain is important for the diagnosis of its cause, and for balancing the need to relieve distress with the goal of optimizing alertness for rehabilitation participation. In some patients, agitated behaviors, in particular, may be taken as indicators of pain. The most widely studied tool for assessing pain in patients with severe brain injury and DOC confounds patients’ level of consciousness with the intensity of the nociceptive stimulus. Because level of consciousness is, itself, challenging to determine accurately and may evolve rapidly, a measure of nociception that is not confounded with consciousness is desirable.

We searched the literature to identify behaviors indicative of pain as well as previously published observational pain measures used in other populations. From these, we identified 15 behavioral and physiological items likely to be sensitive to nociception in a population with severe brain injury. Ratings were conducted on 157 non-communicative patients with TBI in 4 different activity settings predicted to modulate intensity of nociception on each of 2 days. Patients were medicated with acetaminophen on one of the 2 randomly selected days. Level of consciousness and level of agitated behavior were also measured. Item response theory was used to assess item fit to an underlying dimension of nociception.

Five of the 15 items demonstrated poor fit to the underlying dimension. After removal of misfitting items, the 10 remaining items remaining on the Traumatic Brain Injury Pain Assessment Measure (TBI-PAM) demonstrated acceptable fit. Person scores were higher in the activity conditions predicted to produce more nociception, and on the day that patients did not receive acetaminophen. TBI-PAM scores were largely independent of measures of consciousness and agitation, and accurate assessment could be completed in about 10 minutes and was robust to missing data for some items.

The results suggest that the TBI-PAM is reliable and feasible to administer clinically. Scores appear to be largely independent of level of consciousness or agitation, allowing accurate assessment of pain and nociception even in those patients whose consciousness status is uncertain or evolving. Research is needed to determine whether use of the TBI-PAM in clinical management will affect diagnosis of other conditions and judicious use of analgesia.
Treatment for Posttraumatic Stress Disorder in Patients with Traumatic Brain Injury: A Systematic Review

Ana Mikolic1, Maryse Cnossen1, Isabel Retel Helmrich1, Juanita A. Haagsma1, Suzanne Polinder1

1Erasmus Medical Center, Rotterdam, Netherlands

Background/Objective: Posttraumatic stress disorder (PTSD) frequently co-occurs with traumatic brain injury (TBI) but the application of treatments for PTSD remains an open question in TBI patients. Thus, the aims of the current systematic review are the following: 1) to provide an overview of treatments for PTSD (symptoms) in adult patients with TBI; 2) to evaluate the appropriateness of and effectiveness of PTSD treatment, and 3) to explore the impact of methodological quality on obtained treatment outcomes.

Methods: The literature search was conducted via databases EMBASE, Medline Ovid, Web of science, Cochrane CENTRAL, PsycINFO Ovid and Google scholar. Studies were considered eligible if they were longitudinal studies on interventions aimed at treating or preventing PTSD in TBI patients. The search was restricted to papers involving adult (16+) participants and published between 1980 and February 2018 in English. The quality of included studies was assessed with the RTI item bank. Case studies were included for a separate overview.

Results: 20 studies (19 publications) and 23 case studies (18 publications) were included. The majority of studies described types of cognitive-behavioral therapy (CBT), usually as part of comprehensive treatment programs, in male (ex)military patients in the US. They typically sustained a (mild) TBI at least one year before treatment. Civilian studies involved early treatment to prevent PTSD shortly after a mild TBI. CBT, cognitive-processing therapy (CPT) and prolonged exposure (PE), predominately showed favorable PTSD outcomes. The relationship between TBI severity and treatment gains was inconsistent between studies that involved patients across TBI severity spectrum. In addition, a smaller number of studies described other types of therapies with mainly promising results, such as complementary and alternative medicine, hyperbaric oxygen therapy, brain and vestibular rehabilitation, and neurotherapy. Overall, the quality of studies was low due to lack of a control group, many concurrent therapies, and insufficient follow-up time.

Conclusion: PTSD treatments, particularly PE, CPT and CBT, seem appropriate for the TBI population. The evidence is less strong for patients with moderate to high TBI severity and other types of therapies, and for civilian patients with current and chronic PTSD. High-quality controlled studies of available PTSD treatments in civilian and military patients are required, particularly involving participants of both genders and with higher TBI severity.

Keywords: posttraumatic stress disorder, traumatic brain injury, psychotherapy, treatment effectiveness, systematic review.
Watch Out for Terson! - Neurorehabilitation Meets Ophthalmology in Good Practice

**Sylvia Poortenga**

*Heliomare Rehabilitation Center, Wijk aan Zee, Netherlands*

Objectives: Terson syndrome refers to vitreous hemorrhage accompanying acute hemorrhagic vascular brain injury. Terson syndrome occurs in 8-19.3% of patients with subarachnoidal haemorrhage (SAH), 9% of patients with intracerebral hemorrhage (IH), and in 3% of patients with traumatic brain injury (TBI). Visual function problems are sometimes overlooked in the acute phase of vascular brain damage. Occasionally, the rehabilitation doctor in a post-acute neurorehabilitation center is the first to learn about them. Terson syndrome is not rare but may be underdiagnosed in neurorehabilitation due to unfamiliarity with the syndrome. It deserves more attention, moreover because sometimes ophthalmological surgery is indicated, with fine outcome in visual acuity.

Methods: In a presentation the ins and outs of Terson syndrome will be discussed: symptoms, pathogenesis, relationship to neurological outcome, diagnosis, treatment and prognosis. Two case studies of patients with Terson who were admitted to the Dutch Department of Clinical Neurorehabilitation at Heliomare Rehabilitation Center, Wijk aan Zee, are included.

Results: In these case studies, recognition of Terson syndrome in the post-acute phase resulted in vitrectomy with substantial gain in visual acuity directly postoperative, respectively 8 and 10 weeks after the onset of Tenson. There’s a strong indication that the best result of a vitrectomy is achieved when surgery takes place within 3 months after onset. Fundoscopy is the golden diagnostic standard, so involving an ophthalmologist is necessary when the diagnosis is considered. In Dutch regional hospitals Terson syndrome appeared to be relatively unknown among neurologists and neurosurgeons. Not even university hospitals appeared to have an ophthalmologist do a routine check of patients with severe vascular brain injury, who run the major risk to Terson syndrome. Even fewer rehabilitation doctors were familiar with Terson.

Conclusion: Recognizing Terson syndrome: vitreous hemorrhage accompanying SAH, IH and TBI, is not easy for rehabilitation doctors, mostly because of their unfamiliarity with the syndrome. Keeping an eye out for Terson and quickly involving an ophthalmologist when Terson is suspected, can be considered an example of good practice for neurorehabilitation doctors, but also for neurologists and neurosurgeons.
Adding Expertise on Disorders of Visual Perception to Cognitive Rehabilitation– An Example of Good Practice

*Sylvia Poortenga*¹

¹Heliomare Rehabilitation Center, Wijk aan Zee, Netherlands

Objectives: Eight years ago, the Dutch Department of Clinical Neurorehabilitation Heliomare, Wijk aan Zee, established a collaboration with Bartiméus, an institute with expertise in analysis and treatment of patients with visual impairment. In Heliomare post-acute ABI patients with cognitive problems rehabilitate towards safe and independent home functioning and return to work. Around 50% have visual complaints. Inpatient consultation was organized to facilitate the accessibility of Bartiméus.

Methods: Every month an optometrist and a neuropsychologist see inpatients for a 60 minutes checkup with visual functional examination and assessment of higher cortical visual function. A report follows within one week. Recommendations vary from ophthalmological treatment, optometric follow-up, correctional glasses for reading, advice concerning mobility outside the home, computer adaptations, to Bartiméus home training programs after clinical rehabilitation.

Results: Our ABI patients with impaired visual perception appreciate Bartiméus very much. They are often very worried about their visual problems and are quite happy when expert opinion is available to them, and that they receive a full report. The results help the neurorehabilitation team in analyzing problems and in choosing therapeutic interventions. Patients with severe cognitive deficits can be assessed in the early stages of neurorehabilitation, so their benefit from clinical neurorehabilitation increases. Due to the success of our collaboration, Bartiméus now also examines ABI patients in our outpatient neurorehabilitation clinic.

Conclusion: In clinical cognitive rehabilitation setting ABI patients benefit from bringing in expertise on visual impairment. Patient satisfactory is high. They appreciate the expert opinion and recommendations for further treatment or guidance. The examination results help improve a patient’s individual rehabilitation program. Organizing the examinations inside Heliomare Neurorehabilitation Clinic improves accessibility and enables early assessment of patients with severe cognitive deficits. We consider involving an institute with expertise in analysis and treatment of patients with visual impairment an example of good practice in cognitive rehabilitation for ABI patients.
Fall-related Traumatic Brain Injury in Children Ages 0-4 years: National Electronic Injury Surveillance System - All Injury Program, 2001-2013

Juliet Haarbauer-krupa, Tadesse Haileyesus, Julie Gilchrist, Karen Mack, Caitlyn Law, Andrew Joseph

1Division of Unintentional Injury, Centers for Disease Control and Prevention (CDC), Atlanta, United States, 2Division of Analysis, Research and Practice Integration, Centers for Disease Control, Atlanta, United States, 3Rollins School of Public Health, Emory University, Atlanta, United States, 4Wallace H. Coulter Department of Biomedical Engineering, Georgia Institute of Technology, Atlanta, United States

Background: Falls are the leading cause of traumatic brain injury (TBI) for children in the 0 to 4-year age group. There is limited literature pertaining to fall-related TBIs in children age 4 and under and the circumstances surrounding these TBIs. This study provides a national estimate and describes actions and products associated with fall-related TBI in this age group.

Method: Data analyzed were from the 2001–2013 National Electronic Injury Surveillance System - All Injury Program (NEISS–AIP), a nationally representative sample of all records from a sample of emergency departments (ED). Case narratives for fall-related TBIs were coded for actions associated with the fall, and product codes were abstracted to determine fall location and product type. All estimates were weighted to national estimates.

Results: An estimated 139,001 children aged 4 years and were treated annually in EDs for nonfatal, unintentional fall-related TBI injuries (total=1,807,019 during 2001-2013) and released to home. Overall, child actions, (e.g. running) accounted for the greatest proportion of injuries and actions by others (e.g. carrying) was highest for children younger than 1 year. The majority of falls occurred in the home, and involved surfaces, fixtures, furniture, and baby products.

Conclusions: Fall-related TBI in young children represents a significant public health burden. The majority of injuries occurred in the home and most children returned to home after their ED visit. Prevention efforts that target the home environment are indicated.

**Fanny Dégeilh**, **Cathy Catroppa**, **Vicki Anderson**, **Miriam Beauchamp**

1Department of Psychology, University of Montreal, Montreal, Canada, 2Saint-Justine Research Center, Montreal, Canada, 3Department of Child Neuropsychology, Murdoch Children’s Research Institute, Melbourne, Australia, 4Department of Psychology, Royal Children’s Hospital, Melbourne, Australia, 5Department of Psychological Sciences University of Melbourne, Melbourne, Australia

**Background:** Early childhood is a period of rapid brain development characterized by profound changes in grey matter morphometry. Brain injury occurring during this period may impact child brain development differently than in older pediatric groups, with possible long-lasting consequences on child functioning. Pediatric traumatic brain injury (TBI) has been associated with regional grey matter atrophy (Mayer et al., 2015; Ryan et al., 2016). Children included in the studies conducted so far mostly sustained TBI after the age of 10 years. Thus, while TBI is particularly prevalent in children younger than 6 years, the impact of TBI on the brain structure of very young children is still poorly understood. The aim of the present case series was to investigate grey matter brain structure in the very long-term after TBI before the age of 4 years.

**Method:** Two adolescents (mean age: 14.6y) who sustained a severe TBI at 39 and 45 months of age (early-TBI), 10 adolescents (mean age: 16.6y) who sustained a severe TBI between 9.7 and 15.2 years of age (adolescent-TBI group; mean age at injury: 13.2y), and 15 adolescents (mean age: 15.8y) with no history of brain injury (no-TBI group) underwent magnetic resonance imaging (MRI). Processing of structural images (T1-weighted) was performed in SPM12. W-scores (i.e., age and sex-adjusted Z-scores) were calculated voxel-to-voxel to compare the two early-TBI participants with both the adolescent-TBI and the no-TBI groups. W-scores inform on the difference between the observed value of one participant and the expected value in the comparison group for the participant’s age and sex. W-scores were thresholded at 2.33 corresponding to a p-value of .001.

**Results:** The two early-TBI participants had significantly more grey matter volume in the temporal gyrus (inferior, superior and pole) than both those in the adolescent-TBI and in the no-TBI groups.

**Discussion:** Although limited to two cases, the present study provides rare evidence that early TBI may be associated with long-lasting changes in temporal grey matter volume. Children who sustain severe TBI during early childhood show greater grey matter volume in the temporal gyrus more than 10 years post-injury, compared with children who sustain TBI in later childhood/adolescence or who are uninjured. In contrast, severe TBI sustained during adolescence has been associated with volumetric reductions in regions of the social brain network that include the temporal gyrus (Ryan et al., 2016). Early and late pediatric TBI may differentially impact the developing brain, possibly depending on the developmental stage of brain maturation (i.e., synaptogenesis at earlier ages vs. synaptic pruning at later ages).
Heart Rate Variability Biofeedback Training for Persistent Mild Traumatic Brain Injury Symptoms

Vanessa Watorek\textsuperscript{1}, Ayse Unsal\textsuperscript{1}
\textsuperscript{1}Hamilton Health Sciences, Hamilton, Canada

We propose a pilot study evaluating the effectiveness of Heart Rate Variability Biofeedback training (HRVB) for individuals with mild traumatic brain injury (mTBI) or concussion. Concussion results in persistent symptoms for 15 percent of adults (Guideline for Concussion, 2018, Ontario Neurotrauma Foundation). In particular, some individuals may exhibit a change in autonomic function reflected in reduced heart rate variability (HRV), which prevents them from effectively regulating their physiological response to stressors and is also associated with changes in sleep and mood (Galea, Cottrell, Treleaven, and O’Leary, 2018).

Although sub-threshold exercise regimens have been found to improve concussive symptoms in those with physiological dysfunction of the autonomic nervous system, this intervention may be contraindicated for those with cardiac or cervical spine issues (Ellis, Leddy & Willer, 2015). Thus, an alternative approach to this treatment is HRV Biofeedback (HRVB), in which individuals are trained to increase HRV daily for a prescribed period by practicing Respiratory Sinus Arythmia (RSA). HRVB has been hypothesized to increase baroreceptor gain by strengthening the vagal component of HRV and may assist in inhibiting sympathetic output. This method has also been shown to improve other psychological and physiological conditions (Leher & Gevirtz 2014). Prior research on HRV Biofeedback has generally targeted those with moderate or severe brain injury and research for those with mild TBI has been limited to case studies (e.g., Francis, Fisher, Rushby, & McDonald, 2016). Therefore, this pilot study aims to address these limitations by examining the feasibility of HRV Biofeedback and training in an outpatient concussion sample (n = 30). Specifically, this study will utilize a within-subjects design to assess cognitive, behavioural, mood, sleep, pain, vestibular, EEG, and HRV functioning at three time points: baseline, post-training (11 weeks), and at six months follow up. It is hypothesized that the HRV Biofeedback training will result in increased HRV, and relationships between other symptoms and HRV will be investigated.
Characterization of Speech and Language Impairment in Subacute Preschool Traumatic Brain Injury: A Retrospective Chart Review

Carly Cermak1,2, Deryk Beal1,2,3
1Bloordview Research Institute, Holland Bloordview Kids Rehabilitation Hospital, Toronto, Canada, 2Rehabilitation Science Institute, University of Toronto, Toronto, Canada, 3Department of Speech-Language Pathology, University of Toronto, Toronto, Canada

Objectives: Childhood Traumatic Brain Injury (TBI), regardless of severity, is a complex condition associated with impairments in attention, memory, executive functions, and language, consequently impacting performance in academic and social settings long-term. A critical gap in knowledge, however, lies in the speech and language outcomes in the initial stages of early childhood TBI before cognitive communication impairments become evident in academic settings. As an initial step towards bridging this gap, we completed a retrospective chart review on speech and language outcomes in preschool children after TBI. The primary aim of the chart review was to characterize the speech and language impairments experienced by preschool children in the subacute recovery stage (< 3 months of injury).

Methods: A retrospective chart review of 50 preschool aged children with a confirmed diagnosis of moderate to severe TBI was performed. Charts of children that sustained a TBI between the age of 15 months to 5 years 11 months and who were inpatients on the brain injury rehabilitation unit at Holland Bloordview Kids Rehabilitation Hospital between 1 January 2007 to 31 December 2016 were included. Data extracted from charts included demographics (e.g. sex, age at injury, languages spoken), pre-injury factors (e.g. reported language delay), injury-related factors (e.g. mechanism of injury, orthopedic injuries), and speech and language data (e.g. assessments used, standardized scores).

Results: Seventy-two percent of the population was male (n=36) and the average age at injury was 3.66 years (SD = 1.39 years). The highest incidences of TBI were from falls (n=17) followed closely by motor vehicle collisions (n=15). Twenty-eight percent (n=14) of children were documented to have oral motor (e.g. asymmetrical movement of tongue, jaw) and/or motor-speech impairment (e.g. dysarthria). The language domain of greatest individual variability at the time of inpatient admission was expressive language, particularly vocabulary (M=96.28, SD=21.90, n=11). The overall mean of ‘total language scores’ (combined total of receptive and expressive language subtests) was within average based on standardized assessment scores, (M=91.80, SD=12.25, n=20), however, thirty percent (n=6) of these scores fell below average (<85 standard score), two of which were dual-language learners. Interestingly, yet not statistically significant, for children with additional assessment at discharge (n=5), expressive language showed the largest improvement while receptive language scores remained consistent.

Conclusion: Our study provides a new understanding of the speech and language profiles of preschoolers with moderate to severe TBI within the subacute stage of recovery. Our study emphasizes the importance of thorough language assessment, as examination of core language skills (i.e. total language scores) does not render enough information to elucidate the complexities of language impairment experienced by this population. Lastly, our data will inform future early childhood TBI studies of predictive factors of speech, language, and cognitive communication outcome.
Cannabis Use in Individuals with Moderate to Severe Traumatic Brain Injury or Spinal Cord Injury in Colorado

Lenore Hawley¹, Jessica Ketchum¹, Clare Morey¹, Kathleen Collins¹, Susan Charlifue¹
¹Craig Hospital, Englewood, United States

Objective: To describe the prevalence of cannabis use in an adult population with traumatic brain injury (TBI) or spinal cord injury (SCI); and to describe the self-reported reasons and side effects of cannabis use in this population.

Design and Methods: Descriptive mixed methods observational study, using focus group data and telephone survey

Setting: Community

Participants: Colorado adults who have sustained TBI or SCI and were enrolled in the TBI Model System or SCI Model System.

Results: Focus group participants identified issues that were then included in the survey development. Seventy percent of the 116 participants surveyed reported cannabis use before their injury (67% SCI, 74% TBI) and 48% reported use after their injury (53% SCI, 45% TBI). Overall, the most common reason for use was recreational (67%), followed by reducing stress/anxiety (62.5%) and improving sleep (59%). Among the respondents with SCI, the most common reasons for use were to reduce spasticity (70%), recreation (63%), and to improve sleep (63%). Among those with TBI, reasons endorsed were recreational (72%), reducing stress/anxiety (62%), and improving sleep (55%). Smoking was the most common method of use. Negative side effects noted included decreased motivation, fatigue and social stigma.

Conclusions: A majority of this sample report using cannabis prior to injury, and approximately half report using cannabis post-injury. Both SCI and TBI groups report recreational use, while the group with SCI also highly endorses using cannabis to address chronic medical conditions. Clinicians should be aware of the high prevalence of cannabis use in these populations and the impact such use may have on the individual’s medical management. Further research in this area is needed.
Characterizing Symptoms of Traumatic Brain Injury in Survivors of Intimate Partner Violence

Paul van Donkelaar¹, Elisabeth Jones¹, Paige Copeland¹, Jonathan Smirl¹

¹University of British Columbia, Kelowna, Canada

This study examined the extent to which symptoms associated with potential traumatic brain injury (TBI) in women who have experienced intimate partner violence (IPV) overlap with symptoms typically present after a sport-related concussion (SRC). This was accomplished by comparing the responses of a group of IPV survivors on the Brain Injury Severity Assessment (BISA) tool, an IPV-specific questionnaire developed to assess symptoms of TBI in this population; and the Sport Concussion Assessment Tool (SCAT5), a questionnaire commonly used in diagnosing and managing SRC. In addition, psychopathological assessments of post-traumatic stress disorder (PTSD), depression, and anxiety were also completed to account for any potential confounding influence of these factors on TBI symptom reporting. Eighteen women who had experienced IPV were recruited from agencies providing services to this population, primarily a high-barrier community-based women’s shelter. Results showed that the total number of reported brain injuries were higher when employing the BISA compared to the SCAT5, the strongest symptom based correlations linked to the extent of brain injury were associated with arousal states (“Fatigue”, “Anxious”, “Drowsiness”, “Just Don’t Feel Right”) or aspects of memory and cognition (“Difficulty Concentrating”, “Difficulty Remembering”), and the extent of brain injury as determined by both the BISA and SCAT5 was related to the degree of depression and anxiety but not that of PTSD. Taken together, these findings can contribute to the development of enhanced screening tools and supports to help front-line staff at women’s shelters identify TBI as a possible contributor to the challenges faced by IPV survivors. By this means, women who have experienced IPV will be more likely to break the cycle of abuse and have more positive long-term health outcomes.
Empowering Individuals with Brain Injury through Self-Advocacy: A Continuum of Research

Lenore Hawley¹, Clare Morey¹, Jessica Ketchum¹, Donald Gerber¹, Cynthia Harrison-Felix¹
¹Craig Hospital, Englewood, United States

Objective: To outline a continuum of research on self-advocacy (SA) for individuals with brain injury, including measurement development, a treatment feasibility study, and a current Randomized controlled treatment trial (RCT). This body of research investigates the efficacy of the Self Advocacy for Independent Life (SAIL) treatment intervention, aimed at increasing SA beliefs, knowledge, and skills for individuals living with brain injury.

Problem: Brain injury has been conceptualized as a chronic health condition, warranting SA across a lifespan. Individuals often need resources not required prior to the injury yet may lack the self-efficacy, knowledge, and skills required for successful SA. Self-advocacy can be challenging for individuals with TBI as injury related impairments may impact the very skills needed for SA, including self-assessment, problem-solving, and communication. Programs to enhance SA have been developed for individuals with various disabilities and their families, but there is little evidence of interventions to increase SA for individuals after brain injury. Tools to measure SA are lacking, particularly specific to this population.

SA Measurement Development: An instrument development study was completed, using expert panel review with a content validity index, consumer survey, and Rasch analysis. The Self-Advocacy Scale (SAS), a measure of advocacy self-efficacy, and the Personal Advocacy Activity Scale (PAAS), a measure of advocacy activity, were found to be reliable and valid measures of personal advocacy activity and associated self-efficacy for individuals post brain injury.

Treatment Feasibility Study: Two-arm, parallel randomized pilot study, involving 12 individuals one year or more post BI living in the community; designed to assess the feasibility of the methodology for a RCT investigating the efficacy of SAIL intervention.

Results: Feasibility was demonstrated for the methodology, and positive trends in this small sample were noted. The treatment group exhibited improvements from baseline to post-treatment on the measures (self-efficacy, advocacy behaviors, and life satisfaction). The control group improved on the General Self-Efficacy Scale (GSES) only, declining on all others. The SAS and PAAS both differentiated improvement in the treatment group.

Randomized Controlled Trial: An RCT is currently underway, to investigate the efficacy of the SAIL intervention. Primary Hypothesis: Participants receiving the intervention will demonstrate significantly greater improvements in SA baseline to post-treatment as compared to the control group, measured by the SAS.

Methodology: RCT, 80 community-dwelling individuals from 5 geographic areas of Colorado; 9 months or more post TBI. Measures: SAS, PAAS, GSES, Satisfaction with Life Scale (SWLS), Flourishing Scale (FS), and PART-O.

Treatment Intervention: 4 session SA group with 2 individual phone contacts. Control condition: Assessment only, receive workbook after assessment.
Current Status Update: This NIDILRR funded RCT has received IRB approval. Enrollment and intervention are taking place in 5 geographic waves, with Wave 1 completed and Wave 2 underway.
Time Course of Coagulation and Fibrinolytic Parameters in Patients with Traumatic Brain Injury

Ryuta Nakae¹, Shoji Yokobori¹, Yasuhiro Takayama¹, Takahiro Kanaya³, Yu Fujiki², Yutaka Igarashi³, Go Suzuki², Yasutaka Naoe², Akira Fuse¹, Hiroyuki Yokota¹

¹Department of Emergency and Critical Care Medicine, Nippon Medical School, , Japan, ²Emergency and Critical Care Center, Kawaguchi Municipal Medical Center, , Japan

Background: Traumatic brain injury (TBI) has long been associated with coagulopathy; however, the time course of coagulation/fibrinolytic parameters in the acute phase of TBI remains unclear.

Objective: To analyze the time course of coagulation/fibrinolytic parameters in the acute phase of TBI and to elucidate parameter relationships to prognosis.

Methods: We retrospectively evaluated 234 patients with severe isolated TBI with initial blood samples obtained no more than 1 hour after injury. Platelet count, prothrombin time, activated partial thromboplastin time (aPTT), plasma levels of fibrinogen, and D-dimer were measured on arrival and 3, 6, and 12 hours after injury. Multivariate logistic regression analysis was performed to identify risk factors for poor prognosis at each time point.

Results: From admission to 12 hours after injury, an elevated D-dimer level was a significant negative prognostic indicator (admission: p < 0.0001; 3 hours after injury: p = 0.0005; 6 hours after injury: p = 0.005; 12 hours after injury: p = 0.0009). An upward trend of aPTT on admission and 3 hours after injury was also a significant negative prognostic indicator (admission: p = 0.0011; 3 hours after injury: p = 0.013). On multivariate logistic regression analysis which included all initial variables, independent risk factors for poor prognosis included older age (p = 0.0005), low Glasgow Coma Scale score (p < 0.0001), high Abbreviated Injury Score (p = 0.015), aPTT > 30.2 seconds (p = 0.019), and elevated D-dimer level (p = 0.0005).

Conclusion: D-dimer is the best coagulation/fibrinolytic parameter to monitor for prediction of outcome.
Concussion Essentials: Piloting a Clinical Trial to Reduce Persisting Symptoms Following Child Concussion

**Vicki Anderson**1,2,3,4, Michael Takagi1,2, Gavin Davis1, Audrey McKinlay1,2, Peter Barnett7, Alison Crichton1, Stephen Hearps1, Cathriona Clarke1, Vanessa Rausa1, Nicholas Anderson1, Kevin Dunne1,6, Franz Babl1,3,5

1Murdoch Children's Research Institute, Parkville, Australia, 2Melbourne School of Psychological Sciences, University of Melbourne, Parkville, Australia, 3Department of Paediatrics, University of Melbourne, Parkville, Australia, 4Psychology Service, Royal Children's Hospital, Parkville, Australia, 5Emergency Department, Royal Children's Hospital, Parkville, Australia, 6Department of Rehabilitation Medicine, Royal Children's Hospital, Parkville, Australia, 7Royal Children's Hospital, Melbourne, Australia

**Background and Objectives:** By the age of 10, 1 in 5 children will sustain a concussion and suffer acute post-concussion symptoms (PCS). Most children recover spontaneously, but ~40% experience ‘persisting PCS’ lasting 4 weeks or more. The causes of common PCS can be multifactorial (e.g., cognitive disruption) thus a multimodal treatment approach is necessary to address them. Concussion Essentials (CE) is a child-specific multimodal treatment program to facilitate recovery from concussion. The aim of CE is full PCS resolution as measured by the Post-Concussion Symptom Inventory.

**Method:** To pilot CE, we recruited a sample of 9 children who remained symptomatic at 4 weeks post-concussion. Their recovery was compared to that of our prospective longitudinal cohort which included identical time points. CE is an 8-week program, comprised of symptom-specific modules delivered by a multidisciplinary team of paediatricians, neuropsychologists, and physiotherapists, with treatment content determined by individual participant symptoms.

**Results:** 9 participants completed the intervention. Paired-sample t-tests revealed a significant decline in symptoms (p=0.01) relative to baseline. Further, upon completion of the intervention, 80% had fully returned to school (62.5 at baseline), 80% had fully returned to sport (50% at baseline) and 100% had returned to normal activities (50% at baseline).

**Conclusions:** Preliminary evidence supports the efficacy of CE to reduce PCS in children with delayed recovery post-concussion.

**Correspondence:** Vicki Anderson, Vicki.Anderson@rch.org.au
Community Rehabilitation: Strengthening Independence Regardless of Time Since Acquired Brain Injury

Elly Williams¹, Angelita Martini¹, Janet Wagland¹, Lynne Turner-Stokes²,³
¹Brightwater Care Group, Perth, Australia, ²King’s College London, London, United Kingdom, ³Northwick Park Hospital, Harrow, United Kingdom

Previous studies have proposed that the earlier an individual enters a post-acute or community-based rehabilitation service following an Acquired Brain Injury (ABI), the greater improvement in impairments they will make (Hayden et al. 2012; High et al. 2006; Jackson et al. 2017, Micklewright et al. 2011). However, gains can be made in varying cognitive and functional areas when entering community rehabilitation greater than one year following ABI (Hayden et al. 2012; Malec et al. 1993). Also, rehabilitation following ABI is not consistently recommended, nor available to all who would benefit. Providing a program of rehabilitation to improve independent living skills could have long-term impact on improving quality of life and decreasing cost of care. The aim of this study was to determine if gains made by people with an ABI undergoing community rehabilitation in Western Australia were impacted by time between injury and admission to rehabilitation.

Routinely collected demographic and rehabilitation data from n=92 clients admitted to the community rehabilitation service between August 2011 and September 2017 was retrospectively analysed. The data measured functional ability and participation and was collected on admission and yearly review using the Mayo-Portland Adaptability Inventory-4 (MPAI-4) and Functional Independence Measure/Functional Assessment Measure (FIM+FAM). Analysis was stratified by times since injury: <1-year post ABI (n=36), 1-2 years post ABI (n=34) and >2 years post ABI (n=22). Total and subscale scores were analysed using parametric statistics with bootstrapping (sample size n=1000). Between group differences were tested using one-way ANOVA with post-hoc Bonferroni correction, and within group differences were tested using paired T-tests.

The total cohort made significant gains in MPAI-4 Total (p<0.01) and all subscales; Ability (p<0.01), Adjustment (p<0.01) and Participation (p<0.01); FIM+FAM Total (p<0.01), Motor (p<0.01), Cognitive (p<0.01) and Extended Activities of Daily Living (EADL) (p<0.01). People admitted <1-year post injury made the greatest amount of change in all subscales of both outcome measures and all changes were statistically significant (p<0.01). The 1-2 years post injury cohort made the second greatest amount of change and improved significantly in all subscales (p<0.02) excluding MPAI-4 Adjustment. The >2 years post injury cohort made the least amount of change although still made statistically significant gains in all FIM+FAM subscales (p<0.05) and the MPAI-4 Participation subscale (p<0.01). All groups were able to make significant gains in participation, giving them greater ability to integrate successfully into the community following one year of rehabilitation, regardless of time since injury.

Regardless of time between injury and admission, people made functional and cognitive improvements. Rehabilitation is effective at increasing independence of people at any time following ABI. It is important and valuable for health services and systems to allow people rehabilitation following acquired brain injury regardless of time since injury.
The treatment of complex disability is an increasingly critical issue within modern medicine, especially in neurorehabilitation, now that many people survive profound injuries, when previously such conditions would have proved fatal. Traumatic brain injury (TBI) is a case in point, where, while it remains the most frequent cause of death of young men, it is also the most common cause for survivors’ unemployment. Some functions can be compensated for by the use of intact facilities and environmental factors (facilitators), but the concept of disability has become an umbrella term in the international context for functional disorders, activities, participation and environmental factors.

These concepts are the basic pillars of the International Classification of Functioning, Disability and Health WHO (ICF). In 2007 at a conference in Milan, the European Commission, the Organization for Economic Cooperation and Development (OECD), representatives of the WHO, the UN, other European organisations representing citizens with disabilities agreed that ICF would be used as a basic methodology for evaluating the functional abilities.

We developed Core Sets for TBI patients in the 6th Framework program of the EU: Measuring Health and Disability in Europe - Supporting policy development (MHADIE). After applying this Core Set for more than 6 years, we decided to prepare a condensed version for everyday use. We divided categories according to the specialisations of our inter-professional rehabilitation team, resulting in a definitive version for acquired brain injury patients.

The rights of disabled persons are increasingly becoming part of the legislation. We are preparing the new legislation in the field of medical, social, educational and vocational rehabilitation according ICF in Czech Republic.

The European Union and the other countries of the world need good-quality, reliable and comparable data. Without this data, it is impossible to understand and evaluate the development of the overall situation of disabled persons after ABI. From this point of view, ICF is of immense importance, as it forms a conceptual framework permitting further developments in this area.
Default Mode Network Functional Connectivity After Multiple Concussions in Children and Adolescents

Vickie Plourde¹, Christiane Rohr², Shane Virani², Signe Bray², Keith Yeates², Brian Brooks²

¹University of Alberta, Edmonton, Canada, ²University of Calgary, Calgary, Canada

Background: Increased concussion awareness over the past decades and the development of advanced neuroimaging techniques have led to a rise of studies on the acute and subacute effects of concussion on brain functioning in children and adolescents. The default mode network (DMN), a set of brain regions most active during rest, has been highlighted as one network potentially affected. There is currently a lack of studies looking at long-term post-concussion effects on the DMN and investigating differences in DMN connectivity in youth reporting multiple concussions versus a single concussion.

Objective: This research aims to elucidate if long after the injury, youth with multiple concussions present altered DMN functional connectivity in comparison to participants with one concussion or with an orthopedic injury.

Methods: Participants (N=57, 27 girls and 30 boys; M=14.7, SD=2.8, range from 8 to 19 years old) were seen on average 31.56 months post-injury (SD=19.4). They were divided in three groups (orthopedic injury and no concussion=20; one concussion=16; multiple concussions=21) and underwent a resting-state functional magnetic resonance imaging (rsfMRI) scan, followed by the completion of the ADHD Rating Scale-5 for Children and Adolescents (parent-report – only inattention score reported) and the Post-Concussion Symptom Inventory (PCSI; self- and parent-report). Anterior and posterior DMN components were extracted from the fMRI data using FSL’s MELODIC. A dual regression resulted in a set of participant-specific spatial maps for each DMN component. We then tested for pairwise group differences using the respective DMN component as a mask in FSL’s Randomise (5000 permutations) and threshold-free cluster enhancement to estimate cluster activation. We then tested for group differences at a threshold of p<0.01 family-wise error corrected (controlling for age, sex, and inattention symptoms).

Results: Functional connectivity of the anterior DMN was significantly reduced in the group with multiple concussions (M=3.2 concussions, SD=1.7) compared to the two other groups (single concussion and orthopedic injury) whereas functional connectivity of the posterior DMN was not significantly different between groups. Supplementary analyses also revealed no significant associations between the DMN functional connectivity and PCSI scores for any of the three groups.

Conclusions: These results suggest reduced connectivity in the anterior part of the DMN in children and adolescents who had multiple concussions, with no clear links to post-concussive symptoms. This underlines the need for future longitudinal studies using rsfMRI to evaluate DMN changes over time post-injury and to identify predictors of DMN hypoconnectivity in those with multiple prior concussions.
Advice to Rest for More Than Two Days After Mild Traumatic Brain Injury is Associated with Delayed Return to Productivity: A Case-Control Study

Noah Silverberg¹, Thalia Otamendi¹
¹University of British Columbia, Vancouver, Canada

Objectives: Recent expert agreement statements and evidenced-based practice guidelines for the management of mild traumatic brain injury (mTBI) no longer support advising patients to “rest until asymptomatic,” and now recommend gradual return to activity after 1-2 days of rest. The present study aimed to: (i) document the current state of de-implementation of prolonged rest advice, (ii) identify patient characteristics associated with receiving prolonged rest advice, and (iii) examine the relationship between exposure to prolonged rest advice and clinical outcomes.

Methods: In a case-control design, participants were prospectively recruited from two concussion clinics in Canada’s public health care system. At clinic intake, participants (i) provided their demographic characteristics, injury details, and current work/school status, (ii) responded yes or no to the question “Were you advised by at least one health professional to rest for more than 2 days after your injury?”, and (iii) completed standardized questionnaires, including the Rivermead Postconcussion Symptom Questionnaire, Personal Health Questionnaire-9, and Generalized Anxiety Disorder-7.

Results: Eligible participants (N=146) were assessed at an average of 41.2 days post-injury (SD=26.7). The majority were women (67.1%) and Caucasian (60.7%), with a mean age of 40.6 years (SD=12.2). 82.9% of participants reported being advised to rest for more than 2 days (exposure group). Advice to rest was not associated with patient characteristics; that is, participants were no more or less likely to have been told rest if they were women (95% confidence interval for odds ratio = 0.48 to 2.91), Caucasian (0.87 to 6.28), older (0.93 to 1.01), had a history of prior concussion(s) (0.21 to 1.20) or psychiatric problems (0.40 to 2.30), if their index mTBI involved a loss of consciousness (0.23 to 2.10), or if they had access to financial compensation for their injury (0.50 to 2.92). In generalized linear modeling, exposure to prolonged rest advice predicted return to productivity status at clinic intake (β=-1.06, chi-squared(1) = 5.28, p= 0.02; 64.5% in the exposure group vs. 40.0% in the control were on leave from work/school, 19.8% vs. 24.0% partially returned, and 11.6% vs. 24.0% fully returned). The exposure group also had marginally (non-significantly) higher post-concussion, depression, and anxiety symptoms.

Conclusions: Many patients who sustain an mTBI continue to be advised to rest for longer than expert agreement statements and practice guidelines recommend. Knowledge of who is more likely to be told to rest could inform strategic de-implementation of this clinical practice. We could not identify patient characteristics associated with getting prolonged rest advice. However, the present study adds to the body of evidence that advice to rest for more than 2 days after an mTBI is generally unhelpful. Patients exposed to prolonged rest advice were less likely to have resumed work/school at 1-2 months post-injury.
Factors Associated with Concussion Symptom Knowledge and Attitudes Towards Concussion Care-Seeking Among Parents of Children Aged 5-10 Years

Juliet Haarbauer-krupa, Avinash Chandran, Aliza Nedimyer, Melissa Kay, Paula Gildner, K. Hunter Byrd, Johna Register-Mihalik, Zachary Kerr

1Division of Unintentional Injury, Centers for Disease Control and Prevention (CDC), Atlanta, United States, 2University of North Carolina, Chapel Hill, United States

Objectives: Concussion is challenging to prevent, identify, and manage. When considering these challenges among young children, there needs to be a focus on parents as they typically direct concussion identification and care. This study aimed to understand concussion symptom knowledge and concussion care-seeking attitudes among parents of children aged 5-10 years.

Methods: We used a third-party company that recruits United States (US) residents to participate in survey research. This company randomly selected 400 individuals aged 18 years and identifying as parents of children aged 5-10 years to complete our self-administered online questionnaire. The questionnaire assessed parent demographics, parents’ self-identified competitiveness (based upon a pre-validated multi-item scale), and organized sports participation for their children aged 5-10 years. Primary outcomes included in the questionnaire originated from pre-validated measurements. First, concussion symptom knowledge consisted of 25 “yes/maybe/no” items, with correct answers earning 2 points, “maybe” answers earning 1 point, and incorrect answers earning 0 points (range=0-50; higher=better symptom knowledge). Second, concussion care-seeking attitudes consisted of five, 7-point scale items (range=5-35; higher=more positive care-seeking attitudes). Given their discrete ordinal nature, outcomes were categorized into three ordinal levels using ~33% increments to determine the relative cut-points (e.g., for knowledge; 0-16, 17-33, 34-50). Multivariable ordinal logistic regression models identified predictors of higher score levels for each outcome. All models met proportional odds assumptions. Odds ratios (OR) with 95% confidence intervals (CI) excluding 1.00 were deemed significant.

Results: Most respondents were female (70.0%), white non-Hispanic (76.5%), without a college degree (52.3%), and with children aged 5-10 years playing organized sports (72.3%). Mean parent age was 35.8±7.6 [median=35, interquartile range (IQR)=31-39]. We observed mean scores of 36.7±9.3 (median=39, IQR=32-44) for concussion symptom knowledge and 30.2±5.8 (median=32, IQR=28-35) for concussion care-seeking attitudes; both descriptives reflect high symptom knowledge and care-seeking attitudes in our sample. In multivariable models, odds of better knowledge level were higher with increased parental age (10-year increase ORAdjusted=1.74; 95%CI=1.23-2.47), with increased competitiveness (10% scale increase ORAdjusted=1.28; 95%CI=1.07-1.52), in female versus male parents (ORAdjusted=4.49; 95%CI=2.68-7.52), and in white non-Hispanic versus nonwhite parents (ORAdjusted=2.08; 95%CI=1.25-3.44). Odds of more positive concussion care-seeking attitudes were higher among parents with a college degree versus no college degree (ORAdjusted=2.02; 95%CI=1.12-3.65). Odds were not associated with whether parents’ children aged 5-10 years played organized sports (knowledge ORAdjusted=0.95; 95%CI=0.54-1.67; attitudes ORAdjusted=1.64; 95%CI=0.91-2.97).

Conclusions: Parent demographics are associated with concussion symptom knowledge and concussion care-seeking attitudes for parents of children aged 5-10 years. Differences by gender, race/ethnicity, and college educational attainment highlight the potential benefit of tailored strategies for parents regarding
concussion prevention for their young children. Further, the lack of associations with children’s organized sports participation endorses approaches offering messages to all parents and considering multiple causes of concussion beyond sport participation.
A Better Standard of Practice: Baseline Cognitive Assessment for All

Kevin Carroll¹, Mylea Charvat¹², Jim McCollum¹
¹Savonix, San Francisco, United States, ²Founder and CEO, Savonix, San Francisco, United States, ³University of San Francisco, San Francisco, United States

This presentation will discuss how recent advances in digital mobile technology have progressed to the point that accurate and low-cost baseline cognitive testing should become the standard of practice in patient care, particularly for those over age 60. Over the last 15 years there has been increasing awareness of the need to acquire baseline cognition for athletes so that informed return to play decisions can be made and treatments can begin as soon as possible. Preseason baseline cognitive testing has made a positive impact upon the treatment and secondary injury reduction of athletes. This push has undoubtedly been very beneficial to the athletic community and may hopefully reduce serious injuries in the future. However, while athletes are receiving the majority of the press coverage about head injuries, the actual quantity of head injuries incurred from athletics is relatively small as compared to the general population. In fact, the majority of brain injuries do not occur in athletes. According to the Brain and Spinal Cord Organization ¹ the breakdown of head injuries is 28% falls, 20% motor vehicle accidents, 19% struck by objects or against objects, and 11% violence. The CDC ² reports that half of all head injuries go undiagnosed and untreated. Without baseline comparison, it is much harder to evaluate for cognitive change in the general population. Multiple challenges exist including premorbid cognitive abilities, premorbid and concurrent emotional health, learning disorders, ADHD, and difficulties obtaining and verifying history. In the elderly population, concerns for premorbid dementia can be a significant confound in evaluating for new cognitive decline following a head injury.

Access to a neuropsychologist is challenging in many parts of the world. In the US there are approximately 43.4 million people with diagnosed cognitive disorders and approximately 1,129 board certified neuropsychologists to provide cognitive testing. Globally there are approximately 4,000 neuropsychologists but hundreds of millions of people in need around the world and, in many places, it is just not possible to see a neuropsychologist. Additionally, neuropsychological exams tend to be expensive (estimates between from $500 to $3,000), and time intensive (average time from consult to report varies from 4 to 8 weeks). This presentation will discuss how to use the Savonix mobile app to assess baseline cognition and re-administer testing when a suspected head injury has occurred which will streamline assessment to treatment. We propose that acquiring baseline cognitive data will lead to more efficient use of fiduciary resources, neuropsychologists time, and streamline treatment and outcomes of patients with head injuries.

References:
2) CDC: FAQs about baseline testing (https://www.cdc.gov/headsup/basics/baseline_testing.html).
Obstructive Sleep Apnea Risk is Associated with Cognitive Impairment After Controlling for TBI: A Chronic Effects of Neurotrauma Consortium Study

Amanda Garcia¹, Rodney Vanderploeg¹, Elisabeth Wilde², Kimbra Kenney³, Terri Pogoda⁴, Risa Nakase-Richardson¹,⁵,⁶
MHBS, James A. Haley Veterans Hospital, Tampa, United States, ²University of Utah, Salt Lake City, United States, ³Uniformed Services University, Bethesda, United States, ⁴VA Boston Healthcare System, Boston, United States, ⁵Pulmonary/Sleep Medicine, Department of Internal Medicine, Morsani College of Medicine, University of South Florida, Tampa, United States, ⁶Defense and Veterans Brain Injury Center, Tampa, United States

Background: Meta-analysis of civilian post-TBI sleep disturbances highlight sleep apnea is 12 times higher than in large community-based non-TBI studies. The negative consequences of sleep apnea across health, functioning, disability, and economic outcomes are well documented and may influence TBI outcomes. O’Hara and colleagues propose that sleep apnea may contribute to early cognitive decline in chronic stages post-TBI; however, a paucity of data exist to support this relationship. Although sleep apnea is a risk factor for traumatic brain injury, the effect of sleep apnea on cognition in the context of mild TBI is understudied. Obstructive sleep apnea is a modifiable comorbidity with the potential to improve cognition in persons with a history of TBI. Therefore, the purpose of this study is to explore obstructive sleep apnea risk group differences on cognitive outcome in the Chronic Effects of Neurotrauma Consortium (CENC) participants.

Methods: Evaluations from a multi-center, longitudinal study of mild TBI included in-person assessment across multiple domains (demographics, service history, injury characterization, physical health, psychological health, and neuropsychological testing) conducted by trained research assistants. Participants were included in analyses if they completed the STOPBANG (sleep apnea risk), had valid tests scores on neuropsychological testing, and credible self-report on embedded measures. The subsequent sample (N=375) included participants with history of TBI (n=311) and non-TBI controls (n=64). The sample was primarily male (88%) with a median age of 37 (IQR; 31-47) with a median of 13-15 years of education.

Results: A large proportion of the cohort was at risk for OSA (STOPBANG > 3 [62%]; STOPBANG>4, [41%]). History of mild TBI was associated with higher risk (p<.05). After controlling for TBI, OSA risk predicted worse performance on the most complex measures of cognition. OSA risk was associated with worse performance on TMT B, β = 0.13, t(368) = 2.10, p < .05, as well as WAIS IV coding, β = -0.15, t(368) = -2.71, p < .01. OSA risk did not significant predict performance on other measures of memory (CVLT II LDFR, BVMT Delay), processing speed (TMT A), or attention/executive functioning (WAIS IV Digit Span Backward, Flanker Task). Both OSA risk and TBI status were significantly associated with perception of worse cognitive functioning on a self-report measure, OSA β = 0.20, t(368) = 3.8, p < .001, TBI β = 0.28, t(368) = 4.55, p < .001.

Conclusion: OSA risk is prevalent in the CENC cohort particularly among those with history of mild TBI relative to controls. OSA risk appears to be uniquely associated with performance on complex cognitive tasks. Findings suggest that cognitive sequelae attributed to the downstream effects of mild TBI may be even more strongly related to treatable comorbid conditions providing potential targets for future treatment.
The Gendered Experiences of Men with Traumatic Brain Injury (TBI): A Qualitative Study

Andrea D’Souza1,2, Alexis Fabricius2, Vanessa Amodio2, Angela Colantonio1,2, Tatyana Mollayeva1,2
1University of Toronto, Toronto, Canada, 2Toronto Rehabilitation Institute, University Health Network, Toronto, Canada

Background: Traumatic brain injury (TBI), or an alteration in brain function due to an external force, is a major cause of death and disability. Evidence suggests that TBI outcomes are influenced by sex- and gender-related factors, including differences in functional outcomes, return-to-work, and use of healthcare resources. These concepts should be considered in the implementation of clinical interventions as they may lead to a better understanding of barriers and facilitators to uptake.

Objectives: The current study is funded by a Canadian Institutes of Health Research Impact of Gender on Knowledge Translation (KT) Interventions grant and explores the experiences of men with TBI. The research question asks, ‘Using thematic analysis with a focus on gender, what are the healthcare experiences of men with TBI in the acute and chronic phases of recovery?’ We aim to (1) understand how men view gender roles and expectations; (2) explore explicit perceptions and implicit behaviours regarding the impact of gender on outcomes; and (3) learn about gender-related knowledge gaps so as to suggest topics for educational materials.

Study design: This study utilizes one-on-one semi-structured interviews with men who experienced a TBI. The interviews were coded by two analysts. Thematic analysis was used to develop themes and corresponding suggestions for educational materials.

Participants and Recruitment: Ethics approval has been obtained from the University Health Network (UHN) research ethics board, and participants have been recruited from UHN sites. Recruitment was carried out using a maximum variation sampling strategy that aimed for varied representation of injury severity and various sociodemographic factors. Inclusion criteria consist of participants identifying as men who have been diagnosed with TBI of any phase and severity. Participants who were non-English speaking, or who displayed cognitive or physical impairments that would impede interview completion, were excluded. The sample consists of 12 acute (≤ three months post-injury) and 10 chronic participants (> three months post-injury).

Data Collection and Analysis: Transcription and analysis were carried out on 17 interviews. Participants’ experiences fell into six major categories: impact of the injury on oneself, impact on relationships, navigating the healthcare system, thoughts on healthcare professionals, participation in treatment, and views on gender. Hegemonic masculinity was used as a theoretical framework to guide analysis of these experiences. Preliminary themes include performance of masculinity in recovery, motivations for return-to-work, and understandings of gender.

Implications: The results of this study may inform patient-driven clinician and caregiver materials, such as reframing of goals and therapies as more ‘masculine’ and using men’s motivations to inform goal-setting and planning of alternative activities. Men’s understanding of gender and reactions to discussion about gender can be used to strategically inform development of approachable gender-based materials.
Constructing Sex- and Gender-based Interviews for Men and Women with Traumatic Brain Injury (TBI)

Vanessa Amodio¹, Andrea D'Souza¹², Alexis Fabricius¹, Angela Colantonio¹², Tatyana Mollayeva¹²  
¹University Health Network, Toronto, Canada, ²University of Toronto, Toronto, Canada

Background: Traumatic brain injury (TBI) is a significant cause of death and disability. Biological sex (biological construct) and gender (social construct) are discrete terms but interact to impact health experiences for individuals with TBI. Clinical guidelines for TBI should address sex and gender differences. Moreover, there is limited evidence considering how clinicians and families might apply their understanding of these differences to intervention.

Objectives: This Canadian Institute of Health Research-funded project aims to address the following: (1) to understand the sex- and gender-based experiences reported by patients with TBI (2) to develop educational resources using the knowledge gained from patient-participants.

Design: A qualitative methodology, using gender theory as a theoretical framework was applied. The 1-hour semi-structured interviews with TBI patients focused on experiences navigating the healthcare system, follow-up care, pre- and post-injury roles, barriers and facilitators to recovery, and preferences and format for educational materials.

Recruitment: Ethics approval was completed through the University Health Network (UHN) Research Ethics board. Participants were recruited from inpatient and outpatient units across UHN hospitals and facilitated through a variety of formats. Seventeen female and 22 male patients were recruited from UHN hospitals, using a maximum variation sampling strategy. Researchers aimed to gather an equal representation of sex, injury phase, and severity level. Non-English speakers and individuals with neurocognitive deficits that impeded conversation were excluded.

Data Collection and Analysis: A researcher transcribed field notes during the interview and two researchers conducted a thematic analysis. The methodological findings within the interviews suggest that the overall dynamics between the interviewer and patient may have impacted the discussions which arose for men and women. Men and women discussed work as a critical part of their identity, however for men, work was described in terms of the tasks that were performed and for women work was a significant source of social support. When patients were asked directly about the meaning of gender, biological sex, and sexuality, these terms were often conflated or misunderstood. A latent meaning of gender can be interpreted through specific discussions of roles, responsibilities, or familial/personal expectations. Conceptualizations of gender identity were better defined at the chronic phase of recovery, and these patients had increased insight into supports which would be beneficial to consider in future educational interventions.

Implications: This study includes a heterogeneous sample, including participants from varying social positions. The methodological findings suggest that biological sex and gender should be considered in a clinical context to enable patients to critically engage with their behaviors and the impact they may have on recovery. Educational materials which incorporate the practical application of sex- and gender-based discussions among clinicians, patients and their families will be tested in the second phase of this research.
Gender-Related Healthcare Experiences of Women with Traumatic Brain Injury (TBI)

Alexis Fabricius\textsuperscript{1,2,4}, Andrea D'Souza\textsuperscript{1,2,3,4}, Vanessa Amodio\textsuperscript{1,2,4}, Angela Colantonio\textsuperscript{1,2,3,4}, Tatyana Mollayeva\textsuperscript{1,2,3,4}

\textsuperscript{1}Toronto Rehabilitation Institute (TRI), Toronto, Canada, \textsuperscript{2}University Health Network (UHN), Toronto, Canada, \textsuperscript{3}University of Toronto (UofT), Toronto, Canada, \textsuperscript{4}Acquired Brain Injury Laboratory, University of Toronto, Toronto, Canada

Background: Approximately 1.5 million people in Canada are living with a brain injury, with 100 000 people being injured annually. Historically, traumatic brain injury (TBI) literature has focused on men’s experiences, as they are injured more often, and typically more severely. However, women’s experiences are not sought or explored to the same extent, leading to unjustified assumptions about their needs and unnuanced healthcare provision. Consequently, there is little scholarly data to draw from to inform policies, treatment options, rehabilitation plans or informal caregiving for women. Focusing on women’s experiences with TBI is vital on an individual level to support better healthcare provision and promote improved patient outcomes; it also takes critical steps toward macro-level improvements in the health care system by considering sex and gender in health-based research, as well as women’s experiential knowledge.

Objectives: (1) To develop a deeper understanding of women’s gendered experiences of TBI, (2) To offer suggestions for the development of participant-driven educational materials for patients, caregivers and clinicians to improve outcomes and remove barriers to equitable healthcare.

Method: This study was part of a larger CIHR-funded grant examining the effects of sex and gender on TBIs through patient, clinician and caregiver interviews (n=64). Semi-structured interviews with seventeen adult women were conducted and analyzed. A thematic analysis was applied to the transcripts and relevant themes were discerned. We analyzed these experiences drawing on critical health psychology, as well as feminist and critical disability studies.

Results: The analysis revealed that participants experienced distress over the push-pull tension of being unable to perform femininity while still being expected to do so while injured. Additionally, participants discussed issues with informal care in the form of invalidation of their injury and experience, thus exacerbating symptom expression and delaying resolution.

Implications: We suggest that educational materials should include psychoeducation in rehabilitation on how gender socialization impairs recovery. Anxiety, guilt, and distress undermine cognitive functioning during convalescence, especially for women. Teaching women about how gendered behaviours typically do not support their recovery would be an important step in ameliorating their outcomes. Materials should also address post-injury parenting issues, as this was gendered component that impacted recovery for women. Educational materials for informal caregivers should encourage discussions with the patient and the family to better understand the type of care that the woman expects. It is critical that family and friends legitimize the woman’s experience of her injury, as women who had positive experiences with caregiving had better recovery outcomes.
Attention Process Training is Beneficial During Early Training After Acquired Brain Injury. An RCT Study

Aniko Bartfai¹, Gabriela Markovic¹, Marie-Louise Schult¹, Mattias Elg²
¹Karolinska Institutet, Stockholm, Sweden, ²Department of Management and Engineering, IEI, Linköping University, Sweden

Background: Evaluation of outcome after intensive cognitive rehabilitation early after brain injury is complex due to the ongoing biological recovery process.

Objective: Examining the efficacy of Attention Process Training (APT) for attention dysfunction after acquired brain injury (ABI) through time-series measurement with statistical process control (SPC).

Design: RCT study

Method: Patients with ABI (n=59) within five months’ post-injury in interdisciplinary rehabilitation received an additional 20 hours of attention training with Attention Process Training (APT) method or with activity-based attention training (ABAT). The primary outcome variable was PASAT (Paced Auditory Serial Attention Test) evaluated with SPC.

Results: Both groups improved in performance (p<.001), and variability was decreased in the APT group. Three subgroups were identified: stationary, steady and rapid improvers based on individual improvement patterns. APT treatment improved attention for more patients (2 (1, N = 59) = 5.93, p=.015), more patients showed steady improvement (2 (1, N = 59) = 7.411, p=.025) and there were fewer stationary patients. Differences in treatment effects were maintained in 6-months follow-up.

Conclusions: The study identified three different trajectories for recovery after ABI. The subgroups benefited from APT treatment in different ways. The results suggest also that attention training is a promising early after ABI and that APT boosts the improvement process.
Natural History of Recovery Among High School Athletes with Single or Multiple Concussions

Dustin Anderson¹, Kelly Stearns-Yoder, Lisa Brenner, Jeri Forster
¹University of Colorado, Aurora, United States

Background: Sports related concussions are prevalent among high school athletes. The adolescent population has unique risks, physiologic responses, and recovery patterns after concussion. Less is understood about the longitudinal effects of repeated concussion in prospective cohorts. We aim to describe the natural history of concussion and neurocognitive recovery in a sample of high school athletes.

Methods: Secondary analysis of a 3-year prospective, longitudinal cohort study evaluating pre- and post-concussion symptom reporting and neurocognitive performance using the Immediate Post-concussion Assessment and Cognitive Testing (ImPACT) in a sample of public high school athletes, grades 9 – 12. Recovery was operationalized as 3 of 4 neurocognitive indices on the ImPACT (verbal memory, visual memory, motor testing, and reaction time) returning to baseline levels within the standard error of measurement.

Results: Seventy-seven of 914 athletes followed sustained at least one concussion during the study period; 9 of whom (11.7%) sustained two or more. One athlete sustained 3 concussions during the study. No significant differences were observed in age, gender, presence of prior concussion or ImPACT testing at baseline between those with single versus multiple concussions. Four of the athletes with multiple concussions were female (44%) and the median age at injury was 14 (13, 16). All five male athletes played football. There was no significant difference between first and second concussion time to recovery among the 7 athletes who achieved recovery in both instances (p=0.13). Median time to recovery post-first concussion was 8 days (range: 2, 20) and post-second concussion was 3 days (2, 13). Additionally, similar symptom totals and neurocognitive test results were observed across evaluations post-first concussion as compared to post-second concussion.

Conclusions: A number of demographic and performance-based similarities were noted between those who sustained one concussion versus multiple. Among those with repeated concussions, recovery patterns were similar when comparing first and second injuries. We utilized baseline neurocognitive testing to compare in future concussion events. This study was unique as testing and follow-up occurred in the school setting. The results suggest neurocognitive recovery and performance may be preserved in the school setting for high school athletes after second concussion.

Clinician expertise and individual consideration remain important for return-to-play considerations and counseling recommendations. Description of concussion recovery patterns in this high school setting is important, since those seeking health care in a medical setting may have different attributes than those who recover in the school setting. Cognitive reserve after concussion in this population may be intact with up to two events. Additional events beyond the first two may be required to measure delayed neurocognitive recovery in this setting. Further research is warranted to investigate longitudinal recovery patterns in those not seeking medical care, including possible cumulative effects beyond a second concussion event.
Individual Differences in Social Perception and Social Communication in Adults with Moderate-Severe Traumatic Brain Injury

Melissa Duff1, Arianna Rigon1, Jee-Seon Kim2, Bilge Mutlu2, Lyn Turkstra3
1Vanderbilt University Medical Center, Nashville, United States, 2University of Wisconsin, Madison, United States, 3McMaster University, Hamilton, Canada

The outcome of traumatic brain injury (TBI) is highly variable: while some individuals return to near pre-injury abilities and functioning, others report long-term impairments across physical, cognitive, and behavioral domains. In particular, it has been widely reported that deficits in social perception and social communication are common following TBI. However, very little is known about individual differences. Indeed, there is a dearth of data on how many individuals can expect to such deficits, or which demographical or neuropsychological variables may influence its likelihood.

The aim of the current study was to identify factors that drive individual differences in social perception and social communication in adults with TBI. We used a Latent Profile Analysis (LPA), a latent variable modeling technique for identifying unobserved homogeneous subgroups based on a set of key variables, on a sample of 73 individuals with moderate-severe TBI and 73 matched healthy comparison participants. We measured social perception and social communication using six different tasks: (1) the Mehrabian task (which measures response written social cues); (2) the Karolinska Direct Emotion Recognition Task and (3) the Emotion Recognition Test (which measure, respectively, static and dynamic emotion recognition abilities); (4) the La Trobe Communication Questionnaire (which measures the frequency of social communication problems) (5) the Global Executive Composite of the Behavior Rating Inventory of Executive Function (which measures self-reported overall daily life executive functioning) and (6) The Apperley Theory of Mind task. Individuals with TBI underperformed HCs on every task, with the exception of the Mehrabian task.

We found that the two-class model fit the data best, revealing the presence of two latent classes, i.e. two subgroups of individuals, with respectively high (Latent Class I, 77%) and low (Latent Class II, 23%) social perception and social communication abilities. Within the TBI sample, 64% of individuals were in the high social perception and social communication class, vs. 90% of the NC sample. Latent Class I had on average one-year more of education (15.2 vs. 14.2, p = .008) and higher scores on neuropsychological tests of verbal memory and learning, set-shifting, and processing speed (p < 0.001). Interestingly, the two latent classes were comparable in terms of their age and sex compositions, revealing that women and younger individuals with TBI were not more likely to have better social perception and social communication outcome.

The results of the current study reveal that approximately one third of individuals with TBI are likely to develop deficits in social perception and social communication, and that education and neuropsychological functions may aid in identification of this subgroup.
Combination of Physical Exertion and Cognitive Performance to Evaluate the Readiness to Return to Play following a Sport-Related Concussion

**Veronik Sicard**, Jean-Christophe Lortie¹, R. Davis Moore², Dave Ellemberg¹

¹Universite De Montreal, Montréal, Canada, ²University of South Carolina, Columbia, United-States

Introduction: The decision to clear an athlete to return-to-play (RTP) following a concussion is critical given the potential consequences of premature RTP. Prior research (McGrath et al., 2013) suggests that exercise may exacerbate cognitive deficits in athletes who are asymptomatic at rest. Unfortunately, few clinicians evaluate athletes’ cognition pre- and post physical exertion. Accordingly, this study aimed to examine post-exertion cognitive performance in asymptomatic collegiate athletes who were cleared to return-to-play.

Methods: Forty recently concussed athletes who completed step 4 of Zurich’s RTP protocol, and 40 control athletes (teammates) participated in the study. Athletes completed a Switch task before and after an acute bout of cardiovascular exercise (80% maximal predicted maximal heart rate for 20-min) on an stationary bike.

Analyses: Athletes in the concussion group were categorized as Pass or Fail based on their performance at rest and following exercise. Specifically, athletes were placed in the Fail group if their performance was 2 SD lower than the control group’s average score. A Chi-square test was used to test for equality of proportions between conditions.

Results: Irrespective of condition (rest, exercise), 25% of concussed athletes were categorized in the Fail group. Furthermore, Chi-square testing indicated a significant difference in the proportion of Pass/Fail between Rest and Exercise conditions, $X^2 = 19.44, p < .001$, with more athletes failing following exercise (30%), compared to rest (10%).

Conclusion: One out of 4 athletes who successfully completed the RTP protocol exhibit normal abnormal cognitive functioning relative to their uninjured teammates. Furthermore, most cognitive deficits emerged following vigorous exercise. Thus, a significant portion of athletes are being cleared to play before they have healed. Fortunately, these athletes can be readily identified by using sensitive cognitive tests administered pre- and post vigorous exercise.
What Criteria Do Providers Use to Determine Discharge Destination of Patients with Moderate-to-Severe TBI?

Tolu Oyesanya¹, Ron Seel²
¹Duke University, Durham, United States, ²Virgina Commonwealth University, Richmond, United States

Background: Research has shown predictors of discharge destination for patients with moderate-to-severe traumatic brain injury (TBI) include injury severity, race/ethnicity, and insurance status. However, research also shows interdisciplinary providers’ discharge decision-making can influence patients’ discharge destination, but this subjective variable has rarely been captured or assessed in studies investigating predictors of discharge destination for patients with TBI. In addition, limited research exists on interdisciplinary providers’ discharge decision-making for patients with moderate-to-severe TBI discharged home from acute care without inpatient rehabilitation.

Purpose: As a first step in understanding how providers’ discharge decision-making influences discharge destination, the purpose of this study was to investigate the criteria interdisciplinary providers use to determine and prevent discharge home from acute care without inpatient rehabilitation for patients with moderate-to-severe TBI.

Methods: Data were collected from interdisciplinary providers at a Level I trauma center in the U.S. via an electronic survey in April 2018. Data were analyzed using descriptive statistics.

Participants: We invited 199 interdisciplinary providers via email to participate in our electronic survey housed in RedCap. A total of 27 providers responded with a response rate was 13.5%. Responses were received from physicians and physical, occupational, and speech therapists.

Results: Findings showed consensus between 27 interdisciplinary providers on criteria used to determine and prevent discharge home from acute care without inpatient rehabilitation for patients with moderate-to-severe TBI. Top 5 discharge criteria providers use to determine if patients with TBI should be discharged home from acute care without inpatient rehabilitation where majority consensus was found included: 1) physical therapy recommendation for discharge home (N=26), 2) occupational therapy recommendation for discharge home (N=26), 3) anticipated family support at home (N=25), 4) level of independence in activities of daily living (N=24), and 5) speech therapy recommendation for discharge home (N=23). Top 5 criteria that would prevent providers from discharging patients with TBI home from acute care without inpatient rehabilitation where majority consensus was found included: 1) lack of anticipated family support at home (N=26), 2) recommendation from occupational therapy against discharge home (N=25), 3) recommendation from speech therapy against discharge home (N=25), 4) recommendation from physical therapy against discharge home (N=24), and 5) ventilator dependence (N=23).

Conclusions: Findings show there was consensus between interdisciplinary providers on criteria used to determine and prevent discharge home from acute care without inpatient rehabilitation for patients with moderate-to-severe TBI, with consensus from 23 or more of the 27 providers surveyed on several criteria. These findings can be used to inform providers’ decision-making related to discharge destination of patients with moderate-to-severe TBI.
Comorbidity and Acquired Brain Injury in Community-Based Rehabilitation: Influencing Health Service Delivery

Angelita Martini¹, Elly Williams¹
¹Brightwater Care Group, Perth, Australia

People with an acquired brain injury (ABI) often experience the presence of other conditions. Known as comorbidities, they are defined as any disease co-existing with an index disease or condition (Chan et al. 2017). Comorbidities of people with ABI may have existed pre-injury, be a result of injury, or been a factor in causing injury. It is therefore important to consider the comorbidities to ensure the best rehabilitation outcomes, and to enable successful reintegration into the community. The objective of this study was to determine the comorbidities of clients with an ABI on admission to a staged community-based brain injury rehabilitation service and provide recommendations for service delivery.

This was a retrospective, observational cohort study of 271 participants with an ABI who were admitted to a community-based rehabilitation service from February 2010 to September 2018. Data was collected on n=18 pre-defined comorbidities on admission to the service. Descriptive statistics were run using STATA statistical software and data was stratified by age and gender.

Sixty-six percent of people admitted (n=179) had at least one comorbidity; and 53% of that cohort had two or more comorbidities (n=95). The most common comorbidity was depression. Of people with at least one comorbidity - 40% had depression, 30% hypertension, 22% diabetes, 16% alcohol dependency, 13% epilepsy, 12% anxiety and 10% had cardiovascular disease. Cases of depression were prevalent across all age groups however 65% of people under 30 years with a comorbidity had depression, this was 57% for people aged 31-40 and 38% for people aged 41-50. The majority of those with hypertension (55%) and diabetes (48%) were aged 51-60. Anxiety was most common in younger age groups (under30 (32%), 31-40 (32%)). Alcohol dependency was more common in people aged 41-60. Hepatitis was most common in the 31-40 and 41-50 age groups, and mostly in men (83%). When comparing gender, women had a higher prevalence of diabetes.

The numbers in this study are conservative as comorbidity data was only collected for 18 conditions and there are likely greater comorbidities and multi-morbidities experienced by people with ABI. Rehabilitation from an ABI is complex as clients often have comorbidities. It is important for health services to consider these comorbidities in planning treatment and rehabilitation services, particularly for mental health disorders and chronic diseases.
Combining H-FABP and GFAP Increases the Capacity to Differentiate Between CT-Positive and CT-Negative Patients with Mild Traumatic Brain Injury

Jean-Charles Sanchez¹, Linnéa Lagerstedt¹, Juan José Egea-Guerrero³, Alejandro Bustamante², Analiz Rodriguez³, Joan Montaner²

¹University of Geneva, Geneva, Switzerland, ²Hospital Universitario Virgen Macarena, Sevilla, Spain, ³Virgen del Rocio University Hospital, Sevilla, Spain

Mild traumatic brain injury (mTBI) patients may have trauma-induced brain lesions detectable using CT scans. However, most patients will be CT-negative. There is thus a need for an additional tool to detect patients at risk. Combining several biomarkers into panels has become increasingly interesting for diagnoses and to enhance classification performance. The present study evaluated 13 proteins individually—H-FABP, MMP-1, MMP-3, MMP-9, VCAM, ICAM, SAA, CRP, GSTP, NKDA, PRDX1, DJ-1 and IL-10—for their capacity to differentiate between patients with and without a brain lesion according to CT results. The best performing proteins were then compared and combined with the S100B and GFAP proteins into a CT-scan triage panel. Patients diagnosed with mTBI, with a Glasgow Coma Scale score of 15 and one additional clinical symptom were enrolled at three different European sites. Patients were divided into two cohorts and further dichotomised into CT-positive and CT-negative groups. Single markers and panels were evaluated using Cohort 1. Four proteins—H-FABP, IL-10, S100B and GFAP—showed significantly higher levels in CT-positive patients. The best-performing biomarker was H-FABP, with a specificity of 32% (95% CI 23–40) and sensitivity reaching 100%. The best-performing two-marker panel for Cohort 1, subsequently validated in Cohort 2, was a combination of H-FABP and GFAP, enhancing specificity to 46% (95% CI 36–55). When adding IL-10 to this panel, specificity reached 52% (95% CI 43–61) with 100% sensitivity. These results showed that proteins combined into panels could be used to efficiently classify CT-positive and CT-negative mTBI patients.
TBIcheckTM: A Portable Device to Detect Mild Traumatic Brain Injury

Jean-Charles Sanchez¹, Alberto Schena², Leire Azurmendi¹, Sébastien Iva², Joan Montaner³

¹University of Geneva, Geneva, Switzerland, ²ABCDx, Geneva, Switzerland, ³Universitat Autònoma de Barcelona, Barcelona, Spain

Traumatic brain injury (TBI) is the leading cause of death and disability in young adults. The incidence in elderly patients is increasing. In younger patients, Road Traffic Accidents are the most frequent cause of injury, while in older patients it is falls. Sports, army and juveniles are vulnerable collectives. In particular, mild traumatic brain injury (mTBI) is responsible for high health costs. In contrast to severe TBI, brain lesions are not easily detectable in mTBI-affected patients. Current practice is to perform a CT-scan where available, to determine presence of brain lesions. However, CT-scan is expensive, can only be carried out in appropriately equipped facilities and carries some risk and radiation exposure to the patient. Generally, only a small proportion (6-8%) of patients will have confirmation of a brain injury requiring hospital stay, while more than 90% of the patients are dismissed after the CT-scan. TBIcheckTM allows to rule out the presence of brain injury with a simple blood test from a finger prick. So, the unnecessary CT-scan can be avoided in one third of the patients, reducing the costs for healthcare systems, as well as reducing stress, inconvenience and radiation exposure to patients and relieving burden on over-stressed emergency departments. Moreover, TBIcheckTM opens the way to the future immediate diagnosis on the site where the accident occurred, avoiding the transportation to the hospital, especially for accidents occurring in remote locations.
Healthcare Staff Attitudes regarding Wireless Device (WD) use in patients with Brain Injury on an Inpatient Rehabilitation Unit

David Ripley1, Aaron Malina1, Benjamin Ingraham1, Ann Bines1, Kyra Symanski1, Kelsey Watters1, Mary McLoughlin1, Lindsay Long, Nicole Mars1, Kaitlin Reilly, Debjani Mukherjee1

1Shirley Ryan Abilitylab, Chicago, United States

Objective: To investigate allied health staff member attitudes regarding Wireless Device (WD) use by patients receiving inpatient rehabilitation for brain injury.

Design: One time, anonymous, web-based survey.

Setting: Academic rehabilitation hospital in the United States.

Participants: Allied health staff, including nursing, physical therapists, occupational therapists, speech therapists, psychologists, and physicians who provide care to patients on an inpatient brain injury rehabilitation unit.

Main Outcome Measures: Survey results.

Interventions: N/A

Results: Eighty-six staff members who predominately care for patients with brain injury participated in a one-time survey. All results were anonymous. 65% of staff members reported having experienced an issue where use of a WD interfered with providing patient care. 41% reported having seen a patient using a WD in a manner that was believed to put the patient at risk for problems in the future. 45% reported observing a situation where use of WD’s interfered with a patient’s sleep. 45% also reported seeing a patient using a WD in a manner that why believed may threaten their professional identity or financial well-being. 49% of staff had observed patients attempting to use WD’s to photograph or video staff or other patients. 77% had experienced a patient losing a WD while on their service. Staff overwhelmingly believed that a policy was needed to govern the use of WD’s for patients with cognitive impairment, with 82% responding that they “agreed” or “strongly agreed” a policy was needed. When asked if they believed that a policy was needed for all patients, responses were still strongly in favor, although tempered a bit, with 62% either “strongly agreeing” or “agreeing” that a policy was needed.

Conclusions: WD use among patients creates many concerns, particularly for patients with cognitive impairment following TBI. Staff responses reflect concerns regarding issues with patient care, efficiency of therapy, patient safety, protecting professional and personal reputation, healthcare privacy, and loss of the device. Staff responses reflect an overwhelming belief that a policy was needed for WD use in patients with cognitive impairment. Responses were still positive but tempered when asked about policy for all patients regardless of cognitive impairment. Ethical issues regarding dignity of risk, autonomy, issues of communication, healthcare privacy are discussed.
Concussive Head Injury Exacerbates Alzheimer’s Disease Pathophysiology. Neuroprotection by Nanowired Delivery of Cerebrolysin with Neuronal Nitric Oxide Synthase Antibodies and Mesenchymal Stem Cells

Hari Shanker Sharma1, Asya Ozkilicik2, Dafin Muresanu3, Ala Nozari4, Herbert Moessler5, Ryan Tian2, Jose Vicente Lafuente6, Aruna Sharma1

1Uppsala University, Uppsala, Sweden, 2University of Arkansas, Fayetteville, United States, 3University of Medicine & Pharmacy, Cluj-Napoca, Romania, 4Harvard University, Boston, United States, 5EverNeuroPharma, Austria, 6University of Basque Country, Bilbao, Spain

Military personnel are prone to develop Alzheimer’s disease (AD) because of combat stress or due to mild to moderate degree of traumatic brain injury. Previous experiments from our laboratory showed that a mild concussive head injury (CHI) leads to exacerbation of brain pathology following amyloid beta peptide (AβP) infusion model of AD. Thus, there was a significant increase in AβP deposition and tau phosphorylation (p-tau) in the brain and in the cerebrospinal fluid (CSF) as compared to normal rats after identical AβP infusion. Since AD induced pathophysiology, oxidative stress could play key roles. We examined the role of nitric oxide in AD by immunohistochemical evaluation of neuronal nitric oxide synthase (nNOS) in the brain.

Furthermore, we evaluated the influence of cerebrolysin—a multimodal drug with a balanced composition of several neurotrophic factors and active peptide fragment either alone or together with mesenchymal stem cells (MSCs) administration to reduce CHI induced exacerbation of AD brain pathology. AD like symptoms were induced in male Sprague-Dawley rats (age 15 to 20 wks) by administering AβP (1-40, 150 ng/10 µl) into the left lateral ventricle once daily for 4 weeks. In another group of rats, CHI was inflicted by delivering an impact of 0.224 N on the right parietal bone under Equithesin anesthesia by dropping a tapered iron cylinder (114.6 g) from a 20 cm height using a guide tube. A pronounced increase in nNOS immunoreactivity was seen in normal rats after AβP infusion that was prominent in the cerebellum, cortex, hippocampus and the thalamus. The magnitude and intensity of nNOS expression was significantly enhanced in CHI rats after identical AβP infusion. The nNOS expression in neurons was present in the areas showing neuronal injury, edematous expansion and AβP deposition. The biochemical measurement of AβP and p-tau exhibited 40 to 58 % higher levels in the brain and in the CSF of CHI rats after AβP infusion as compared to naive animals. TiO2-nanowired delivery of cerebrolysin (5 ml/kg, i.v.) together with antibodies of nNOS (1:20, 20 µl/min, i.c.v.) and MSCs (106 cells) significantly reduced nNOS expression, AβP and p-tau levels in AD model with CHI and induced marked neuroprotection.

These observations are the first to show that blockade of nNOS expression in AD induces neuroprotection, not reported earlier. Further studies using nanodelivery of NOS inhibitors are needed to understand the role of nitric oxide in AD.
Validation of the French-Canadian Adaptation of the Mayo-Portland Adaptability Inventory in an Adult Traumatic Brain Injury (TBI) Rehabilitation Setting

Marie-Claude Guerrette¹,², Michelle McKerral¹,²
¹Université de Montréal, Montréal, Canada, ²Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR), Montréal, Canada

Introduction: The Mayo-Portland Adaptability Inventory-4 (MPAI-4) (Malec, 2005) assesses functional abilities, global outcome and community integration of individuals with brain injuries by covering a wide range of physical, cognitive, emotional and social problems that may arise after the injury. The original version of the MPAI-4 has undergone rigorous psychometric testing (Kean et al., 2011; Malec et al., 2003), and given its clinical usefulness, the questionnaire was translated and adapted to other languages, such as French (McKerral et al., 2014). However, the psychometric properties of the French-Canadian version of the MPAI-4 have not yet been reported. Therefore, our objective was to establish the psychometric properties of the French-Canadian MPAI-4, using a Canadian sample of adults with TBI receiving post-acute rehabilitation services.

Method: The MPAI-4, a 30-item questionnaire divided into three subscales (Abilities, Adjustment, Participation), gives rise to specific indexes and a total score reflecting the general level of adaptation/social participation. The French-Canadian MPAI-4 was implemented in four rehabilitation centres in the greater Montreal region and MPAI-4 data are systematically obtained for all individuals participating in interdisciplinary rehabilitation at the start and end of the programs. Participants (N = 513) were adults having sustained a mild, moderate or severe TBI who received rehabilitation interventions at one of the four rehabilitation centres, and for whom a first MPAI-4 measure was completed between 2013 and 2018.

Results: To evaluate the construct validity of the French-Canadian MPAI-4, an exploratory factor analysis (EFA) using a varimax rotation method was performed on z-scores for the 30 items. The final and best solution was a three-factor solution, which accounted for 42.77% of the variance. Three of the 30 items failed to have a loading value ≥ .30 on any factor. Since failure of these items to load reflects the homogeneity of participants’ responses, the three items were theoretically assigned to a factor. The internal consistency of the French-Canadian MPAI-4 was determined using Cronbach’s alpha, and all three subscales showed good internal consistency (all α ≥ .73).

Conclusions: The three factors extracted using data from the French-Canadian MPAI-4 and a Canadian TBI sample are similar, but not entirely identical to the three subscales found in the original version of the MPAI-4. This may be explained by cultural and clinical differences between the studied samples, which can affect the distribution of items across factors. The factor labels suggested by Malec (2005) also suited the extracted factors and were thus retained for the French-Canadian MPAI-4 (Abilities, Adjustment, Participation). Overall, the French-Canadian MPAI-4 factor structure is validated, and the questionnaire shows good psychometric properties. The French-Canadian MPAI-4 thus represents a suitable tool to measure functional evolution, outcomes and social integration of individuals with TBI receiving rehabilitation services in a French-Canadian context.
Cognitive-Communication Performance Following Mild Traumatic Brain Injury: Acute Outcome Prediction

Joanne LeBlanc1, Alena Seresova1, Andréanne Laberge-Poirier1, José Correa2, Sabrina Tabet3, Mitra Feyz1, Elaine de Guise3

1McGill University Health Centre, Montreal, Canada, 2McGill University, Montreal, Canada, 3Université de Montréal, Montreal, Canada

Objective: Although several studies have investigated outcomes post mild traumatic brain injury (mTBI), little information is available in the literature regarding the effects and consequences of language and communication deficits, particularly in the acute stage. The goal of our study was to determine how performance on measures of auditory comprehension, verbal reasoning, oral expression and reading comprehension obtained during acute care hospital admission in patients with complicated mTBI contribute to acute care discharge outcomes.

Method: Speech-language pathologists administered the Boston Naming Test (short form), the conversational discourse subtest of the Montreal Protocol for the Evaluation of Communication, verbal fluency tasks, the verbal absurdity subtest of the Detroit Test of Learning Aptitude, the complex ideational material subtest of the Boston Diagnostic Aphasia Examination and the reading comprehension subtest of the Canadian Adult Achievement Test to 128 patients with a diagnosis of complicated mTBI admitted to the TBI program of the McGill University Health Center-Montreal General Hospital, a supra-regional Level I trauma hospital. Medical charts of participants were retrospectively reviewed to gather demographical data, language test results and accident-related information. Outcome measures obtained from the TBI program database included length of stay (LOS), discharge destination and scores on the extended Glasgow Outcome Scale (GOSE).

Results: Over half of the patients with complicated mTBI (56.3%) required rehabilitation services post discharge from acute care. Of this group, 39.1% were transferred to an in-patient rehabilitation center whereas 17.2% were discharged home and obtained services in an out-patient facility. Performances on tasks of auditory comprehension, verbal reasoning, confrontation naming, and verbal fluency as well as conversational discourse skills predicted transfer to an in-patient rehabilitation facility at discharge (p<.05). Thus, those patients who had more difficulty naming, understanding oral information, organizing spontaneous discourse and those with poorer verbal reasoning and verbal fluency skills were more likely to require specialized in-patient rehabilitation services versus being discharged home with no services. Those patients with worse skills in naming, conversational discourse and letter-category verbal fluency also had a greater chance of requiring out-patient rehabilitation services (p<.05). In addition, LOS was more likely to be longer in patients with poorer letter-category naming (p<.05) and the probability of greater disability as measured with the GOSE was linked to worse conversational discourse skills and semantic category naming (p<.05).

Conclusion: Rehabilitation services are often required after complicated mTBI. In this study, the likelihood of patients needing such services was related to performance on several oral expression and auditory comprehension tests. It is therefore important to evaluate these skills in acute care post mTBI. The results of this study add to the information available to healthcare professionals in predicting overall acute outcomes following complicated mTBI.
Brain Injury and the Vestibular System

Amy Zellmer¹, Jeremy Schmoe²
¹Faces of Tbi, Hastings, United States, ²Midwest Functional Neurology Center, Minnetonka, United States

Brain Injury is an invisible and silent epidemic with 2.8M Americans affected annually. It is the leading cause of death and disability in the World. Yet, it is far too often misunderstood and undiagnosed by doctors, leaving survivors and their family members to tread through murky waters while trying to understand why their life has been turned upside down. We believe that better education and awareness through advocacy is the front line of defense in this battle that so many struggle through daily.

After a slip on the ice in February of 2014 Amy's life has never been the same. She was living with constant dizzy and balance problems, cognitive deficits, and short-term memory issues. She was easily fatigued after doing simple tasks that she used to take for granted such as washing the dishes or carrying in the groceries. She was easily confused by anything with touch buttons and some days still doesn’t understand how to use the microwave or pay-at-the-pump gas stations.

While friends and family drifted away, doctors kept telling her she would be fine in a few more weeks (even after months of no improvement), and some even accused her of not trying hard enough to get better. It took her two and a half years to finally find a doctor who had a better understanding of how her eyes and brain weren't communicating with each other properly and was able to help her with simple eye exercises which integrated the full body.

Through this presentation you will receive a unique doctor-patient perspective on how finding the right doctor who truly understands how the vestibular system is disrupted by a jolt to the head. You will hear Amy's struggle through 2.5 years of not finding the right doctor, and how her life changed when she found Dr. Schmoe. You will also hear from Dr. Schmoe on how his use of Functional Neurology is helping those struggling with the lingering symptoms of concussion/TBI. He will share with you his testing, diagnostics, and treatments that he used with Amy, as well as hundreds of other patients.

Through their presentation, they hope to help the healthcare professionals understand what it’s really like to live with a brain injury, and how there are different modalities available to help patients recover. They will also instill hope for those who are still struggling and seeking a doctor who will listen.
Efficacy and Safety of Decompressive Craniectomy with Non-Suture Duroplasty for Traumatic Brain Injury: Is Watertight Suture Necessary?

Woo Seok Kim¹, Woo Kyung Kim, Gi Taek Yee, Jeong Nam Lee, Myeong Jin Jang, Tae Kyu Lim
¹Neurosurgery, Gil Medical Center, Gachon University, Incheon, South Korea

Introduction: Decompressive craniectomy is an important surgical treatment for severe traumatic brain injury (TBI). Several reports have been published on the efficacy of watertight sutures in duroplasty after decompressive craniectomy, but study about cases of TBI are rare. Therefore, we compared non-suture duroplasty craniectomy which technique do not perform watertight dural closure and sutured duroplasty craniectomy and report the results.

Methods: One hundred thirty patients who visited the single trauma center through 2016-2017 and underwent craniectomy enrolled the present study. We retrospectively collected the data and classified patients into the non-sutured duroplasty craniectomy and sutured duroplasty craniectomy groups. We compared characteristics of patients and the incidence of complications such as infection, wound healing disturbance, CSF leakage, and hygroma.

Results: There were 45 patients in non-sutured duroplasty craniectomy group and 86 patients in sutured duroplasty craniectomy group. There was no statistically difference in age and injury severity score, preoperative Glasgow coma scale. Mean duration of operation was 166(75-375) minutes in non-sutured duroplasty craniectomy group and 211(65-380) minutes in sutured duroplasty craniectomy group. (P<0.05) Hygroma was more frequent in non-sutured duroplasty craniectomy group. No other complications were significant different between two groups.

Conclusion: Non-suture duroplasty craniectomy is helpful in reducing duration of operation and there is no difference in complications compared with control group. Therefore, non-suture duroplasty craniectomy can be assumed to be safe and useful technique in patients with severe TBI.
A magnetic resonance diffusion tensor imaging analysis of post-traumatic headache

Yasushi Shibata¹, Sumire Ishiyama¹
¹University of Tsukuba, Mito, Ibaraki, Japan

Purpose: Post-traumatic headache is a complicated disorder. Magnetic resonance imaging (MRI) typically shows no or only mild injury despite patients complaining of severe sustained headache. In this study, we applied a new MRI technique involving diffusion tensor imaging (DTI) and neurite orientation density dispersion imaging (NODDI) in patients with post-traumatic headache. The purpose of this study was to establish an objective diagnostic method for post-traumatic headache and to discover its pathophysiology.

Patients: Six post-traumatic headache patients were included in this study (4 male and 2 female patients; 14 to 81 years old). One young patient suffered from a sports concussion, while the other five adult patients had been injured in traffic accidents. Anatomical MRI showed temporal contusion for two patients, white matter lesions for two patients and no abnormality for two patients. The time from injury to imaging ranged from 2 months to 26 years. One young patient showed migraine-type headache that improved with migraine medication. One older patient showed neuropathic pain for which pregabalin was effective. The other four patients showed tension-type headache.

Methods: Whole-brain DTI and NODDI scans were analyzed using tract-based spatial statistics for all patients. Regions of interest (ROIs) were placed at the splenium, body and genu of the corpus callosum, and the mean fractional anisotropy (FA) was measured. Six healthy age- and sex matched volunteers underwent the same imaging. Informed consent was obtained from all patients and healthy volunteers. This study was approved by the internal review board and registered as a clinical trial in the UMIN Clinical Trial Registry. Statistical analyses were performed using the SPSS software program. Age was analyzed using a t-test, sex using a chi-square test and FA using the Mann-Whitney U test.

Results: There were no marked difference in the age and sex between patients and healthy volunteers (p>0.05). Tract-based spatial statistics and ROI analyses showed no significant differences in DTI findings and the FA between patients and healthy volunteers.

Discussion: The limitations of our clinical study were the retrospective design, small patient number and heterogeneity of symptoms, trauma type and duration from trauma to imaging. Social and psychological factors may have influenced the headache symptoms. A large prospective study will therefore be needed to control these variables. However, post-traumatic headache is relatively rare, so a preclinical animal study may be performed instead.

Conclusion: We performed DTI and analyzed the FA in patients with post-traumatic headache. Because of the small patient number and heterogenous population, no marked differences were observed compared with age- and sex-matched healthy controls.
The Impact of Yoga-Based Physical Therapy on Heart Rate Variability for Individuals with Traumatic Brain Injury: A Pilot Study

Kelly Krese¹, Benjamin Ingraham¹, David Ripley¹, Mary McNulty¹
¹Shirley Ryan Abilitylab, Chicago, United States

Introduction: A significant proportion of individuals with traumatic brain injury (TBI) experience anxiety, depression, and difficulty sleeping. These issues can affect cognitive and physical performance during rehabilitation, and impact long-term outcomes and quality of life. Given the high incidence of these issues post-TBI, and their profound impact on physical independence and functioning, this population may benefit from an alternative approach to rehab. There is growing body of evidence proposing yoga as an alternative medical approach to exercise and health maintenance in healthy individuals. When compared with control groups completing traditional exercise protocols that do not integrate mindfulness-based practices, yoga has been shown to reduce depression, anxiety, and stress. Evidence also supports that yoga affects cardiac autonomic regulation by increasing heart rate variability (HRV) during yoga practices in healthy, non-regular yoga practitioners, and in regular yoga practitioners, at rest. HRV is an indicator of autonomic nervous system (ANS) activity/control and has been found to be a surrogate marker for anxiety and depression. There is evidence that some individuals with TBI have demonstrated persistently low HRV which was then correlated with anxiety and depression in these individuals. This pilot study aims to explore if a yoga-based physical therapy (PT) session would promote increased, or improved, heart rate variability (HRV) relative to other treatments.

Methods: Approximately thirty participants will be recruited from the inpatient TBI unit at SRAL over a span of six months. Exclusion criteria include those with pacemakers, arrhythmias, aphasia, or history of previous neurological diagnoses. The crossover design consists of three conditions: yoga-based PT, traditional PT, and seated rest in a relaxing environment. Each participant will participate in each condition on one occasion for one hour. The analysis will involve comparing changes in HRV, self-reported anxiety, self-reported fatigue, and agitation immediately before and after each group, as well as sleep after each condition relative to baseline sleep quality. HRV will be measured with body-worn MC10 sensors. Anxiety will be measured with the 6-question version of the State-Trait Anxiety Inventory (STAI), and fatigue will be measured with a modified 3-question version of the Global Fatigue Index (GFI). Agitation will be measured with the Agitated Behavior Scale (ABS). Sleep quality will be measured by an Actigraph monitor.

Anticipated Results: Subjects will experience a greater improvement in HRV, anxiety, fatigue, agitation and sleep not only after the yoga group relative to the traditional PT group, but also after the seated rest in a relaxing environment relative to the traditional PT group.

Conclusion: The results of this pilot study will inform a larger-scale study of the effects of regular participation in a yoga-based program as an adjunct to traditional PT, and hopefully support the integration of more holistic-based programs in the acute rehabilitation setting.
Concurrent and Divergent Validity of the Client’s Intervention Priorities (CIP)© Tool in A Sample of Individuals with Traumatic Brain Injury: Preliminary Findings on an Innovative Canadian Instrument

Alexander Moreno1,2, Eduardo Cisneros1,2,3, Geneviève Léveillé1, Marie-Claude Guerrette1,2,3, Michelle McKerral1,2,3
1Centre for Interdisciplinary Research in Rehabilitation (CRIR), Montreal, Canada, 2CIUSSS Centre-Sud-de-l’île-de-Montréal (CCSMTL), Montreal, Canada, 3Université de Montréal, Montreal, Canada

Introduction: The Client’s Intervention Priorities (CIP)© is a tool for the assessment of self-perceived functioning in daily life situations and for determining intervention priorities. It is based on an anthropological model of human development and disability (Disability Creation Process-DCP). Conceived on principles of active participation, empowerment, and autonomy during neurorehabilitation, the CIP is a person-centred collaborative tool for setting rehabilitation goals with individuals with traumatic brain injury (TBI).

Objective: To investigate the concurrent and divergent validity of the CIP tool.

Design: Cross-sectional descriptive study.

Methods: Sixty-four individuals with TBI with a mean age of 39.6 (SD=14.1) years and 4.3 (SD=3.7) months post-injury were recruited at admission to the outpatient TBI rehabilitation program of an interdisciplinary neurorehabilitation centre in Montreal, Canada. The majority were men (57.8%), either single (43.8%) or married (42.2%), having sustained a moderate TBI (45.3%). Using the CIP tool, individuals were asked to judge their degree of functioning in 41 everyday/life situations corresponding to 12 categories (Daily Activities, 21 items: nutrition, fitness, personal care, communication, housing, mobility; Social Roles, 20 items: responsibilities, interpersonal relationships, community life, education, employment, recreation) reflecting the DCP model. A five-point Likert-type response scale ranging from 1- “I do not do it because of my present condition – somebody else does it for me” to 5- “I do it alone, without difficulty” was used. The CIP tool scores (Daily Activities and Social Roles subscales, and the total CIP total score) were calculated. The Mayo-Portland Adaptability Inventory-4 (MPAI-4) (indices of Ability, Adjustment, Participation, and the MPAI-4 total score, higher scores correspond to lower levels of functioning) was used as the criterion for convergent validity and a composite score of the MPAI-4 addressing associated conditions (i.e., alcohol and drug use, psychotic symptoms, and law violations) was used to estimate divergent validity.

Results: There was a statistically significant strong negative (as expected) correlation between the total score of the CIP tool and the total score of the MPAI-4 (r = -.56, p < .01). Conversely, the CIP did not show statistically significant associations with a composite score of the MPAI-4 addressing associated conditions (r = -.14, p > .05). The CIP Daily Activities subscale and the Social Roles subscale showed medium to large negative associations with the three subscales of the MPAI-4 (r’s ranging from -.41 to -.55, p < .01).

Conclusions: The CIP tool has strong concurrent and divergent validity in individuals with mild to severe TBI, as shown by its relationships to a widely accepted social participation outcome measure in brain injury. The CIP tool is a theoretically grounded tool with excellent psychometric properties to assist individuals with TBI and their rehabilitation professionals in the self-assessment of life habits and setting of common rehabilitation goals.
Measuring Clinical Evolution with the Client’s Intervention Priorities (CIP)© Tool in Individuals with Traumatic Brain Injury Participating in a Comprehensive Neurorehabilitation Program

**Alexander Moreno**\(^{1,2}\), Eduardo Cisneros\(^{1,2,3}\), Geneviève Léveillé\(^{1}\), Marie-Claude Guerrette\(^{1,2,3}\), Michelle McKerral\(^{1,2,3}\)

\(^{1}\text{Centre for Interdisciplinary Research in Rehabilitation (CRIR), Montreal, Canada,}\)
\(^{2}\text{CIUSSS Centre-Sud-de-l’Île-de-Montréal (CCSMTL), Montreal, Canada,}\)
\(^{3}\text{Université de Montréal, Montréal, Canada}\)

**Introduction:** The Client’s Intervention Priorities (CIP)© is an instrument for the self-assessment of life habits and for determining intervention priorities during neurorehabilitation. Through a collaborative process, individuals with traumatic brain injury (TBI) use the CIP tool to determine the life habits (i.e., Daily Activities and Social Roles frequently disrupted as a consequence of TBI) that will be prioritized in the rehabilitation process.

**Objective:** To explore the utility of the CIP tool to track the clinical evolution of individuals with TBI participating in an outpatient comprehensive neurorehabilitation program and to determine the relationship between post-TBI mental health problems (i.e., depression and anxiety) and the CIP tool at admission and at the end of the rehabilitation program.

**Design:** Descriptive cohort study.

**Methods:** Thirty-six individuals with TBI with a mean age of 41.9 (SD=15.8) years and 4.3 (SD=3.8) months post-injury were recruited at admission to the outpatient TBI rehabilitation program in an interdisciplinary neurorehabilitation centre in Montreal, Canada. The majority were men (55.6%), either married (41.7%) or single (38.9%) individuals having sustained a moderate TBI (47.2%). The CIP tool scores (Daily Activities and Social Roles subscales, and the total CIP total score; higher scores indicate greater levels of functioning), as well as measures of mental health (Beck Depression and Anxiety Inventories, BDI-II/BAI) and social participation (Mayo-Portland Adaptability Inventory-4, MPAI-4) (higher scores indicate lower levels of mental health or functioning, respectively). Measures were administered at admission and discharge from the interdisciplinary neurorehabilitation program - mean duration of 6.5 (SD=3.8) months of rehabilitation.

**Results:** Results of paired-samples t-tests showed that there was a statistically significant increase in the CIP total score, \(t (32) = -5.1, p < .0001\), and its subscales (Daily Activities, \(t (33) = -5.5, p < .0001\), and Social Roles, \(t (32) = -4.2, p < .0001\)) from rehabilitation admission to discharge (large effect sizes). Conversely, there was statistically significant decrease in the BAI, \(t (35) = 3.2, p < .01\), the BDI-II, \(t (35) = 5.1, p < .05\), and the MPAI-4 score, \(t (34) = 2.6, p < .05\), from the beginning to the end of rehabilitation (medium to large effect sizes). At both admission and discharge, there was a statistically significant negative association between the CIP total score with the BDI-II and the BAI (\(r = -.44\) and \(-.49, p < .01\), respectively).

**Conclusions:** The CIP tool is useful to track the clinical evolution of individuals with TBI in neurorehabilitation. Also, the CIP tool has moderate associations with mental health measures at admission to rehabilitation and at discharge. As such, its use is recommended in clinical settings and research evaluating interventions for individuals with TBI.
Keywords: Neurorehabilitation, clinical evolution, self-assessment, social participation, mental health, person-centred, intervention priorities, goal setting.
Peer Support Interventions for Individuals with Acquired Brain Injury, Cerebral Palsy, and Spina Bifida: A Systematic Review

Ben Levy¹, Dorothy Luong², Laure Perrier², Mark Bayley¹, Sarah Munce¹
¹Toronto Rehabilitation Institute, University Health Network, Toronto, Canada, ²University of Toronto Libraries, University of Toronto, Toronto, Canada

Background: Neurological disorders may negatively impact community integration and/or quality of life. Peer support has emerged as a potential strategy to enhance patients’ efficacy in managing their own health. This review examines the key characteristics and impact of peer support interventions for adults with acquired brain injury, cerebral palsy, and spina bifida on community integration and quality of life.

Methods: Eligible studies reported on peer support interventions for adults (16 years of age or older) with acquired brain injury, cerebral palsy, or spina bifida. Only randomized controlled trials published in English in the last 10 years were included. MEDLINE, EMBASE, PsycINFO, and CINAHL were used to conduct the literature search. Two reviewers independently screened studies, abstracted data, and evaluated the risk of bias using the Cochrane Risk of Bias Tool.

Results: The systematic review included 6 trials reporting on acquired brain injury only. Of these studies, 4 reported on stroke and 2 reported on traumatic brain injury. Two studies found significant improvements in quality of life following peer support. No studies reported significant results on community integration. Considerable heterogeneity existed in the key characteristics of interventions.

Conclusions: There is limited evidence on the impact of peer support interventions for adults with acquired brain injury, cerebral palsy, or spina bifida on community integration and quality of life. Standardization of key intervention characteristics may aid the global adoption of peer support as a formalized, evidence-based practice.
Six Years Methylphenidate Treatment for Mental Fatigue and Cognitive Function After A Traumatic Brain Injury

Birgitta Johansson

Institute of Neuroscience and Physiology, Gothenburg, Sweden

Introduction: Long-term mental fatigue and cognitive complaints are common after a traumatic brain injury (TBI) and can have a substantial effect on working capacity and ordinary life. Fatigue is suggested as being one of the most distressing and long-lasting symptoms following mild TBI.

This prospective clinical follow up was designed to evaluate the long-term efficacy and safety of methylphenidate treatment after TBI. We also evaluated the effect after a four–week treatment break and compared subjective and objective effects with and without methylphenidate.

Method: Seventeen out of 18 patients who had continued with methylphenidate were followed up in the clinic. The mean time on the methylphenidate treatment for patients was 5.5 years (ranging from 6 years and 4 months to 4 years and 5 months). All patients answered questionnaires about mental fatigue (Mental Fatigue Scale, MFS) and were assessed for cognitive function measuring processing speed (digit symbol coding, DSC); attention (trail making test, TMT A and B) and working memory (digit span, DS). For safety, their blood pressure, heart rate, and ECG were measured. The mean dose at follow up was 58.5 mg/day (range between 40-80 mg/day).

Those who discontinued with methylphenidate during the study were all contacted by mail and asked to answer the MFS questionnaire. Of these, 19 answered and 9 did not respond.

The distribution of sex, education, and age were similar between the groups at follow up, including the participants not responding.

Results: Compared to baseline, significant decreased mental fatigue (MFS, p=0.001) and improved processing speed (DSC, p =0.008) were found after 5.5 years with methylphenidate treatment. No significant change in MFS was found for those without treatment.

Methylphenidate was well-tolerated, and the clinical effect remained without any adjustment of dose. Compared to the baseline, a slight increase in heartbeat and blood pressure were found, but still within the normal range.

A four-week treatment break showed a clear and significant deterioration in mental fatigue and processing speed when methylphenidate was withdrawn.

Conclusion: We suggest methylphenidate to be a possible option for patients with post-TBI mental fatigue and cognitive impairment. Long-term use of methylphenidate was well-tolerated, and the effect remained.
Altered Neuronal Activity in the Frontal Cortex in Individuals Suffering from Mental Fatigue After A Mild Traumatic Brain Injury

Simon Skau¹, Birgitta Johansson¹
¹Institute of Neuroscience and Physiology, Gothenburg, Sweden

Background: Pathological mental fatigue after mild traumatic brain injury (TBI-MF) is characterized by pronounced mental fatigue after moderate cognitive activity. We aimed in the following study to investigate neuronal activity in frontal cortex and relate it to cognitive performance during a longer test session.

Methods: We recruited individuals with TBI-MF (n=20) more than 5 months after injury and age-matched healthy individuals (n=20). We used functional near-infrared spectroscopy (fNIRS) to assess hemodynamic changes (oxygenated hemoglobin) in the frontal cortex during prolonged cognitive activity. A block of six neuro-psychological tests was performed in sequence and was repeated once. A sustained-attention test was done between blocks. In total, the test procedure took 2 ½ hours.

Results: The TBI-MF group demonstrated an altered functional brain activity in the frontal cortex during cognitive tests. No difference in brain activity between the two test sessions was found, and this was the case for both groups. Group differences in brain activity were detected already during the first test session relating to the test for conflict processing and processing speed. The fNIRS adapted Stroop-Simon test, measuring brain activity for each single task, showed a generally lower event-related activity in the frontal polar area, ventrolateral motor cortex, and dorsolateral prefrontal cortex. The fNIRS assessment for processing speed (Digit Symbol Coding) demonstrated more widespread activity in the frontal cortex in the TBI-MF group as compared to controls. The controls improved their processing speed in the second session while the TBI-MF group performed at a similar level (interaction, p<0.01). The TBI-MF group reported reduced mental energy after the test session.

Conclusion: An altered neuronal activity in the frontal cortex was found already from the start in the TBI-MF group compared to healthy controls when performing cognitive tasks over a longer period. The controls improved in processing speed during the second test session, while the TBI-MF group remained at a similar level - indicating a reduced efficiency. The reduced efficiency may result in the experience of mental fatigue after an extended mental activity.
Cognitive Functioning: A Determinant of Safe and Effective Driving in Power Wheelchair

Alice Pellichero¹, Krista Best¹, Eric Sorita², François Routhier¹
¹Centre interdisciplinaire de recherche en réadaptation et en intégration sociale (CIRRIS), Quebec, Canada, ²Université de Bordeaux - Handicap Activité Cognition Santé (EA 4136 HACS), Bordeaux, France

Individuals with mobility impairments can benefit from power wheelchair (PWC) mobility. Benefits of PWC use include increased independence, social engagement, and better mobility, and can improve participation and quality of life. In addition, enabling independent mobility through PWCs can reduce reliance on caregivers. However, PWC provision is complex. Ensuring safe and effective driving requires consideration of diagnosis and prognosis, motor cognitive and perceptual capacities, and environments. Although cognition is a large concern that is expressed by clinicians when prescribing PWCs, existing PWC driving tools do not fully include cognitive items. Moreover, there are limited validated screening tools to assess readiness for PWCs, and current validated tools focus predominantly on performance and driving skills. Additionally, existing PWC training programs focus mainly on the principles of motor learning. It is likely that individuals with cognitive impairments due to brain injury could benefit from PWCs, but they may be precluded from provision of a PWC due to premature clinical judgement about cognitive readiness for PWC driving. It is critical to examine methods for assessing and training the cognitive skills required to drive a PWC.

The aim of this presentation is to describe the protocol for a program of research designed to enhance PWC provision through better assessment and training of cognitive capacity and ability to learn according to various cognitive factors (e.g., executive function, problem solving). The following 4-step sequential process and methodologies will be used: Study 1) A systematic review to identify factors related to PWC driving and cognition that are present in existing outcome tools and training programs, Study 2) A cross-sectional study with n=40 PWC users with varied cognitive functioning to explore the relationship between the skills required for PWC driving and cognitive functioning, Study 3) A cognition-enhanced PWC driver program will be developed using an integrated approach to identify the cognitive factors that are critical for PWC driving, and Study 4) A pre-post feasibility design will be used to develop and evaluate a cognition-enhanced PWC training program.

The proposed protocol outlines the steps for selecting adequate screening tools for cognitive readiness for PWC driving, methods for selecting and implementing evidence-based approaches to develop a cognition-enhanced PWC driving program, and a plan to evaluate the feasibility and influence of a novel intervention. Realization of the proposed research will lead to the development of a novel intervention that will be evaluated in a future clinical trial. If feasible and effective, a cognitive-enhanced PWC driving program may improve access to PWC mobility for individuals with brain injury, who may have otherwise been excluded. In turn, successful PWC mobility could improve participation and quality of life for the individuals, while reducing caregiver burden.
Coenzyme Q10 Affects Radiation Treatment by Modulating GFAP Network

Chong-Chun Liao¹, Chi-Shuo Chen¹
¹Department of Biomedical Engineering and Environmental Science, NTHU, Hsinchu, Taiwan

Introduction: Astrocytoma is an aggressive primary malignant brain tumor in adults. Radiation therapy is an effective medical treatment, but one of its undesired side-effects is the induced genomic instability of surrounding astrocytes, which can lead abnormal distribution of GFAP and associates with severe brain injury (BI).

Purpose: In order to cope with this serious difficulty, various antioxidants have been applied with radiation therapy. Among antioxidants, Coenzyme Q10 (Q10) is one of the few candidates without double-edged sword effect. However, the understand about Q10 therapeutic effect on radiological protection is limited. In this study, we aimed to investigate the potential therapeutic effects of Q10 on brain tumor radiation treatment.

Materials and Methods: Astrocyte and glioma cell lines were cultivated with Q10 (10 µM–50 µM) and exposed to 10 Gy single dose from Cobalt-60 (60Co). After the radiation exposure, cell viability was analyzed using MTT assay, GFAP responses was examined by immunofluorescence staining and qPCR, and other cell phenotype indexes, such as the morphology, migration, and invasion in vitro, were observed by microscopy.

Results: Our results indicated that Q10 treatment was capable of maintaining GFAP network of astrocyte after radiation exposure. Besides, Q10 synergistically eliminated glioma proliferation after radiation treatment. By extending horizontally along the base of GFAP remodeling, we further investigated the ability of 3D tumor invasion in co-culture model which simulated the microenvironment composed of reactive astrocyte and glioma in clinical research. Results indicated that radiation therapy with Q10 can further suppress the invasive ability in vitro.

Conclusions: In sum, our results demonstrated the potential radiological protection of Q10 on astrocyte and amplified the therapeutic effectiveness for brain tumor therapy.
Altered Resting-State Functional Connectivity Within the Social Brain in Adolescents Who Sustain Moderate-Severe Traumatic Brain Injury

Carola Tuerk, Fanny Dégeilh, Cathy Catroppa, Vicki Anderson, Miriam Beauchamp

1University of Montreal, Montreal, Canada, 2CHU Sainte-Justine Research Center, Montreal, Canada, 3University of Melbourne, Melbourne, Australia, 4Murdoch Children’s Research Institute, Melbourne, Australia

Objective: Pediatric TBI can lead to interruption of normal development given the vulnerability of the developing brain. In particular, TBI can have an impact on social skills through a disruption of social cognitive functions subsumed by the social brain network (SBN). While some studies have shown structural changes to the SBN as a result of TBI, few studies have focused on functional disruptions. This study explored functional connectivity (FC) within the SBN following moderate to severe TBI (msTBI) in two independent samples of adolescents.

Participants and Methods: In studies 1 and 2 (prospective longitudinal), adolescents with msTBI (N=14, mean age=13.1y, SD=1.4) and healthy controls (HC; N=16, mean age=13.6y, SD=1.7) underwent resting-state functional magnetic resonance imaging one to two years post-injury. ROI-to-ROI functional connectivity (FC) and seed-to-voxel FC was compared between the groups using selected seeds from the SBN. A grey matter (GM) mask of previously defined anatomical regions within the SBN was applied. In study 3 (cross-sectional), ROI-to-ROI replicative analysis was performed in an independent sample of adolescents (msTBI: N=9, mean age=16.8 years, SD=0.8; HC: N=9, mean age=15.8 years, SD=1.3) using peak coordinates from clusters and ROIs that showed significant differences in FC in studies 1 and 2. Pearson partial correlations were performed using FC z-scores and the Child Behavior Checklist (CBCL) in the TBI groups. All results were adjusted for age, sex, socio-economic status, total GM volume and corrected for multiple comparisons (p<.05).

Results: Studies 1 and 2 revealed significant differences between msTBI and HC in FC between the dorsomedial prefrontal cortex and left fusiform gyrus (FG; p=.004), as well as between left FG and left superior frontal gyrus (SFG; k=483 voxels, p=.001), both indicating stronger negative connectivity (anti-correlation) for HC and positive connectivity for TBI. In the replication sample (study 3), we found stronger negative connectivity between left SFG and right FG in HC as compared to msTBI participants who showed positive left SFG-right FG connectivity (p=.049). Partial correlation analyses between the FC and CBCL scores in the TBI groups did not yield any significant result. However, participants with TBI had overall more internalizing problems (p=.027).

Conclusions: These studies suggest that TBI can lead to functional disruption of the SBN. Altered frontal-fusiform connectivity may reflect deficits in emotion recognition, such as facial-affect recognition, involving both inter- and intra-hemispheric connections. Failure to deactivate frontal areas may be associated with more effortful and inefficient processing in the TBI group. Abnormal connectivity in areas implicated in facial-affect recognition could underlie more general impairments in social competence. Findings may help to shed light on the complex association between adverse social functioning and TBI in adolescence.
IL-10 and H-FABP as Early Outcome Predictors in Traumatic Brain Injury Patients

Jean-Charles Sanchez¹, Linnéa Lagerstedt¹, Jussi Posti², Olli Tenovuo²
¹University of Geneva, Geneva, Switzerland, ²University of Turku, Turku, Finland

Patients having experienced a traumatic brain injury (TBI) may later suffer from cognitive, behavior, emotional and physical impairments. Several proteins have been investigated as biomarkers to guide clinicians’ decision making in order to optimize patients’ care taking. Single proteins such as S100B, GFAP and NF-L have been widely studied for this purpose. More recently, combinations of biomarkers have gained interest to enhance the performance. Here, the aim was to evaluate the prediction capacity of two proteins – IL-10 and H-FABP – and to compare and combine them to the well-studied proteins S100B, GFAP and NF-L. Patients diagnosed with a TBI were recruited from the Turku University Hospital, a blood sample was collected <24h post trauma and a follow-up performed after 6-months. The outcome was measured using the Glasgow Outcome Scale Extended (GOSE) score. Patients were dichotomized into i) favorable (GOSE ≥ 5) and unfavorable outcome (GOSE ≤ 4) and ii) complete (GOSE 8) and incomplete (GOSE ≤ 7) recovery groups for statistical analysis. All proteins were significantly different in both outcome groups (p < 0.05). The best performing protein to correctly classify favorable and unfavorable outcome was the IL-10 with a sensitivity of 96% (95% CI 89–100) and specificity reaching 50% (95% CI 37–63). A panel combining IL-10 and H-FABP increased the prediction capacities to a sensitivity of 96% (95% CI 89–100) and a specificity of 58% (95% CI 45–71). The single protein H-FABP was the best performing protein for detection of complete recovery reaching a sensitivity of 97% (95% CI 92–100) and a specificity of 28% (95% CI 12–44). When combined with GFAP the performance enhanced to 95% (95% CI 89–100) sensitivity and 36% (95% CI 16–56) specificity. These results indicate that the proteins IL-10 and H-FABP could individually be used to differentiate between good and poor outcome patients. Furthermore, proteins combined together into panels could greatly increase the accuracy in predicting TBI patients’ outcome.
Serum Amyloid A – A Novel Predictor of Stroke Associated Infections

Jean-Charles Sanchez1, Julianne Schweizer2, Alejandro Bustamante3, Vanessa Lapierre-Fétaud1, Júlia Faura3, Leire Azurmendi1, Joan Montaner3, Mira Katan2

1University of Geneva, Geneva, Switzerland, 2University Hospital Zurich, Zurich, Switzerland, 3Universitat Autònoma de Barcelona, Barcelona, Spain, 4University Hospital Wuerzburg, Wuerzburg, Germany

Objectives: The aim of this study was to evaluate and independently validate serum amyloid A (SAA), a recently discovered blood biomarker, to predict post stroke infections.

Methods: The derivation cohort (A) was composed of 283 acute ischemic stroke patients and the independent validation cohort (B), of 367 patients. The primary outcome measure was any stroke-associated infection, defined by the criteria of the U.S. Centers for Disease Control and Prevention, occurring during hospitalization. To determine the association of SAA levels on admission with the development of infections, logistic regression models were calculated. The discriminatory ability of SAA was assessed, by calculating the area under the receiver operating characteristic curve.

Results: After adjusting for all predictors which were significantly associated with any infection in the univariate analysis, SAA remained an independent predictor in study A (adj. OR=1.36 (95% CI, 1.10 – 1.67), P=0.004) and in study B (adj. OR=1.56, (95%-CI 1.07 – 2.26), P=0.019). Adding SAA to the best regression model without the biomarker, the discriminatory accuracy improved from 0.75 (95% CI, 0.67 – 0.82) to 0.78 (95% CI, 0.71 – 0.85) P<0.0036 (likelihood ratio test) in study A. These results were externally validated in study B with an improvement in the AUC, from 0.75 (95% CI, 0.69 – 0.80) to 0.76 (95% CI, 0.71 – 0.81) P<0.018.

Conclusion: Among ischemic stroke patients, blood serum amyloid A measured on admission is a novel independent predictor of infection after stroke. SAA improved the prediction model of patients who developed an infection in a derivation and validation cohort.
Development of a Predictive Risk Score for Persisting Concussion Symptoms in Adults Using Administrative Health Data

Laura Langer1, Mohammad Alavinia1,2, Mark Bayley1,2
1University Health Network - Toronto Rehab, Toronto, Canada, 2University of Toronto, Department of Medicine, Toronto, Canada

Background: Most people with a concussion recover from their symptoms within weeks to a month of their injury. An estimated 15% continue to experience persisting concussion symptoms months to years after their injury. Systematic reviews suggest that being female and premorbid diagnoses of mental health disorder or headaches increase the risk of prolonged concussion symptoms (PCS) however few large scales adult studies estimate risk scores for PCS.

Objectives: To determine demographic and premorbid health conditions as predictors for persisting concussion symptoms in order to create a risk score to be used in clinical practice.

Methods: A cohort of residents of Ontario, Canada with a physician made diagnosis of concussion between Jan 1, 2008 and Dec 31, 2016 was assembled using administrative data from the Ontario Health Insurance Plan (OHIP) Physician Billing and National Ambulatory Care Reporting System (NARCS) databases held by the Institute of Clinical and Evaluative Sciences (ICES). Using linked data, pre-concussion diagnoses and health care utilization were identified by retrospective review 5 years prior to the index concussion; each person was tracked for 2 years after the injury for concussion-related health care utilization with specialists i.e. physiatry, neurology, psychiatry, ophthalmology, ENT, etc. The PCS Cohort was defined as adults with >2 visits more than 6 months after their injury. Univariate logistic regressions were performed for all a priori variables. Those with significant odds ratios (P<0.01) were entered into a stepwise regression model in the Derivation cohort (all adults diagnosed between 2009 and 2013). Retained variables were entered in a multivariate regression model and significant variables were entered into a classification and regression tree model. Risk scores were calculated for the significant variables and forward sampled in the Validation cohort (adults diagnosed in either 2008 or 2014).

Results: 587 057 adults were diagnosed with a concussion between 2008 and 2016; 13% of this cohort met the criteria for persisting symptoms. The variables remaining in the final model were number of visits to a primary care physician the year before injury, age, sex, mental health diagnoses, migraine diagnosis, pain disorders, neurological disorders, and sleep disorders. The variables with the highest risk of persisting concussion symptoms were high use of primary care (> 8 visits a year), anxiety and/or depression diagnoses, and those older than >60 years. People with neurological disorders had the most concussion related health care usage in the 2 years after their injury.

Discussion: People with a concussion and high level of primary care usage and mental health diagnoses are at high risk to develop persisting concussion symptoms. Clinicians will be able to use this tool to identify patients at risk for persisting symptoms and initiate earlier appropriate health care to help reduce symptom burden of the patient.
Biofeedback Can Improve Driving Performance in Individuals with Persistent Post-Concussive Symptoms: Preliminary Findings from An Eight-Week Intervention

**Marquise Bonn**, Liliana Alvarez, James Dickey

1Western University, London, Canada

Background: Acute concussions impair driving performance. Similar impairments may be present in individuals experiencing persistent post-concussive symptoms (PPCS). Therefore, there is a need for interventions that can improve driving outcomes in this population. Low resolution electromagnetic tomography (LoRETA) neurofeedback and heart rate variability (HRV) biofeedback can improve attention, impulse control, peripheral vision, and reduce stress, all of which may impact driving ability.

Objective: To evaluate the preliminary impact of LoRETA neurofeedback and HRV biofeedback on driving performance in individuals experiencing PPCS.

Methods: Over an eight-week span, individuals with PPCS (n = 7) received LoRETA neurofeedback and HRV biofeedback interventions three times per week. Additionally, they performed HRV biofeedback twice a day at home. We evaluated the simulated driving performance (i.e. reaction time and lane deviation) and self-reported symptoms in this experimental group, as well as two control groups (nine individuals with PPCS and eight healthy controls) at baseline and post-intervention.

Results: Headache, nausea, and dizziness severity decreased in the experimental group (p = 0.003) and the PPCS controls (p = 0.001) compared to healthy controls. Additionally, there was some evidence of improved lane deviation in the intervention group, although not statistically significant in this small sample (p = 0.067). This result may have clinical significance. Future studies with larger sample size, longer follow-up times, and additional driving simulation metrics may help to evaluate the efficacy and effectiveness of this intervention for individuals with PPCS.
Repetitive Trans-Cranial Magnetic Stimulation (rTMS) for the Treatment of Chronic Tinnitus in Patients with and without A History of Traumatic Brain Injury (TBI)

Garret Horton¹, Omar Ibrahim¹, Marcus Jansen², Roumen Milev³, Jason Beyea¹, Jessica Trier²
¹Department of Otolaryngology, Kingston Health Sciences Centre, Queen’s University, Kingston, Canada, ²Department of Physical Medicine and Rehabilitation, Kingston Health Sciences Centre, Queen’s University, Kingston, Canada, ³Department of Psychiatry, Providence Care Hospital, Queen’s University, Kingston, Canada

Background: Tinnitus is a common and debilitating condition with no known cure. Hearing loss is the primary risk factor for tinnitus, but head trauma is also a significant risk factor. Research indicates that tinnitus results from neuroplastic changes that lead to neuronal hyperexcitability within the auditory cortex. Repetitive transcranial magnetic stimulation (rTMS) has the potential to treat tinnitus by reducing neuronal activity within this brain region using magnetic pulses to promote a lower firing rate. However, findings regarding the efficacy of rTMS in the tinnitus population as a whole have been mixed. We hypothesize that tinnitus etiology may determine the efficacy of potential therapies; thus, studying subpopulations of tinnitus patients will yield a more accurate assessment of therapeutic efficacy. In this study, we test the efficacy of low frequency rTMS in patients with and without a history of traumatic brain injury (TBI).

Methods: In this preliminary parallel clinical trial, tinnitus patients were stratified into two subpopulations: patients with and without a history of TBI. Each participant underwent 10 treatment sessions in which 2000 pulses of low frequency (1Hz) rTMS were applied to the primary auditory cortex. Each participant’s tinnitus symptoms and hearing were evaluated before and after the intervention using the Tinnitus Functional Index (TFI), Tinnitus Handicap Inventory (THI), Hearing Handicap Inventory for Adults (HHIA), and audiogram testing. Tinnitus symptoms and hearing before and after treatment were compared to assess treatment efficacy within and between groups. These comparisons were made using a one-way repeated measures ANOVA.

Results: As a whole, rTMS significantly improved the mean speech reception threshold of tinnitus patients. However, when patients were analyzed based on history of TBI, TBI patients had a substantial improvement in speech response threshold, with no improvement in non-TBI patients. Tinnitus symptom severity questionnaire scores were not significantly affected by treatment. Finally, 33% of patients with a history of TBI chose to withdraw from the study due to discomfort or a perceived worsening of their symptoms. Comparatively, 14% of patients without a history of TBI withdrew.

Conclusion: Our preliminary results suggest that tinnitus of differing etiologies may respond differently to low frequency rTMS. Patients with a history of TBI may respond better to low frequency rTMS but have more difficulty tolerating the treatment due to the noise sensitivity often associated with traumatic brain injuries.
Psychometric Evaluation of the World Health Organization Disability Assessment Schedule 2.0 for Mild Traumatic Brain Injury Using Rasch Analysis

Deborah Snell1,2, Richard Siegert3, Noah Silverberg4,5

1Department of Orthopaedic Surgery and Musculoskeletal Medicine, University of Otago, Christchurch, New Zealand, 2Burwood Concussion Service, Canterbury District Health Board, Christchurch, New Zealand, 3Faculty of Health and Environmental Studies, Auckland University of Technology, Auckland, New Zealand, 4Division of Physical Medicine & Rehabilitation, University of British Columbia, Vancouver, Canada, 5Rehabilitation Research Program, GF Strong Rehab Centre, Vancouver, Canada

Background and Objectives: The World Health Organisation Disability Assessment Schedule 12-item version (WHODAS-2.0) is a measure of disability representing six International Classification of Disability, Functioning, and Health activity and participation domains, including cognition, mobility, self-care, interpersonal functioning, life activities, and participation. Preliminary validation analyses of the WHODAS-2.0 as an outcome measure for mild traumatic brain injury (MTBI) using classical test theory methods, were promising. The objective of this study was to further examine the psychometric properties of the WHODAS-2.0 for MTBI by applying Rasch Analysis, specifically considering undimensionality and responsiveness to injury recovery.

Method: Adults (n = 148) who were recruited from outpatient clinics in Vancouver following MTBI completed the WHODAS-2.0 at on average 10 weeks and then again 20 weeks following injury. We used Rasch analysis to determine overall and individual item fit to the Rasch model at each time point, differential item functioning (DIF), local independence, unidimensionality and person-separation reliability of the WHODAS 2.0 using RUMM2030 software. Paired t-tests were used to evaluate change in scores with time.

Results: Participants were on average 40 years old (SD 12.1), predominantly Caucasian (66%), with slightly more women (66%) than men in the sample. The most common injury mechanism was motor vehicle accident (48%). Best fit to the unidimensional Rasch model at time one was achieved after locally dependent items were combined into three subtests or super-items (Chi square = 3.63, df 6, p = 0.73). The modified WHODAS-2.0 demonstrated high internal consistency (Person Separation Index (PSI) = 0.91) and there was no DIF across person factors examined. Time 2 analyses although exploratory, due to a small (n = 80) sample, were also suggestive of good fit to the Rasch model and high internal consistency (Chi square = 22.21, df 22, p = 0.45; PSI = 0.90). The results support retaining the original response format and content of the measure. From these analyses we created ordinal-to-interval conversion tables that will allow more precise assessment of MTBI outcome across individuals on an interval scale. Finally, differences in WHODAS-2.0 summed raw scores between times one and two were significant (mean difference = 5.59; 95% confidence interval 4.05, 7.14; p<0.01), and person-item threshold distributions from Rasch analysis reflected reducing disability with time in this sample.

Conclusions: With minor modifications, the WHODAS-2.0 demonstrated adequate properties as a unidimensional scale and showed responsiveness to improvement with time and MTBI recovery. Rasch analyses supported the WHODAS-2.0 as a psychometrically sound measure of outcome in adults after MTBI.
Psycho metric Evaluation of a New Measure of Fear Avoidance Behavior After Mild Traumatic Brain Injury Using Rasch Analysis

Deborah Snell1,2, Richard Siegert3, Chantel Debert4, Noah Silverberg5,6

1Department of Orthopaedic Surgery and Musculoskeletal Medicine, University of Otago, Christchurch, New Zealand, 2Burwood Concussion Service, Canterbury District Health Board, Christchurch, New Zealand, 3Faculty of Health and Environmental Studies, Auckland University of Technology, Auckland, New Zealand, 4Department of Clinical Neurosciences, Division of Physical Medicine and Rehabilitation, University of Calgary, Calgary, Canada, 5Division of Physical Medicine & Rehabilitation, University of British Columbia, Vancouver, Canada, 6Rehabilitation Research Program, GF Strong Rehab Centre, Vancouver, Canada

Background and Objectives: Fear avoidance is a known risk factor for chronic disability after musculoskeletal injury and has been shown to be associated with a range of adverse outcomes after mild traumatic brain injury (MTBI). A psychometrically valid measure of fear avoidance behavior after MTBI could help advance the field. In this study, we examined the psychometric properties of a 16-item fear avoidance behavior questionnaire in a sample of people after MTBI. The Fear Avoidance Behavior in Traumatic Brain Injury questionnaire (FAB-TBI) is comprised of items from existing fear avoidance behavior measures (primarily in chronic pain literature), selected on the basis of principal component and factor analyses in prior studies, and presented with uniform Likert-type response options. Ordinal scales may not discriminate precisely between fear avoidance behaviors across individuals. The current study aimed to improve precision and item functioning of the FAB-TBI by applying Rasch analysis.

Method: Adults (n=120) who were recruited from outpatient clinics in Vancouver and Calgary following MTBI completed the FAB-TBI at a median of six weeks post-injury (IQR 4-8). First, using Classical Test Theory methods we examined item-total correlations, Cronbach's α and dimensionality. We used Principal components and Varimax rotation to explore dimensionality. Second, we used Rasch analysis to determine overall and individual item fit to the Rasch model, differential item functioning (DIF), local independence, unidimensionality and person-separation reliability of the FAB-TBI using RUMM2030 software.

Results: Participants were on average 39 years old (SD 12.5), predominantly Caucasian (68%), with slightly more women (61%) than men. The most common injury mechanism was motor vehicle accident (39%). FAB-TBI item-total correlations were all above 0.3, Cronbach's α=0.9, and we observed a clear four-factor structure (activity avoidance, general pain concern, headache avoidance, general symptom avoidance). Initial analysis indicated the FAB-TBI demonstrated adequate but not perfect fit with the Rasch model with one misfitting item. Best fit to the unidimensional Rasch model was achieved after locally dependent items were combined into four subtests based on the initial exploratory factor analysis, retaining the misfitting item (Chi square=3.4, df 8, p=0.9). Finally, the modified FAB-TBI demonstrated high internal consistency (Person-Separation Index=0.8); there was no DIF across person factors examined. There was DIF by recruitment site, but this finding was unstable, requiring further evaluation. The results support retaining the original response format and content of the measure. From these analyses we created ordinal-to-interval conversion tables that will allow more precise assessment of fear avoidance behavior across individuals on an interval scale.

Conclusions: With minor modifications, the FAB-TBI demonstrated adequate properties as a unidimensional scale. Rasch analysis supported the FAB-TBI as a psychometrically sound measure of fear avoidance behavior in adults after MTBI, with potential to assist clinicians develop targeted MTBI interventions.
IBIA DOC-SIG International Comparison of Treatment Approaches for Disorders of Consciousness (DOC) Part II – Availability of Treatment Approaches at the Clinical Level

Petra Maurer-Karattup¹, Ann-Marie Morrissey²

¹SRH Fachkrankenhaus Neresheim, Ulm, Germany, ²Trinity College, Dublin, Ireland

Introduction: Part I of this international study found significant variability in the care and treatment of people with acute and prolonged DOC in fourteen countries across four continents (Maurer-Karattup & Morrissey, 2017). The survey revealed major international differences in regard to treatment pathways, structures of care and availability and length of treatment. The second part of this study examines the care and treatment of DOC at the clinical level and explores treatment and intervention approaches, goal setting, intensity of rehabilitation, assessment of treatment efficacy, team training and family involvement. This study will have important implications for clinical service providers for people living with DOC globally.

Method: A cross-sectional online questionnaire was developed by the lead authors, with the support of a subgroup of clinicians and researchers of the IBIA-DOC-Special Interest Group (DOC-SIG)). The survey explored clinical care and treatment under a number of key areas. It underwent three rounds of consultation and feedback by clinicians and researchers of the IBIA-DOC-SIG subgroup prior to being finalized. It was disseminated to all members of the IBIA DOC-SIG (clinicians and researchers). The results were analyzed, using descriptive statistics.

Results: Results were not available yet at the time of the submission of the abstract.

Conclusion: The results will shed light on the real world, in-practice treatment for patients with DOC across a number of countries. These will be discussed in relation to current international clinical guidelines and current evidence informed practice.
Premature Infants At 14 Months of Age Have A Delay in Development Expressive Language

**Sergey Kiselev**, Nadja Bakushkina, Katerina Suleymanova, Inna Tuktareva

*1Ural Federal University, Ekaterinburg, Russian Federation*

Background: It is known that premature children have a risk for neurodevelopmental disorders [Anderson & Doyle, 2008]. There is not enough data about the impact of prematurity on neurocognitive development in early stages of development. We have shown that prematurity has negative effect on cognitive scale, receptive language and gross motor from the Bayley Scales (3rd Edition) in infants at 5 months of age (Kiselev et al, 2017). The aim of study was to reveal differences in development of neurocognitive functions in mature and premature infants at 14 months of age.

Methods: The participants were 26 premature infants and 26 age-matched healthy full-term infants. The gestational age of preterm infants was between 29 and 35 weeks. The Bayley Scales (3rd Edition) were used to evaluate the neurocognitive abilities in infants at 14 months of age.

Results: One-way ANOVA was used to reveal group differences in performing tasks from the Bayley Scales. We have revealed the significant differences (p<.05) between groups only in expressive language. Premature children performed significantly (p≤0,05) more poorly than the full-term infants on this scale. However, we did not find the same result for gross and fine motor, cognitive scale and receptive language.

Conclusion: Premature infants at 14 months of age have delay in development expressive language. It can be assumed that prematurity has a specific negative effect on neurocognitive functions of children in different stages of development. Particularly, the prematurity has more negative effect on neurocognitive abilities at 5 months of age in comparison to premature children at 14 months of age.

Funding: This work was supported by grant Russian Science Foundation № 16-18-10371.
Incidence and Predictors of Sleep Apnea Treatment Adherence After Acquired Brain Injury

Marc Silva1,2,3, Dayana Calvo1, Daniel Schwartz1,2, Risa Nakase-Richardson1,2,3
1James A Haley VA Hospital, Tampa, United States, 2University of South Florida, Tampa, United States, 3Defense and Veterans Brain Injury Center, Tampa, United States

Background: Obstructive sleep apnea (OSA) is a breathing-related sleep disorder that is common among persons with ABI, co-occurring in 45% of those admitted for neurorehabilitation. In addition to raising risk of early mortality, OSA is associated with structural brain changes and cognitive deficits which are reversible with treatment.

Positive airway pressure (PAP) is the frontline therapy for OSA. When used properly, PAP is effective in reducing the negative consequences of untreated OSA. Research suggests that, in persons with ABI and comorbid OSA, those treated with PAP demonstrate better functional outcomes compared to those untreated. In non-brained injured persons with OSA, PAP adherence is poor. There is scant research on PAP adherence in persons with ABI during early recovery, which is a critical time for neurorepair. Thus, the objectives of this study were, in patients with OSA admitted for neurorehabilitation following ABI, to: examine the incidence and identify predictors of PAP adherence.

Methods: Participants were persons admitted for inpatient neurorehabilitation at a VA Polytrauma Rehabilitation Center, diagnosed with OSA, and for whom PAP was recommended. PAP adherence was defined as ≥ 4 hours per night > 70% of nights using smartcard downloads.

Results: Ninety-six participants (94.6% male, 85.5% Caucasian, age mdn=52, IQR=41-65, with varying injury etiology: 56.1% traumatic, 43.9% nontraumatic) were diagnosed with OSA and recommended for treatment with N=17 (18%) refusing PAP. Of those receiving PAP, smart card downloads were not received from 27. Of the remaining 52, 24 met criteria for adherence and 28 were not-adherent. Participants with known PAP usage did not differ significantly from the 27 with unknown adherence status on demographic, injury, and sleep variables (ps>05). Median hours of device usage was 7 hours in the adherent group and 1 hour in the nonadherent group. Adherers used the device an average of 99% of nights whereas non-adherers used the device 29% of nights. Univariate logistic regression revealed that adherers were more likely to have lower oxygen nadir (p=.01, d=.64) and poorer motor functioning on the Functional Independence Measure (p=.05, d=.60). Although not statistically significant, adherent participants had a larger reduction in the Apnea-Hypopnea Index while using PAP (p=.09, d=.20).

Conclusion: Results suggest that greater OSA disease severity and poorer motor functioning predict adherence to PAP. Demographic predictors on adherence in non-brain injured persons with OSA were not significant in this hospitalized brain injury sample, which had a high incidence of OSA. Further research is necessary to delineate factors associated with noncompliance to improve treatment compliance and subsequent therapeutic benefit.
White Matter Changes Caused by Mild Traumatic Brain Injury in Mice

Lisa Gazdzinski1, Miranda Mellerup1,2, Tong Wang1,2, John Sled1,2,3, Brian Nieman1,2,3, Anne Wheeler1,2

1Hospital for Sick Children, Toronto, Canada, 2University of Toronto, Toronto, Canada, 3Mouse Imaging Centre, Toronto, Canada

Introduction: There is a need to better detect and describe white matter damage following mild traumatic brain injury (mTBI) with neuroimaging in order to better predict outcome and evaluate emerging treatments.

While commonly used to probe white matter microstructure, standard diffusion tensor imaging (DTI) is non-specific. More complex geometric models of diffusion, including the Neurite Orientation Dispersion and Density Imaging (NODDI) model, may be more sensitive and specific to different aspects of white matter pathology. MRI sequences with greater specificity to myelin, including quantitative susceptibility mapping (QSM), may help elucidate the role of myelin changes following mTBI.

Here, we assess white matter changes over time using multi-shell diffusion weighted imaging (msDWI) and QSM in a mouse model of mTBI in order to examine the sensitivity and specificity of these techniques to mTBI pathology.

Methods: Mild TBI was induced in 8-week-old C57BL/6J mice using a closed-skull impact model. Sham mice underwent the same surgical procedure without the impact. At 1- or 6-weeks post-injury the mice were perfusion-fixed for ex vivo MRI (n = 13/group/time point). Brains were imaged within the skull using an msDWI protocol and with a spoiled gradient echo sequence from which quantitative susceptibility maps were calculated.

The diffusion data were modelled with the tensor model to compute standard DTI metrics (fractional anisotropy (FA), mean, axial, and radial diffusivities (MD, AD, RD)) and with the NODDI model to obtain the orientation dispersion index (ODI), and the intracellular, extracellular, and isotropic (CSF) volume fractions. The images were registered together to enable statistical comparisons between the TBI and sham groups at each white matter voxel and in each white matter structure of a segmented atlas. Multiple comparisons were corrected for using the false discovery rate (FDR).

Results: Voxel-wise and structure-wise analyses revealed significant differences in FA (TBI < sham, 20% FDR) and ODI (TBI > sham, 1% FDR) between TBI and sham mice in the optic tracts. These results were driven by differences at the 6-week time point and were greater on the side contralateral to the impact. No other regional differences in DTI or NODDI metrics survived multiple comparison correction, however uncorrected t-statistic maps suggested possible increased RD in the optic tracts and decreased ODI below the impact site at 1-week post-injury. No differences in magnetic susceptibility were observed.

Conclusion: These results suggest that ODI may be a more sensitive measure of mTBI pathology than FA and RD, thus combining multiple measures has the potential to characterize mTBI pathology more fully. Our msDWI results show that the optic tracts are particularly susceptible to damage in this mouse model of mTBI. QSM suggests that there is minimal overt myelin loss, however myelin structure may be disrupted following mTBI.
Nano Wired Delivery of Antibodies to Amyloid Beta Peptide, Phosphorylated Tau and Serotonin Together with Cerebrolysin Induces Superior Neuroprotection Following Sleep Deprivation Induced Exacerbation of Alzheimer’s Disease Pathophysiology

Aruna Sharma1, Asya Ozkizilcik2, Dafin Mursanu3, Herbert Moessler4, Ala Nozari5, Rudolph Castellani6, Jose Vicente Lafuente7, Ryan Tian2, Hari Shanker Sharma1

1Uppsala University, Uppsala, Sweden, 2University of Arkansas, Fayetteville, United States, 3University of Medicine & Pharmacy Cluj-Napoca, Romania, 4Ever NeuroPharma, , Austria, 5Harvard University, Boston, United States, 6University of Maryland, Baltimore, United States, 7University of Basque Country, Bilbao, Spain

Military personnel are often quite susceptible to sleep deprivation (SD) and related mental abnormalities such as attention deficit or decision-making abilities. Previous experiments from our laboratory show that sleep deprivation (SD) itself induces neuronal damage and further exacerbates traumatic brain injury induced pathology. It is likely that increased levels of serotonin in the brain and in plasma following SD contributes to blood-brain barrier (BBB) and blood-cerebrospinal fluid barriers (BCSFB) breakdown and cell injuries. Breakdown of the BBB and BCSFB will allow passage of proteins and other harmful agents into the fluid compartment of the brain causing brain edema and cellular damage. Since SD is also associated with upregulation of amyloid beta protein (AβP) and phosphorylated tau (p-tau) it appears that breakdown of the BBB and BCSFB could enhance their transport into the brain fluid compartment resulting in exacerbation of AD pathology. Thus, it is quite likely that infusion of antibodies to AβP, p-tau and serotonin together to neutralize their actions in vivo with a known neuroprotective agent-cerebrolysin (a balanced composition of several neurotrophic factors and active peptide fragments) using TiO2 nanodelivery could induce superior neuroprotection in AD following SD. AD like pathology was induced in Male Sprague-Dawley rat (Age 30-35 weeks) by infusion AβP (1-40 human, soluble in water) intraventricularly (i.c.v.) in the left lateral ventricle (250 ng/10 µl once daily for 4 weeks. SD was induced by inverted flowerpot method in rat for 48 h. Our results showed 190 to 264 % increase in AβP and p-tau in different brain areas along with 250 to 310 % elevation of plasma and brain serotonin levels in AβP administration in SD as compared to AβP infusion alone. The BBB and BCSFB showed 230 to 290 % increase to radiiodine in AD with SD from AD alone. Nanowired delivery of cerebrolysin (25 µl), with antibodies (dilution 1:10) to AβP (10 µl), p-tau (10 µl) and serotonin (20 µl) given i.c.v. 10 days after AβP infusion for 1 week significantly reduced AβP and p-tau levels in the brain and thwarted serotonin accumulation in the plasma and brain. This treatment also restored BBB and BCSFB function to radiiodine by 85 to 90%. Neuronal damages, astrocytic activation and axonal injuries were also significantly reduced by the combined treatment in AD with SD. These observations are the first to show that co-administration of TiO2-nanowired cerebrolysin with antibodies to AβP, p-tau and serotonin has remarkably superior neuroprotective effects in AD following SD, not reported earlier.
Improvement of GOAT Scores after Initiation of Donepezil in Acute Traumatic Brain Injury

Emma Nally¹, Heidi Fusco¹
¹NYU Langone Medical Center/Rusk Rehabilitation, New York, United States

Case Description: A 55-year-old male with a past medical history of rheumatoid arthritis suffered a severe TBI after a fall while skateboarding without a helmet. His initial Glasgow coma scale was 4. Imaging demonstrated subdural hemorrhaging with midline shift and herniation and he underwent emergent hemicraniectomy followed by cranioplasty after 11 days. On admission to acute rehab roughly 3 weeks post injury he demonstrated antigravity strength in bilateral upper and lower extremities and required moderate assistance with ambulation. His Galveston Orientation and Amnesia Test (GOAT) on admission was 8 out of 100 points, demonstrating severe post-traumatic amnesia (PTA) and confusion and he required maximum cueing for attention, and constant observation for safety. While he made functional and cognitive improvements over the next 5 weeks, his GOAT scores fluctuated, and he remained in PTA without a trend toward improvement. During week 6, he was started on donepezil 5 milligrams nightly his subsequent eight daily GOAT scores improved ranging from 70 to 79. The patient was discharged 9 days after starting donepezil with a GOAT score of 79. He required minimal cues for attention and required distant observation for safety. He was independent with transfers and required supervision with ambulation.

Discussion: Donepezil is an acetylcholinesterase inhibitor that is FDA approved for the management of symptoms of Alzheimer’s dementia by decreasing the degradation of acetylcholine thereby improving cognitive side effects. More recently, it has been used in the treatment of patients with cognitive disorders after traumatic brain injury, however the current literature demonstrates inconsistent effects with some trials finding cognitive and memory improvements with donepezil in TBI patients, and others finding no difference between placebos. To our knowledge there are no published reports using the GOAT to quantify improvement in post-traumatic amnesia with donepezil after TBI. This case study demonstrates a clear improvement and stabilization of the GOAT score after initiation of donepezil.

Conclusion: This case highlights the benefits of donepezil as an early intervention in traumatic brain injury as demonstrated by improved scores on the GOAT testing indicating an improvement in post-traumatic amnesia. Future studies should focus on the use of the GOAT to quantify an improvement in post-traumatic amnesia with donepezil in patients with TBI.
Introduction: Catatonia is a medical condition that is underdiagnosed in the general medical population. Clinical features associated with neurological disorders can overlap with those of catatonia, therefore it is theorized that catatonia is also underdiagnosed in neurorehabilitation. The Bush-Francis Catatonia Rating Scale (BFCRS) is a standardized quantifiable examination of catatonia designed to screen and diagnose catatonia. We present one case of delayed diagnosis of catatonia and two cases of early diagnosis using the BFCRS and their treatment outcomes in patients with encephalitis.

Case 1: A 23-year-old male with acute demyelinating encephalomyelitis. He presented to neurorehabilitation in a minimally conscious state (MCS). One month after admission he was emerging from MCS with cognitive and motor impairments including trace left upper and lower extremity movement, and antigravity right upper and lower extremity movement. He received 3mg lorazepam to minimize motion for a routine MRI and experienced a paradoxical improvement in cognition and motor function with antigravity strength in left upper and lower extremity and improved vocal volume and speech latency. Lorazepam was continued and then eventually tapered off when his cognition improved.

Case 2: A 20-year-old female with anti-NMDA receptor encephalitis. She presented with catatonic features (CF) of mutism, staring, echopraxia, and negativism (BFCRS 20). Lorazepam was started and after 30 days of treatment her BFCRS scale was 7 and lorazepam was tapered off. Subsequently the patient became non-verbal, withdrawn, and BFCRS increased to 10; resumption of lorazepam resulted in improvement of BFCRS to 5. She was discharged home on lorazepam.

Case 3: A 32-year-old female with anti-NMDA receptor encephalitis. She presented with CF of mutism, echopraxia, stereotypy, verbigeration, withdrawal, and gegenhalten (BFCRS 22). A trial of Ativan 1mg was given with noted improvement in CF. She was started on 0.5mg BID of lorazepam with initial improvement of BFCRS scale to 8. Lorazepam was titrated to 2mg TID. She was electively transferred to acute care for further infusion treatment of NMDA receptor encephalitis and her BFCRS at discharge was 12.

Discussion: Clinical features of neurological injury and catatonia frequently overlap and are underdiagnosed in the general medical population, and likely acute rehabilitation, leading to delay in treatment and recovery. Recognizing CF and screening using the BFCRS allows for early identification and intervention. Future studies will focus on verifying if catatonia is underdiagnosed in neurorehabilitation and in neurologic disorders other than encephalitis and identifying the results of treatment in those identified as catatonic and if response to treatment changes with the etiology of the neurological disorder.

Conclusion: This case series highlights the importance of recognizing and treating catatonia in the acute rehabilitation setting, allowing patients to participate in therapies, improving functional outcomes, and contributing to a successful recovery.
Neurorehabilitation Research Gaps for Adults with Traumatic Brain Injury and Depression: A Scoping Review

Adora Chui1,2, Samantha Seaton1, Deirdre Dawson1,2,3, Heather Colquhoun1,3
1Rehabilitation Sciences Institute, University of Toronto, North York, Canada, 2Rotman Research Institute, Baycrest, Toronto, Canada, 3Department of Occupational Science & Occupational Therapy, Toronto, Canada

Background: One-third of adults with traumatic brain injury (TBI) experience comorbid depression and the resulting increase in disability and comorbidity. As TBI is the most prevalent and expensive neurological condition in Canada, comorbid depression is presumably widespread and likely to complicate recovery. However, it is unknown how well the rehabilitation sciences literature addresses and reports on adults with both TBI and depression. Understanding research gaps is critical since scientific literature is the basis for effective, evidence-based neurorehabilitation.

Objectives: To describe the nature of the rehabilitation research on TBI and depression, and to examine how these comorbid conditions are described, defined, measured, and reported in primary studies.

Method: A scoping review was undertaken. The focus was on non-penetrating and non-military TBI; diagnosed or measured depression; and non-pharmacological and non-biological modalities in rehabilitation. Systematic searches were done of six electronic databases (MEDLINE, EMBASE, CINAHL, AMED, PsycINFO, Cochrane) and grey literature, resulting in 3737 records after de-duplication (current to October 17, 2018). Two independent reviewers followed PRISMA guidelines to perform Level I (title and abstract) and Level II (full-text) eligibility review, and handsearch reference lists to yield 137 included records. After piloting the data extraction form to 80% agreement, the two reviewers extracted bibliographic, demographic, TBI, and depression variables. Data were analyzed using descriptive statistics and presented in summary tables.

Findings: Three categories of documents were identified: guidance-providing literature such as consensus statement and practice guidelines (n=3), reviews with specified methodology (n=8), and primary studies (n=126). The most frequent country of research was the United States (61%), most of the research was published this decade (56%), and only 11% of the research was experimental studies. Studies typically included all severity levels of TBI (46%) and categorized participants as depressed or not depressed (45%), rather than by depression severity level. Clinical diagnoses of TBI (12%) and depression (10%) were rarely conducted in these studies. Self-report instruments were most frequently used to measure depression severity (70%). More than nine self-report depression instruments were commonly used, with the most common being the Beck Depression Inventory (23%) and the Patient Health Questionnaire-9 (20%). Depressed participants were typically not selected as a subgroup (55%); only 11% of studies prospectively enrolled depressed participants.

Conclusion: While many primary studies have been conducted in recent years, few are experimental designs and the perspective is heavily representative of one country. TBI and depression severity levels are poorly specified and originate from numerous self-report instruments. Rehabilitation research on TBI and depression is heterogeneous, incompletely reported, and often includes participants that are not depressed. Addressing these research gaps in reporting, definition, and measurement of comorbid TBI and depression is critical to improve neurorehabilitation.
Principal Component Analysis of the Client’s Intervention Priorities (CIP)© Tool in A Sample of Individuals with Traumatic Brain Injury: Preliminary Evidence of the Underlying Factor Structure

Alexander Moreno1,2, Eduardo Cisneros1,2,3, Geneviève Léveillé1, Marie-Claude Guerrette1,2,3, Michelle McKerral1,2,3

1Centre for Interdisciplinary Research in Rehabilitation (CRIR), Montreal, Canada, 2CIUSSS Centre-Sud-de-l’Île-de-Montréal (CCSMTL), Montreal, Canada, 3Université de Montréal, Montreal, Canada

Introduction: The Client’s Intervention Priorities (CIP)© is an innovative tool for the self-assessment of life habits and for determining intervention priorities during neurorehabilitation. Its development was based on an anthropological model of human development and disability (Disability Creation Process Model). According to this model, life habits are defined as Daily Activities and Social Roles, frequently disrupted following traumatic brain injury (TBI). The CIP tool helps individuals with TBI and rehabilitation clinicians to assess both of these theoretically based domains in a collaborative process (Daily Activities, 21 items: nutrition, fitness, personal care, communication, housing, and mobility; Social Roles, 20 items: responsibilities, interpersonal relationships, community life, education, employment, and recreation). However, the underlying factor structure of the CIP has not been previously reported.

Objective: To determine the factorial structure of the CIP tool.

Design: Cross-sectional exploratory study.

Methods: A total of 108 individuals with TBI with a mean age of 39.9 (SD=14.5) years and 4.3 (SD=3.9) months post-injury were recruited at admission to an outpatient TBI rehabilitation program in an interdisciplinary neurorehabilitation centre in Montreal, Canada. The majority were men (55.2%), either single or married (19%), having sustained a mild (31%) or moderate TBI (46.6%). The CIP tool was administered at admission to the multidisciplinary rehabilitation program.

Results: The 41 items of the CIP tool were subjected to Principal Component Analysis (PCA) using SPSS, version 25. The Kaiser-Meyer-Olkin value was .56, slightly below the recommended value. The Barlett’s Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix. PCA revealed 15 components with eigenvalues exceeding 1. Together, the 15 components explained a total of 71.2% of the variance. An inspection of the screeplot and the results of Parallel Analysis supported the retention of four components. The four-component solution explained a total of 33% of the variance. Oblimin rotation was performed to aid in the interpretation with the four components showing a number of strong loadings and all variables loading substantially on only one component. Components and their respective percentages of contributing variance were labelled as follows: a) Component I – Social activities and self-care (17 items, 14.2%); b) Component II – Occupational roles (7 items, 7.3%); c) Component III – Home and family activities (9 items, 6%); and d) Component IV - Autonomy and independence (6 items, 5.5%). Two items did not load in any of the components (e.g., “I prepare meals” and “I use alarms, advertising posters, traffic signs, and sirens). There were weak correlations between the four factors (r = .07 to -.19).

Conclusions: There is preliminary evidence suggesting the existence of four components within the CIP tool. Confirmatory analyses with larger samples are necessary to corroborate the factor structure.
Keywords: Neurorehabilitation, self-assessment, factor structure, person-centred, participation.
Support and Services Aimed at Improving Disability Self-Awareness Among Individuals with Cognitive Impairment Due to Acquired Brain Injury

Tamami Aida
1Mejiro University, Saitama-shi, Japan

Background: Professionals should seek to cultivate disability self-awareness in individuals with cognitive impairment due to acquired brain injury, since those with this trait not only benefit more from rehabilitation programs, but also are better able to secure and maintain employment, build positive personal relationships, and participate in their community. This study’s objective was to investigate the characteristics of self-awareness among this population and their families, including how professionals informed them of their diagnosis, their comprehension thereof, and subsequent changes in disability-associated difficulties.

Method: Consenting individuals with cognitive impairment due to acquired brain injury (“disabled subjects” below) and family members affiliated with the Tokyo Higher Brain Dysfunction Association (Tōkyō Kōjinjōkinōshōgai Kyōgikai: TKK) participated in a questionnaire survey. Survey items regarded basic attributes, social participation, their cognitive impairment diagnosis (disclosure timing, comprehension, and subsequent disability self-awareness), social connectedness, difficulties while in the hospital and post-discharge, and services perceived as useful for coming to terms with their disability. Basic descriptive statistics, Spearman correlation analysis, Kruskal–Wallis H tests, Mann–Whitney U tests, and χ2 tests were used for statistical analysis (IBM SPSS Statistics for Japan 24).

Results: Valid responses were received from 197 participants (106 disabled subjects, 91 family members; recovery rate of 60.2%). A total of 71% of disabled subjects were of working age; 15% were employed. Feelings of social connectedness were reported by 74% of disabled subjects and 86% of family members. Perceptions of social connectedness significantly differed between disabled subjects and their families; they were correlated with employment status among the former (p=0.04). Disabled subjects and family members significantly differed in when they reportedly felt they had cognitive impairment (respectively, 31% vs. 67% while in hospital, and 25% vs. 15% following discharge; p=0.00). A total of 35% of disabled subjects and 60% of family members claimed to have understood their subsequent challenges and coping methods following initial disclosure and explanation by a professional. Both disabled subjects and family members reported more difficulties after discharge compared with during hospitalization (p=0.04, 0.03, respectively), with the former’s shifting from basic activities of daily living (ADLs) to instrumental ADLs. Large numbers of both disabled subjects and family members cited social welfare day rehabilitation centers as a useful service for enhancing disability self-awareness.

Discussion: Educating individuals with cognitive impairment due to acquired brain injury and their families about their condition as soon as possible after hospitalization improves their ability to adapt to post-discharge difficulties and fosters community participation.
Does the Window to Hope Program Reduce Suicide Risk after Moderate-Severe Traumatic Brain Injury? A Pooled Data Analysis

Grahame Simpson1, Lisa Brenner2,3,4,5, Jeri Forster2,3,4,5, Adam Hoffberg2
1Ingham Institute of Applied Medical Research, Liverpool, Australia, 2Rocky Mountain Mental Illness Research, Education & Clinical Center, Aurora, United States, 3University of Colorado School of Medicine, Department of Physical Medicine & Rehabilitation, Aurora, United States, 4University of Colorado School of Medicine, Department of Psychiatry, Aurora, United States, 5University of Colorado School of Medicine, Department of Neurology, Aurora, United States

Introduction: People with moderate-severe Traumatic Brain Injury (TBI) are at greater risk of suicide than the general population. Window to Hope (WtoH) is a manualised psychological intervention to reduce chronic hopelessness after TBI. An initial randomised controlled trial and subsequent replication trial both found statistically significant reductions in the primary outcome (hopelessness). However, there were only non-significant trends for improvements in the secondary outcomes. The aim of the current study was to determine whether WtoH had an effect on the secondary outcomes of suicide ideation and depression after pooling the results of the two trials.

Methods: Both trials employed a parallel two arm (intervention vs usual care) design. The pooled sample comprised 23 clients who participated in the treatment arm and 29 in the Usual care arm. Measures for the primary and secondary outcomes comprised the Beck Hopelessness Scale (BHS), the Beck Scale for Suicide Ideation (BSS) and the Beck Depression Inventory Fast-Screen (BDI-FS). Analysis of covariance was conducted testing the three outcome scores for the pooled data at the conclusion of WtoH (Time 2) as a function of group (WtoH vs Usual care) and the baseline value of the respective outcome.

Results: The pooled sample were predominantly male and middle aged. Baseline scores were elevated for all three measures across both the WtoH and Usual care groups (BHS 15.3±3.3 vs 12.8±3.7; BSS 6.3±7.9 vs 6.0±6.3; BDI-FS 11.1±3.7 vs 9.3±3.6). Controlling for the baseline values, there was a significant reduction in the primary outcome (BHS scores) at Time 2, which was maintained at 3-month follow-up. The pooled analysis also found a significant reduction in BSS scores and depression scores for the treatment group (baseline - Time 2), not found in the Usual care group, and sustained at the 3-month follow-up.

Conclusions: The pooled analysis provided sufficient power to demonstrate the WtoH had broader effects in reducing suicide risk after TBI.
Proximal Sympathetic Hyperactivity Following mTBI

Tony Doran
1
2Headfirst, Millersville, United States

Patient’s with mTBI often experience sympathetic hyperactivity manifest by HBP, dyspnea, palpitations, hyperhidrosis, atypical menstrual cycle. Typically, proximal sympathetic hyperactivity has been documented in the literature and seen in more serious mechanisms of injury such as blast injuries for the military and shock trauma injuries. Our outpatient concussion clinic has observed the need for an “autonomic treatment focus” in pediatric and adult patients

- 16-year-old male s/p mTBI play football LOC - 5 minutes experienced increased BP for 4-6 weeks
- 18-year-old male s/p mTBI playing football experienced excessive sweating and increased blood pressure for 5 weeks
- 17-year-old female s/p mTBI took a lax ball to the head and later head-to-head contact playing field hockey. She experienced hyperhidrosis and amenorrhea.

Previously this syndrome was called dysautonomia. Symptoms typically begin within a week and can last for years. Pathophysiology is a disconnection of inhibitory pathways from cortical to sub-cortical areas

Examining of subcortical areas that provide the clinician with clues that the autonomic system is dysfunctional. pupillomotor, orthostatic, vasomotor, gastrointestinal, bladder, sensomotor.

Treatment: - non-pharmacological treatment - HRV BFB can be used to reduce sympathetic nervous system - Pharmacological - Propranolol and diazepam are effective treatments.

Case Study: ID - 16-year-old male; MOI - helmet-to-helmet / helmet to ground hits playing high school football
LOC - 5 minutes; Amnesia - +; Seizures – None; Neuroimaging – WNL; Complicating factors - None
ACE – 2; CAS – 0; ImPACT - 50th percentile
Initial symptoms are some headaches and fatigue; during visits BP is elevated and periodically the patient reports that his HR is racing out of the blue
Patient completed his RTL and his RTP; BP is still elevated
Treated with propranolol for several weeks; BP WNL taken off medication and returned to sports
FU 8 weeks later - WNL no experiencing any difficulties

Case Study: ID - 17-year-old female; MOI - lax ball to head and Head-to-head playing field hockey; LOI - left temporal
LOC – none; Amnesia – none; Seizures – none; Complicating factors - previous mTBI; ACE – 2; CAS - 0
ImPACT reduced - still recovering
Symptoms - amenorrhea and one-sided sweating

Both of these cases indicate that although the patient reports their “concussion” symptoms have resolved, the patient is still injured, and they are still recovering from that injury.

In addition to vestibular, ocular, cognitive, emotional, migraine, and cervical treatment focuses for mTBI, another area of functioning that might be driving recovery is autonomic functioning. Recommendations for assessment, diagnosis, treatment, and future research are reviewed.
Brain Injury Case Managers' Experience of Mental Capacity and the UK's Mental Capacity Act: Supporting Decision Making

Mark Holloway¹,²,⁵, Alyson Norman³, Jackie Dean⁴,⁵
¹Head First, Hawkhurst, United Kingdom, ²University of Nottingham, Nottingham, United Kingdom, ³University of Plymouth, Plymouth, United Kingdom, ⁴N-Able, Wirral, United Kingdom, ⁵British Association of Brain Injury Case Managers, Bury, United Kingdom

Background: The Mental Capacity Act (MCA) is an Act of the Parliament of the United Kingdom applying to England and Wales. Its primary purpose is to provide a legal framework for acting and making decisions on behalf of adults who lack the capacity to make particular decisions for themselves. Assessments of mental capacity of people affected by acquired brain injury (ABI) can be complex to undertake and the results contested. Brain Injury Case Managers (BICM) work over the longer term with individuals affected by ABI and have experience that may inform this debate.

Aims: This research aimed to gain a greater understanding of the experiences and knowledge of BICMs of the issues presented by mental capacity and the application of the MCA. The intention of undertaking this research was to utilise the knowledge and experience of BICMs to inform policy makers and support improvements in the services provided to brain injured people and their relatives.

Methods: BICMs were asked to complete an online survey completed a questionnaire of open and closed questions. This allowed for the collection of both qualitative and quantitative data detailing BICM's experience with brain injured clients in the preceding five years. 93 BICMs provided feedback on the issues they had experienced regarding capacity and assessment following ABI. A thematic analysis of the results was undertaken.

Results: All BICMs noted that their role was to support decision-making by people affected by ABI. Conflict or difficulties with other professionals most usually arose in relation to decisions regarding welfare needs, risk taking behaviours and living arrangements. Judgements regarding "unwise" versus "incapacitous" decisions were contentious. An assessment process that failed to take account of third party knowledge, relying solely on verbal output, was criticised.

Conclusions: BICMs have valuable insights into how aspects of ABI affect an individual's ability to take decisions and be supported to take decisions that may be in their best interests. A failure by non-specialist professionals to understand or integrate family and specialists' knowledge relating to how people "weigh up and use" information was a key issue in relation to inter-professional conflict.
Long Term Care Needs Following Acquired Brain Injury and Social Care Services in the UK

Mark Holloway¹,²,⁴, Alyson Norman³
¹Head First, Hawkhurst, United Kingdom, ²University of Nottingham, Nottingham, United Kingdom, ³University of Plymouth, Plymouth, United Kingdom, ⁴British Association of Brain Injury Case Managers, Bury, United Kingdom

terms of relationships, employment, education, and mental health. Such needs may require long-term specialised care or support from a variety of different services. Behavioural changes can make it difficult for people with an ABI to maintain existing relationships/form new ones.

Aims: This study focused on identifying what community services people with ABI, and their families, access. The study focused on understanding the needs of people with ABI and how these may/may not be being met by current community services.

Methods: Individuals affected by ABI, their family members and professionals (ABI specialists and generalists) completed an online questionnaire which included methods such as multiple choices, 5-point Likert Scale, comment boxes and rating scales. This allowed for the collection of both qualitative and quantitative data detailing respondents experience of services. A thematic analysis of the results was undertaken

Results: A general lack of knowledge of the impact of ABI by was described as were difficulties accessing generalist services that lacked an understanding of the condition. Where services were accessed, quality was assessed as poor to average. The breadth and complexity of needs following ABI was key to the issues around service use. A lack of understanding of the impact of changes to behaviour, executive abilities and insight was noted to impact negatively upon Safeguarding investigations and the hidden nature of impairments was central to the poor response received.

Conclusions: Survivors of ABI and their family members identified a need for consistent, specialised and long-term support from multiple agencies who work together. Services were generally rated from poor to average and lack of awareness of ABI, in particular the invisible aspects of the condition, was noted as a significant issue by family members and specialist professionals
The Development of a Prediction Model in Mild Traumatic Brain Injury with CT Scan Abnormality: Preliminary Findings of A Multi-Centre Cohort Study

Carl Marincowitz\textsuperscript{1}, Fiona Lecky\textsuperscript{2}, William Townend\textsuperscript{3}, Victoria Allgar\textsuperscript{1}, Andrea Fabbri\textsuperscript{4}, Trevor Sheldon\textsuperscript{5}

\textsuperscript{1}Hull York Medical School, York, United Kingdom, \textsuperscript{2}University of Sheffield, Sheffield, United Kingdom, \textsuperscript{3}Hull and East Yorkshire NHS Trust, Hull, United Kingdom, \textsuperscript{4}Emergency Unit, Presidio Ospedaliero Morgagni-Pierantoni, Italy, \textsuperscript{5}University of York, York, United Kingdom

Background: There are over 1.4 million annual attendances in the UK to Emergency Departments (EDs) following a head injury, and in 2010 2.5 million people were treated for traumatic brain injury (TBI) in the United States. Nine-five percent of head injured patients present with an initial Glasgow Coma Scale (GCS) score of 13-15, indicating a normal or near normal conscious level. In this group around 7% of patients have brain injuries identified by CT imaging but only 1% of patients have serious injuries. It is unclear which injuries are clinically significant, so patients with brain injuries identified by CT imaging are admitted for monitoring. If risk could be accurately predicted admissions for low-risk patients could be avoided and resources could be focused on those with greater need.

Aims: 1) Estimate the proportion of GCS13-15 patients with traumatic brain injury identified by CT imaging admitted to hospital who clinically deteriorate

2) Develop a prognostic model highly sensitive to clinical deterioration which could help inform discharge decision making in the ED.

Methods: A retrospective case note review of 2000 patients with an initial GCS13-15 and traumatic brain injury identified by CT imaging is being completed at three English major trauma centres. The prevalence of clinically significant deterioration including death, neurosurgery, intubation, seizures or drop in GCS by more than 1 point will be estimated. Candidate prognostic factors have been identified in a previous systematic review. Multivariable logistic regression will be used to derive a prognostic model and its sensitivity and specificity to the outcome of deterioration will be explored.

Results: To date, data has been collected on 1479 patients: 66% were male, mean age 58 years, 10% were anti-coagulated, 19% were taking pre-injury anti-platelet medication, 57% presented with an initial GCS15, 32% presented with an initial GCS14, and 11% presented with an initial GCS13.

Outcomes: 26.5% of patients clinically deteriorated as a result of their TBI, 8% of patients underwent neurosurgery and 4% of patients died.

The following were highly predictive of deterioration in uni-variable analysis: age, initial GCS, use of anti-coagulants, use of anti-platelets, abnormal neurological examination, size of intra-cranial injury and number of intra-cranial injuries.

Discussion: Data collection is projected to finish in March 2019. The estimated rate of deterioration in the cohort was relatively high compared to previous studies but consistent with the older age and high rate of anti-coagulation of the study population. Analysis will now focus on developing a multivariable model which is highly sensitive to deterioration which could be used to risk stratify this population and inform further clinical management.
The Impact of the NICE/SIGN Head Injury Guidelines on Deaths and Hospital Admissions in England and Scotland: An Interrupted Times Series

Carl Marincowitz¹, Fiona Lecky², Victoria Allgar¹, Trevor Sheldon³
¹Hull York Medical School, York, United Kingdom, ²University of Sheffield, United Kingdom, ³University of York, United Kingdom

Background: There are over 1.4 million annual attendances to Emergency Departments in the UK following head trauma. 1% of patients have life-threatening injuries, whilst most are discharged. National guidelines (NICE and SIGN) were introduced in England and Scotland with the aim of achieving early identification of acute intracranial lesions through increased CT imaging and safely reducing hospital admissions. Later NICE guidelines recommended that patients with severe injuries are managed in specialist centres.

Aims: To evaluate the impact of the NICE/SIGN head injury guidelines on TBI outcomes and hospital admissions.

Methods: An interrupted time series analysis for the period 1998 to 2017 was completed using Office of National Statistics linked Hospital Episode Statistics and Information Services Division data for all hospitals in England and Scotland. This constitutes complete national NHS administrative data for England and Scotland for the study period.

Time dependent models for the monthly rate of death and hospital admissions for traumatic brain injuries and head trauma were estimated. A change in the level or trend in the model was assessed for at intervention points for each guideline and the introduction of the 4-hour target. All models were adjusted for seasonality and autocorrelation. The time series for TBI mortality was further adjusted for comorbidity and demographic factors.

Due to the co-introduction of the 4-hour target with the NICE guidelines, the effect of increased CT imaging on hospital admissions was assessed using Scottish data.

Findings: Both Scottish SIGN guidelines were associated with a monthly decreasing trend in total hospital admissions per 100,000 population (Guideline 1: -0.14 (95% CI: -0.27 to -0.01); Guideline 2: -0.09 (95% CI: -0.13 to -0.05)). The introduction of the 4-hour target was associated with increased hospital admissions (0.13 (95% CI: 0.06 to 0.20)).

The only guideline associated with a reduction in mortality was the 2nd NICE guideline in England (-0.005 95% CI: -0.007 to -0.002). This guideline specifically recommended that patients with severe injuries should be managed in specialist centres. This effect was only observed in the 16-64 age group.

The monthly TBI mortality and admission rate in the 65+ age group in England increased from 0.5 to 1.5 and 10 to 30 per 100,000 population respectively. The increasing mortality rate was unaffected by the introduction of any of the guidelines.

Conclusion: Increased CT imaging needs to be coupled with the management of patients with severe injuries in specialist centers to reduce deaths. The 4-hour target increased admissions with no observed mortality benefit. Although measures that solely increased CT imaging had no effect on mortality, they reduced
hospital admissions. The cause of the observed increased admission and mortality rate in those 65+ and potential treatments for TBI in this age group requires further investigation.
The Risk of Deterioration in GCS13-15 Patients with Traumatic Brain Injury Identified by CT Imaging. A Systematic Review and Meta-Analysis

Carl Marincowitz1, Fiona Lecky2, William Townend3, Aditya Borakati1, Andrea Fabbri4, Trevor Sheldon5
1Hull York Medical School, York, United Kingdom, 2University of Sheffield, Sheffield, United Kingdom, 3Hull and East Yorkshire NHS Trust, Hull, United Kingdom, 4Emergency Unit, Presidio Ospedaliero Morgagni-Pierantoni, Italy, 5University of York, York, United Kingdom

Background: There are over 1.4 million annual attendances in the UK to Emergency Departments (EDs) following a head injury (any trauma to the head), and in 2010 2.5 million people were treated for traumatic brain injury (TBI - injury to the brain or alteration of brain function due to an external force) in the United States. The optimal management of mild traumatic brain injury (GCS13-15) patients with injuries identified by CT brain scan is unclear. Increased CT imaging of minor head injured patients associated with the implementation of clinical decision rules has led to a growth in size of this population. Some guidelines recommend hospital admission for an observation period of at least 24 hours. Others argue that selected lower-risk patients can be discharged from the Emergency Department (ED).

Aims: The objective was to estimate the risk of death, neurosurgical intervention and clinical deterioration in mild TBI patients with injuries identified by CT brain scan and assess which patient factors affect the risk of these outcomes.

Method: A systematic review and meta-analysis adhering to PRISMA standards of protocol and reporting. Study selection was performed by 2 independent reviewers. Meta-analysis using a random effects model was undertaken to estimate pooled risks of clinical deterioration, neurosurgical intervention and death. Meta-regression was used to explore between-study variation in outcome estimates using study population characteristics.

Results: Forty-nine primary studies and 5 reviews were identified that met the inclusion criteria. The estimated pooled risk of the outcomes of interest were: clinical deterioration 11.7% (95% CI: 11.7 to 15.8); neurosurgical intervention 3.5% (95% CI: 2.2 to 4.9%); death 1.4% (95% CI: 0.8% to 2.2%). Twenty-one studies presented within-study estimates of the effect of patient factors. Meta-regression of study characteristics and pooling of within-study estimates of risk factor effect found the following factors significantly affected the risk of adverse outcomes: age; initial GCS; type of injury and anti-coagulation. The generalisability of many studies was limited due to population selection.

Conclusion: Mild TBI patients with injuries identified by CT brain scan have a small but clinically important risk of serious adverse outcomes. This review has identified several prognostic factors but no multivariable models that could be applied clinically to risk stratify the population and triage further management. Research is needed to derive and a validate a usable clinical decision rule so that low-risk patients can be safely discharged from the ED.
A Scoping Review of the Clinical Studies on Concussion and Mild Traumatic Brain Injury: Diversity of Research Initiatives and Variability of Injury Definitions

Julio Furlan1,2, Michael Radan1
1Lyndhurst Centre, Toronto Rehabilitation Institute, University Health Network, Toronto, Canada, 2Department of Medicine, Division of Physical Medicine and Rehabilitation, University of Toronto, Toronto, Canada

Background: While many patients with concussion and mild traumatic brain injury (mTBI) recover completely, prolonged post-concussive remains a challenge and opportunity for clinical practice and research. This led numerous research initiatives over the last two decades. We reviewed all clinical studies on diagnosis and management of concussion/mTBI that were registered in website at www.clinicaltrials.gov.

Methods: This systematic review with scoping synthesis included all clinical studies on diagnosis and management of patients with concussion/mTBI that were registered in the website at www.clinicaltrials.gov since 2000. The terms “concussion, brain” were used for the primary search on the condition or disease on June 25th, 2018. Definitions of concussion and mTBI were obtained from the study protocols as documented in the website. When a definition was missing in the website, the study’s principal investigator was contacted via email for clarification.

Results: There were 273 studies registered either as interventional studies (n=188) or observational studies (n=85). Most of the studies were single-center initiatives (72.5%). The majority of the studies are from institutions in the United States (n=191) followed by Canada (n=33), Denmark (n=6), France (n=5) among other countries. Most of the studies are either completed (37.4%) or still recruiting (29.7%). The majority of the studies are focused on diagnosis of concussion/mTBI (n=109) using clinical assessments, imaging, biomarkers, and novel technological tools. Additionally, there are studies on non-pharmacological therapies (including exercise-based therapy neuromodulation [n=15], vision therapy [n=12], balance therapy [n=10], hyperbaric oxygen therapy [n=8]), pharmacological treatments (n=27) and prevention measures (n=7). Of note, there was a single study using cell-based therapy. The definitions of concussion and mTBI were widely different among the studies. Only 70 study protocols in the website included a definition of concussion or mTBI. Of the 203 studies missing a definition, a clarification was provided by the investigators of 26 studies.

Conclusion: The results of this scoping review suggest that most of the clinical studies are focused on diagnosis and non-pharmacological therapies for patients with concussion/mTBI. In additional, the majority of the studies are single-center initiatives and are led by American and Canadian institutions. The broad variety of definitions of concussion/mTBI among the clinical studies suggests significant limitations when comparing studies in terms of diagnostic accuracy, treatment effectiveness, and generalizability. Disease or injury definition should be required when registering clinical studies in the website.
Concussion Ontario Network: Neuroinformatics to Enhance Clinical Care and Translation (CONNECT)

Andrew Baker¹, Mark Bayley², Roger Zemek³, Lisa Fischer⁴, Cindy Hunt¹
¹St. Michael’s Hospital, Toronto, Canada, ²University Health Network, Toronto, Canada, ³University of Ottawa, Ottawa, Canada, ⁴Western University, London, Canada

Concussion is an extremely complex problem that requires multi-disciplinary collaborative efforts. CONNECT is a new alliance from centres across Ontario, Canada, representing different sectors, different health disciplines and includes consumer engagement. The goal of CONNECT is to address complex research questions to ensure that new knowledge is translated into better diagnosis and enhanced concussion care. Utilizing a socio-ecological model together with the Haddon injury matrix, a new conceptual model to undertake concussion research has emerged. The CONNECT alliance has integrated the injury sequenced themes with research platforms used for systematic data collection, that yields a novel conceptual map to better understand the patient experience of concussion. Injury themes align with the continuum of care (pre-concussion factors, acute, post-concussion, and chronic) and inform the data frameworks for the platforms of standardized clinical assessments, biomarkers, neuroimaging and interventions to better answer key research questions.

The research themes also address key study objectives needed to achieve the CONNECT vision. Themes 1 & 2 before trauma and the trauma- address the objectives to discover the most innovative tools to assess and diagnose concussion (Recognize). Themes 3 & 4 after the trauma and long-term consequences- address the objective to test novel targeted interventions that not only speed recovery but prevent re-injury and the long-term problems and late deterioration of concussion (Maximize). The arrow through the model emphasizes the integrating role of Neuroinformatics in collecting and collating all available data in a form that harness advanced data-analysis processes such as machine learning. This will address the third broad objective to identify the most important individual, environmental, community, biological and imaging findings to guide treatment across the continuum of concussion, thus ensuring the right care at the right time to the right patient (Personalize).

Features that characterize the CONNECT alliance apart from the traditional project-based and short-term funding approaches include: a) the collaboration of Ontario concussion researchers, b) the use of neuroinformatics, c) infrastructure to perform large clinical trials, and d) a translational pipeline for sharing discoveries with clinicians and policy makers across the province. Funding for CONNECT to date has been provided by the Ontario Brain Institute. Additional funding opportunities are also being explored to further advance the project.
Pilot Project for Functional Tools Assessment on Stroke Units

Yvona Angerova\textsuperscript{1,2}, Olga Svestkova\textsuperscript{1,2}, Tereza Gueye\textsuperscript{1,2}, Pavel Marsalek\textsuperscript{3}, Irina Chmelova\textsuperscript{4}, Vladimir Rogalewicz\textsuperscript{2}  
\textsuperscript{1}General Teaching Hospital Prague, Praha, Czech Republic, \textsuperscript{2}Charles University, The First Faculty of medicine, Prague, Czech Republic, \textsuperscript{3}Masaryk Hospital, Ústí nad Labem, Czech Republic, \textsuperscript{4}Teaching Hospital, Ostrava, Czech Republic

We have established the network of Stroke Units with acute rehabilitation wards in Czech Republic only in 2012. Since that time, we try to unify functional assessment tools to compare the functional status of patients in different centers. Long term goal is to predict which type of patients according to functional assessment will profit most from hospitalization on acute rehabilitation wards of stroke units. In 2017 the General Health Insurance Company supported a project in three centers in different part of Czech Republic to help in this process.

Method: The data were collected from April to November 2017, Barthel Index (BI), Extended BI (EBI), Functional independence measure (FIM) and International Classification of Functioning and Health (ICF) were measured the third and each fourteenth day after admission. The results were statistically processed and compared.

Results: 94 randomised patients were evaluated. Average age was 66,59 years, there were 55 men and 39 women included. Average length of hospitalization was 23,4 days. One of the most important information was the place where the patient was dismissed. We distinguish four categories – home, social facility, rehabilitation units or institutions with further rehabilitation and nursing care only. Patients who went home had FIM 100 and more, those who went to social facilities or Rehabilitation were FIM 60 – 80. Patients who went to nursing homes had FIM 40 and less. Using BI plus EBI, patients with 170 points and more went home, 120 to social facilities, 130 to rehabilitation and those with 75 points went to nursing homes. Very important was also the percentage of functional improvement during hospitalization of patients comparing with maximal values in different functional tests. In BI it was 15,92%, in FIM (motor part) 12,29%, in EBI 5,88%, in FIM (cognitive) 4,27%, in BI plus EBI 11,16% and FIM (total) 10,06%. The biggest improvement was in the first 14 days.

Conclusion: Some of the results are presumable and they will be of course found in literature. But we have no such data in Czech Republic, and we need them for further negotiations with health insurance companies to convince them that intensive acute rehabilitation is the must and can minimize the disability of the patients after brain damage. Our up to date goal is to see as much patients from this group as possible after one year from dismissal and try to work on predictive data which can help us to decide which patients are the best candidates for intensive acute rehabilitation.
Cannabis Use, Premorbid History and Symptom Severity Following A Concussion: A Cross Sectional Study in A Canadian Tertiary Care Clinic

Cindy Hunt, Meiqi Guo, Alicja Michalak, Cheryl Masanic, Chantal Vaidyanath, Alan Tam, Robert Hastings, Shree Bhalerao, Sonya Torreiter, Andrew Baker

1St. Michael's Hospital, Toronto, Canada

Background: Close to 14% of Canadians aged 15 years and older reported some use of cannabis products for medical or non-medical use. Non-prescriptive drug use of cannabis has been reported among patients with a concussion. The recent legalization of cannabis in Canada is leading health practitioners to investigate patient-reported use of cannabis on concussion care practices.

Objective: We hypothesize that premorbid history and symptom severity may contribute to a patient’s use of cannabis following a concussion. We sought to compare the relationships between premorbid characteristics and symptom severity scores with cannabis use in an adult population of patients attending a tertiary care clinic (TCC) for persistent post-concussion symptoms.

Methods: Patients in the study population visited the TCC for post-concussion care from July 2013 to December 2017 and completed the survey at the time of their first visit. Cannabis use was defined as patient-reported use in the past 12 months before the concussion and/or current use. Premorbid characteristics included history of learning disability, ADD/ADHA, anxiety and depression. Symptom severity was measured using the Rivermead Post Concussion Questionnaire (RPQ). Chi Square statistics were used to test for significant relationships.

Results: The prevalence of cannabis use among the TTC study population was 10.9% (179/1643). At this TCC, patients with or without learning disability had a rate of cannabis use of 28.6% vs. 10.2% (p<.05). Similarly, patients with or without a history of ADD/ADHA had a rate of cannabis use of 34.4% vs. 9.9% (p<.05). In patients with or without a history of depression or anxiety the rate of cannabis use was 15.5% vs. 10.0% (p<.05) or 15.6% vs. 10.2% (p<.05). In contrast, patients with or without high RPQ symptom scores had a rate of cannabis use of 10.7% vs. 15.9 (p<.05).

Discussion: In our TTC study population we determined the rate of cannabis use in several premorbid conditions. In the treatment of concussion, it may be helpful for clinicians to know along with their premorbid history, if the patient is taking cannabis.
Challenges in Recruitment and Retention of Dyadic Care Partners in a Veterans Affairs’ Intervention: ANSWERS-VA

Laura Murray1, Laurie Plue2, Ashley Schwartzkopf2, Kiara Walker2, Virginia Wilder2, Sandra Beech2, Katherine Judge3, Archana Dube4, Chandan Saha5, Megan Loughnane5

1Western University, London, Canada, 2Richard L. Roudebush VAMC, Indianapolis, United States, 3Cleveland State University, Cleveland, United States, 4Indiana University Purdue University Indianapolis, Indianapolis, United States, 5Indiana University, Indianapolis/Bloomington, United States

Subsequent to a traumatic brain injury (TBI) or stroke, Veterans and their families face a myriad of care issues in concert with changes in each Care Partner’s respective roles and responsibilities and thus, negative psychosocial outcomes (i.e., depression, anxiety, strain) for both Care Partners. Developing and evaluating non-pharmacological interventions to address these care issues are essential. However, researchers conducting dyadic research face challenges in recruiting, enrolling and retaining both Care Partners. The following study reports recruitment and enrollment data from ANSWERS-VA (Acquiring New Skills While Enhancing Remaining Strengths), which via a strength-based approach, addresses the wide range of care issues faced by Veterans with TBI/stroke and their family Caregivers including: communication, cognitive engagement, understanding emotions and behaviors, and managing role changes and social activities. Data are reported from a two-step recruitment and enrollment process consisting of: 1) chart review to determine initial eligibility (e.g., Veteran has a history of stroke and/or TBI); and, 2) an in-depth review with each Care Partner to determine eligibility (e.g., Care Partner availability to participate in the study). A total of 1307 charts were initially reviewed for study eligibility. Of the n=738 (56%) who met the initial study eligibility and were contacted: n=272 (37%) were ineligible at the 2nd step; n=263 (36%) refused; n=120 (16%) could not be reached during the recruitment period; and, n=83 (11%) consented to participate and were subsequently enrolled and randomized in the study. The most frequent reasons for study ineligibility at the 2nd step included: n=119 (44%) had no informal family/friend Caregiver; n=61 (22%) were no longer community-dwelling in the designated area or were deceased; n=43 (16%) were too impaired based on cognition, vision, hearing, or physical health; and, n=49 (18%) had a range of different reasons (e.g., drug and/or alcohol abuse, homeless, incarcerated). Common reasons for study refusal included: n=139 (53%) were not interested in participating and n=65 (25%) indicated the Caregiver was too busy. These data highlight the difficulties in recruiting and enrolling Veterans and their family Caregivers in dyadic intervention protocols, and consequently, the unique challenges to researchers, which may hinder study progression and limit generalizability of study findings. Particularly, in the current study, many Veterans and their families had competing demands for their time (e.g., work-life balance; child rearing), were not equipped to participate in a research study, and/or may not have believed there was a benefit to participate. Additionally, this dyadic research requires participation of both Care Partners, which necessitates a more complex set of inclusion/exclusion criteria to be met. Discussion will focus on lessons learned including: 1) streamlining recruitment processes; 2) strategies for enrolling caregiving dyads; and 3) working with vulnerable populations and their families.
Can Early Life Experiences Effect Cannabis Use Following A Concussion? A Survey of Patients Attending A Tertiary Care Clinic

Cindy Hunt1, Alicja Michalak1, Cheryl Masanic1, Chantal Vaidyanath1, Alan Tam1, Meiqi Guo1, Robert Hastings1, Shree Bhalerao1, Sonya Torreiter1, Andrew Baker1

1St. Michael's Hospital, Toronto, Canada

Background: Current estimates report 15% to 40% of adults with a concussion will experience symptoms lasting longer that the expected 3 months post injury. For patients with persistent post-concussion symptoms, we are interested in examining cannabis use and we seek to understand the determinants that may be associated with this behavior.

Purpose: We hypothesize that early life experiences pre-injury may contribute to a patient’s use of cannabis in adulthood, specifically in those who seek tertiary care services for persistent symptoms following a concussion. In order to evaluate this hypothesis, we asked the question whether a measure of early life experience would be related to cannabis use.

Methods: Study participants were patients who visited a tertiary care concussion clinic from July 2013 to December 2017. Patients completed the survey at the time of their first visit to the clinic. Participants self-reported cannabis use within the 12 months prior to injury and /or current use. The Adverse Childhood Experience (ACE) score was used as a measure of early life stressful experiences.

Results: A total of 1145 patients completed the study questions. In our study population we found a significantly greater proportion of patients with high ACE scores ≥4/10 among cannabis users 21.7% (34/157) as compared to nonusers ACE scores 14.3% (141/988) (p<.05).

Discussion: In our tertiary care clinic study population, we conclude that for patients being treated for persistent post-concussion symptoms and having stressful early life experiences, it may be helpful for the clinician to know if the patient is taking cannabis.
Measurement Invariance of a Four-Factor Model of the Post-Concussion Symptom Scale across Gender at Pre-Season Baseline Testing

**Dr. Justin Karr**, Dr. Bruce Maxwell, Dr. Paul Berkner, Dr. Grant Iverson

Department of Physical Medicine and Rehabilitation, Harvard Medical School; Spaulding Rehabilitation Hospital; Massachusetts General Hospital for Children Sports Concussion Program; & Home Base, A Red Sox Foundation and Massachusetts General Hospital Program, Boston, United States, Department of Computer Science, Colby College, Waterville, United States, Health Services and the Department of Biology, Colby College, Waterville, United States

**Background:** Previous researchers used exploratory factor analysis (EFA) to evaluate the latent structure of the Post-Concussion Symptom Scale (PCSS) among a large sample of athletes at baseline (Kontos et al., 2012). These researchers excluded two items due to low loadings and cross-loadings, and ultimately supported a four-factor model for a 20-item PCSS, inclusive of cognitive-sensory, sleep-arousal, vestibular-somatic, and affective symptom clusters. These researchers also compared factor scores across male and female athletes; however, they did not establish measurement invariance to ensure the factor structure held across genders prior to running their analysis. The current study expanded on this research by accomplishing three sequential aims: (a) determine whether the four-factor model replicated in a different sample using confirmatory factor analysis (CFA), (b) assess measurement invariance across gender to ensure factor means are comparable across male and female athletes, and (c) evaluate gender differences across the four factor scores.

**Method:** Participants included a large sample of adolescent athletes (N=39,242; 54.4% boys; 13-18 years-old, M=15.50±1.27 years). Participants were excluded if they had a concussion in the past six months, previous brain surgery, or preexisting epilepsy or meningitis. All participants completed the English-language PCSS as part of pre-season baseline testing, rating the severity of 22 nonspecific symptoms on a six-point Likert-type scale. Statistical analyses included CFA and configural, weak, and strong invariance analysis across boys and girls. Good fit was defined as CFA≥0.95 and RMSEA≤0.05, and significant change-in-fit was defined as ∆CFI≥0.01.

**Results:** The four-factor model was replicated and fit well within the sample (CFI=0.965; RMSEA=0.032), although inter-factor correlations were high (r=0.701-0.852) which potentially supports a unidimensional model. Two items removed in the original EFA, sleeping more than usual and numbness, were reintroduced and loaded highly on the sleep-arousal (λ=0.587, p<.001) and vestibular-somatic (λ=0.759, p<.001) factors, respectively. The model met configural (CFI=0.961), weak (ΔCFI=-0.002), and strong invariance (ΔCFI=0.005) across gender. Girls scored significantly higher than boys on all factors, with the smallest effect observed for cognitive-sensory symptoms (β=0.066) and the largest effect observed for affective symptoms (β=0.239).

**Discussion:** The current findings support a four-factor model of the PCSS and indicate that means for symptom clusters are comparable across genders, with greater baseline symptom burden evident for girls. Although many researchers use only the PCSS total score, this research supports usage of subscale scores for symptom clusters at baseline. Future research can examine longitudinal invariance of these factors following concussion, assessing the stability of the factor model following injury and whether symptom clusters show distinct recovery trajectories, especially in relation to individual differences among athletes (e.g., gender, competitive level, and pre-existing conditions).
Pre-Existing Health Problems in Older Adults with Mild Traumatic Brain Injuries

Justin Karr1, Grant Iverson1, Harri Isokuortti2, Anneli Kataja3, Antti Brander3, Juha Öhman4, Teemu Luoto4,5
1Department of Physical Medicine and Rehabilitation, Harvard Medical School, Spaulding Rehabilitation Hospital, and Home Base, A Red Sox Foundation and Massachusetts General Hospital Program, Boston, United States, 2Department of Neurology, Neurocenter, Helsinki University Central Hospital, Helsinki, Finland, 3Medical Imaging Centre, Department of Radiology, Tampere University Hospital, Tampere, Finland, 4Department of Neurosurgery, Tampere University Hospital, Tampere, Finland, 5University of Tampere, Tampere, Finland

Background: This study documents pre-injury health, psychiatric, substance abuse, and neurological problems of older adults who were evaluated within an emergency department following a suspected mild traumatic brain injury (MTBI). We hypothesized that a substantial minority of older adults would present with preexisting medical problems that could affect brain and cognitive health.

Method: Data collection was performed retrospectively from hospital records of the Emergency Department at Tampere University Hospital. The 1,427 older adults aged 55-104 (47.4% men), underwent head CT following suspected MTBI.

Results: Men were overrepresented between ages 55-69 (63.1%), whereas women were overrepresented over the age of 80 (69.7%). Across age bands, most injuries resulted from ground-level falls (75.3%). Diseases of the circulatory system were increasingly common with higher age (55-59=28.7%; 60-69=54.7%; 70-79=71.9%; and 80+=81.9%), as were diseases of the nervous system (55-59=21.3%; 60-69=24.4%; 70-79=44.1%; 80+=58.2%). Roughly a quarter (27.3%) of adults over the age of 80 presented with a neurodegenerative disease. The prevalence of preexisting imaging abnormalities also increased with age (55-59=29.3%; 60-69=39.4%; 70-79=62.1%; and 80+=78.9%). Psychiatric and substance use disorders decreased in frequency with age (55-59=50.0%; 60-69=38.3%; 70-79=18.6%; and 80+=9.2%).

Discussion: Older adults are at-risk for MTBI, most commonly due to falls. Among older adults sustaining a suspected MTBI, preexisting circulatory and neurological problems were very common, and showed dramatic increases in prevalence with higher age. Preexisting medical conditions that could impact brain and cognitive health occur commonly among older adults with MTBI and could confound research examining post-injury outcomes within this age group.
The Regulation of Intimacy and Personal Space Following Traumatic Brain Injury: A Human-Robot Interaction Study

Bilge Mutlu¹, Melissa Duff², Lyn Turkstra³
¹University of Wisconsin–Madison, Madison, United States, ²Vanderbilt University, Nashville, United States, ³McMaster University, Hamilton, Canada

A commonly reported change in social behavior following traumatic brain injury (TBI) is the anormative management of personal space, including staying too close to others and touching behavior that others find inappropriate. Prior literature has suggested that this behavior might result from an inability to regulate intimacy due to a combination of impairments in social perception and poor executive function. Research in proxemics—the study of physical and psychological distancing in social interactions—suggest that individuals continuously engage in a complex process of intimacy regulation, responding to attempts by others to increase intimacy with attempts to reduce intimacy, such as distancing themselves from strangers who get too close to them and breaking eye contact with others who maintain eye contact with them for extended periods, as suggested by the Intimacy Equilibrium Theory. This study investigates how individuals with moderate-to-severe TBI differ from healthy participants in engaging in intimacy regulation by responding to attempts by a partner to increase intimacy. Specifically, following a human-robot interaction paradigm, we studied the physical distance that participants maintained from an unlikable robot that attempted to increase its intimacy with them by maintaining constant eye contact.

In the study, 34 individuals with moderate-to-severe TBI and 48 demographically matched healthy comparison participants were asked to sit at a table across the room from a humanoid robot and to repeatedly approach the robot to retrieve information from a list placed on its back. In half of the trials, the robot directed its gaze toward the participant as the participant approached the robot and looked away from the participant in the other half of the trials. Building on results from prior work, we hypothesized that healthy participants would maintain greater distance from the robot when it looked toward them than when it looked away, and individuals with TBI would not differ in their behavior. We measured the minimum distance that participants maintained during their approach. A two-way repeated measures ANOVA found no effect of population, F(1,78.8)=1.03, p=.313, but found a significant effect of the robot’s gaze on the distance that the participants maintained from the robot, F(1,77.86)=9.08, p=.004. A priori comparisons with Bonferroni correction showed that the TBI group maintained a significant distance when the robot looked toward them than when the robot looked away (p=.034), while differences for healthy participants were not significant (p=.157). These findings contrast with our hypothesis, suggesting that individuals with TBI are indeed able to manage personal space and regulate intimacy with others by distancing themselves, and offer implications for future research and therapy.
Experiences of Using GAD-7 And PHQ-9 Outcome Measures During Counselling with People Living with Acquired Brain Injury in Essex, England

Steven Shears1
1Headway Essex, Colchester, United Kingdom

Objectives: Depression and anxiety are frequently reported following acquired brain injury (Ponsford et al 2016). A study by Ponsford et al that Motivational Interviewing plus Cognitive Behavioural Therapy (CBT) and Non-Directive Counselling plus CBT were effective in reducing symptoms of depression and anxiety in patients living with the traumatic type of acquired brain injury (TBI) and were more effective than the Waiting List Control group. Ponsford stated that the CBT materials were adapted specifically for people living with TBI.

Dyer et al (2016) considered that the Patient Health Questionnaire (PHQ-9) was an appropriate measure to track outcomes in the brain injury patient group undergoing therapy in which there is frequent overlap reported between symptoms of depression and the effects of brain injury. This report highlights the client comments made about problem descriptors within the measures used to capture data on improvement during modified counselling with community clients of Headway Essex. The measures were the Patient Health Questionnaire (PHQ-9) and the Generalized Anxiety Disorder Measure (GAD-7).

Methods: During modified counselling for people with brain injury who had reported symptoms of depression and anxiety the GAD-7 and PHQ-9 measures were used to track outcomes and improvement. Improvement criteria used were the ones adopted by the UK NHS Improving Access to Psychological Therapies (IAPT) service being Clinically Significant Change, Reliable Improvement, No Change and Reliable Deterioration. These are all dependant on the scores being above a certain threshold prior to therapy and comparing these to the final scores. The clients in this report filling out the depression and anxiety descriptors made the point that scores were due to brain injury rather than depression or anxiety.

Results: A table of a small sample (6) of recent counselling contacts was made which included their pre and post therapy scores on GAD-7 and PHQ-9 measures along with the problem descriptor item numbers on either measure that the clients thought were more influenced by either the cognitive or physical effects of brain injury.

Conclusions: The results give rise to a consideration about the use of the use of the GAD and PHQ measures where people living with ABI are presenting with depression and anxiety symptoms as to what we are measuring with the descriptors? It could also be argued therefore that both the initial scores on the measures and the final scores may be inaccurate. Similar points might be raised in relation to the fact that the counselling had been integrated with some measure of cognitive compensatory strategies which would influence improvement on the final outcome scores too but perhaps due to cognitive rehabilitation therapy. More research into suitable adapted outcome measures for depression and anxiety with this client group is indicated.
Discourse Formulation and Neurovascular Activation: Implications for Treating Cognitive Communication Disorders

Prof. Me Cannizzaro¹
¹University Of Vermont, Burlington, United States

Background & Significance: Impaired function of the prefrontal cortex (PFC) is a common occurrence following traumatic brain injury (TBI). These changes are reflected behaviorally in the disruption of cognitive process that are necessary to support complex and naturalistic communication in one of the many forms of discourse (e.g., conversation, description, narrative, etc.). Discourse is a commonly occurring and cognitively demanding form of communication that relies on an interaction of cognitive (e.g., executive functions necessary to guide the goal-directed information exchange) and linguistic components. Because of the prevalence and importance of discourse in daily routines (educational, vocational, family, social), disrupted discourse is an important target for rehabilitative treatment for persons with cognitive-communication impairments (CCI) associated with TBI (American Speech-Language Hearing Association [ASHA], 2005). However, there is a paucity of information about the underlying “cognitive architecture” and processing demands that support various forms of discourse. This is in part due to methodological constraints of many neuroimaging technologies (e.g., fMRI) that severely limit ecologically typical communication acts such as listening and speaking during neuroimaging. To overcome these limitations, functional near infrared spectroscopy (fNIRS) can be used to identify patterns of neural activity by monitoring hemodynamic activity related to the production of discourse during natural speaking situations.

Methods: Eleven neurologically healthy adults formulated procedural discourse, personal narrative (recount), fictional narrative, and conversation. One microstructural behavioral measure (efficiency) and one macrostructural measure (informativeness) were measured from each genre using established clinically relevant protocols, and prefrontal neurovascular activation was measured using functional near infrared spectroscopy (fNIRS).

Results: Efficiency was similar between the four genres. There were significant differences in informativeness between high and low complexity procedural discourse, and between fictional narrative and conversation. Informativeness was highest in conversation and lowest in complex procedural discourse. Neurovascular activity was highest for the high emotional intensity personal narrative. There was significant negative correlation between fictional narrative informativeness and neurovascular activation. Generally, there was a negative association between discourse efficiency and neurovascular activation.

Conclusion: The findings suggest that measurement of efficiency enables meaningful comparison of discourse across genres. Procedural, personal, and conversation discourse are formulated with lower efficiency than fictional narratives. Processing demands (PFC) and communicative efficiency should be considered in treating CCI. Training discourse structure and support strategies for persons with cognitive-communication impairments should use a hierarchical approach based on genre. Exploration of ecologically relevant genres of discourse is feasible and relevant for individuals with cognitive-communication impairments and SLPs planning treatment interventions for persons with CCI.
In Vitro Simulation of Traumatic Brain Injury Induces Dopaminergic Dysfunction in Human Neurons

Hector Rosas-Hernandez¹, Susan Lantz¹, Elvis Cuevas¹, Syed Ali¹

¹National Center for Toxicological Research, Jefferson, United States

Traumatic brain injury (TBI) is defined as a damage to the brain that consequently disrupts normal function. One of the hallmarks of TBI is neuronal death, but TBI has also been related with the development of neurodegenerative disorders, including Parkinson’s disease (PD), where loss of dopaminergic neurons and dopaminergic dysfunction are observed. To date, no in vitro model exists in which the dopaminergic damage observed in TBI is replicated. In the present study, we evaluated the effects of in vitro simulated TBI on human dopaminergic neurons. To simulate TBI, neurons were subjected to 0%, 5%, 10%, 15%, 25% and 50% deformation. Twenty-four hours after injury, cell viability and apoptosis were determined by lactate dehydrogenase (LDH) release and DNA fragmentation, as well as ethidium homodimer and caspase 3/7 staining. Dopamine (DA) levels were determined by ELISA. Increased LDH release and ethidium homodimer staining, suggesting the induction of necrosis, were observed after 50% stretch but not after lesser stretches. On the contrary, 25% and 50% stretch increased DNA fragmentation while 15%, 25% and 50% increased caspase 3/7 staining, suggesting that moderate and severe TBI promote neuronal apoptosis. Finally, levels of intracellular DA decreased in a stretch-dependent manner with 15%, 25% and 50% stretch, while extracellular levels were increased only at 50%. These data support the use of stretch as a model to simulate TBI in vitro in dopaminergic neurons, replicating the acute effects of TBI in the dopaminergic system. This method can be used to study the long-term consequences of TBI, including PD and other neurodegenerative disorders.
The Clinical Interface of Cerebral Fat Emboli Syndrome and Traumatic Brain Injury

Taron Davis, Alan Weintraub, Gary Maerz, Eric Spier, Michael Makley

University of Colorado School of Medicine, Aurora, United States, Craig Hospital, Englewood, United States, CNS Medical Group PC, Englewood, United States

Objective: To review the historical, clinical, radiographic, and functional outcome characteristics of patients diagnosed with an acquired brain injury due to cerebral fat embolism syndrome (CFES). This study specifically examined the features between two cohorts of patients, one with an isolated diagnosis of CFES, “classic CFES”, and no evidence for traumatic brain injury (TBI) along with a cohort of patients with dual diagnoses of both CFES and evidence of classic TBI including focal cortical contusions (FCC) and/or traumatic diffuse axonal injury (TDAI).

Methods: Consecutive CFES cases were retrospectively reviewed between the years of 2009-2018 admitted to an acquired brain injury rehabilitation program. Of the fourteen cases selected for review, two case studies are specifically presented, a poly orthopedic trauma patient with classic features of CFES without coinciding features of TBI, and the other; a patient example with a dual diagnosis of CFES and associated features of TBI, each illustrative of key characteristics of their respective cohorts. Historical and clinical features were characterized by the Glasgow Coma Scale (GCS), loss of consciousness (LOC) - time to follow commands (TFC), duration of posttraumatic amnesia (PTA), length of stay (LOS), Functional Impairment Measure (FIM), Rancho Los Amigos (RLA) scale, and Glasgow Outcomes Scale (GOS). CT imaging and relevant MRI findings reviewed by an independent Neuroradiologist.

Results: A total of fourteen patients had neurologic injury secondary to CFES, seven patient’s historical, clinical and radiographic findings were consistent with a single diagnosis of CFES, and seven patients were diagnosed with dual diagnosis of CFES and TBI.

Conclusion: Patients with neurologic injury secondary to CFES with or without evidence of TDAI/FCC have good functional neurologic recovery outcomes as measured by discharge FIM, and GOS at 3- and 6-months post injury. Providers should use caution in providing poor prognostics in clinical situations in which patient’s primary neurologic derangement is secondary to CFES. Comprehensive neuroimaging with advanced MRI techniques are key to differentiating lesions secondary to CFES versus FCC and/or TDAI and must be utilized in conjunction with history and clinical examination in order to best prognosticate a patient’s potential neurologic recovery.
Predictors of Neurobehavioral Symptom Reporting in a Community Based Sample with Mild Traumatic Brain Injury (MTBI)

**Dmitry Esterov**, Thomas Bergquist, Allen Brown

1Mayo Clinic, Rochester, United States

Introduction: The Neurobehavioral Symptom Inventory (NSI - 22) is a validated, self-reported questionnaire designed to assess Post-Concussion Syndrome (PCS) symptoms. Though used in various settings, this scale is widely used in TBI evaluations within the Veterans Health Administration and the Department of Defense. Studies have shown that psychological and behavioral measures are strong predictors of persistent neurobehavioral symptom reporting in veterans; however, there is still a gap in knowledge about these associations in a civilian population presenting for treatment. This study seeks to identify the predictors of increased neurobehavioral symptom reporting on the NSI-22 in a treatment seeking population with MTBI, in order to continue developing strategies for the treatment of patients with PCS.

Methods: Retrospective data analysis of 80 participants between 2014 and 2018, with a diagnosis of probable (consistent with mild) or possible (consistent with concussive) MTBI, classified using the Mayo Classification System for traumatic brain injury severity. All participants received interdisciplinary outpatient rehabilitation, with the specific therapy and duration determined by clinical need. On admission, participants were given assessment measures of neurobehavioral symptoms (NSI – 22), depression (PHQ-9), satisfaction with life (SWLS), and participation (M2PI). The primary outcome of interest was NSI – 22 scores on admission. Predictor variables used in a univariate analysis were PHQ-9, SWLS, M2PI, age at injury, prior history of MTBI, premorbid history of PTSD, mood disorder, ADHD, sleep disorder, chronic pain, substance abuse, migraine disorder, employment at time of assessment, education years, and method of injury. Predictor variables identified by univariate analysis were entered into a multivariable regression model, which was adjusted for demographic variables, time since the injury, marital status, as well as the mechanism of injury.

Results: Increased NSI 22 total scores, as well as all subsets within the NSI-22, were significantly correlated with increased level of depressive complaints (PHQ-9), higher disability (M2PI), lower satisfaction with life (SWLS), prior MTBI, fewer years of education, and unemployment at time of assessment. When those variables were used in a multivariable linear regression model, the PHQ 9, M2PI, and years of education remained statistically significant.

Conclusions: Within a treatment-seeking civilian sample diagnosed with mild TBI, increased endorsement of depressive symptoms, greater level of disability, and lower level of education predicted increased neurobehavioral symptoms. These results further support the need for comprehensive assessment and interdisciplinary treatment that assist with the management of physical, cognitive, behavioral, and emotional symptoms that impact quality of life in persons with mild TBI presenting for treatment.
Development of a Structured Approach to Goal Setting and Goal Attainment in Prolonged Disorders of Consciousness

Lynne Turner-Stokes¹, Hilary Rose², Celine Lakra¹, Heather Williams², Stephen Ashford¹,², Richard Siegert³
¹King's College London, London, United Kingdom, ²Northwick Park Hospital, London, United Kingdom, ³Auckland University of Technology, Auckland, New Zealand

Background and Aims: Goal-setting forms the cornerstone of management in rehabilitation programmes. Patients in prolonged disorders of consciousness (PDOC) are unable to engage in goal-setting, but a similar process involving the team and family can still provide a useful framework for coordinating care and establishing shared expectations for outcome. However, individualised goal-setting can be time-consuming in a busy clinical setting. One solution is the use of standardised goal-sets (or ‘objectives’), from which the most relevant can be selected for each individual patient.

Our unit uses a semi-structured approach to goal-setting in PDOC patients, combining standardised objectives with more personalised goal-setting agreed with the family. The standardised set of objectives has evolved over 15 years from an initial set of 20 goals in 12 domains, to 40 goals in 19 domains.

In this study, we present a retrospective cohort analysis of the frequency with which different objectives were set and achieved and describe how this was used to refine a final structured goal-set.

Methods: De-identified data were extracted for consecutive admissions to the programme between 2007 and 2018. Analysis involved the following steps:

a) Evaluation of Goal Attainment Scaling (GAS) for both the standardised objectives and personal goals, to examine the relationship between the two.
b) Frequency analysis of the standardised objectives that were set and achieved under each domain, to identify any that may be combined/re-organised.
c) Mapping personalised goals onto the domains, to identify any key goal areas currently missing from the standardised set.
d) Production of the final structured goal-set.

Results: Data were extracted for 162 patients: 64% males; mean age 43 years (SD 13.5) Aetiology: trauma 61(38%), hypoxia 61(38%), cerebrovascular accident 30(19%), other 10(6%). The mean length of stay was 111 days (SD 82). By discharge, 34(21%) had emerged into consciousness, 112(69%) were still in PDOC, 16(10%) had died. Mean achieved GAS T-scores for standardised and personal goals were 47.2 (95%CI 46.7, 47.6) and 47.7 (95%CI 46.7, 48.8) respectively, with no significant difference between the two sets. The Pearson correlation was r=0.482 (p<0.001). A total of 2959 standardised objectives were examined across 15 domains.

The rates of achievement ranged from 11-100% (mean 75%). Objectives commonly set and achieved included: Assessing communication; Establishing the PDOC diagnosis; Providing a wheelchair, and Care package; and Providing information to the family. Achieving tastes of food for pleasure; Increasing joint range; and Discharge home proved more challenging.

Of 661 personal goals, 89% were achieved/over-achieved. 509 mapped to existing domains, with 4 new goal areas identified: Medical care; Pain management; Physical function and Social interaction. The final structured goal-set comprised 36 goals in 18 domains.
Conclusions: Developed through clinical practice in one centre, the structured goal-set now requires testing in other similar programmes.
Preliminary Validation of the Sleep and Concussion Questionnaire as an Outcome Measure for Sleep Following Brain Injury

Catherine Wiseman-Hakes1, Danielle Toccalino1, Dora Zalai2

1University of Toronto, Toronto, Canada, 2EBT - Evidence-based Therapy, Training and Testing, Toronto, Canada

Background and Rationale: Alterations in sleep and wakefulness are widely reported in the acute stage following traumatic brain injury of all severities, and sleep is further reported to change over time. For some individuals, these initial disturbances can evolve into debilitating sleep disorders that have been found to compromise recovery and outcomes, as well as placing the individual at risk of sustaining further injury. Assessment and management of sleep has been identified as a priority in the management of concussion/TBI. However, to date there has not been a measure specifically designed to capture the changes in sleep in response to a TBI. Clinicians and researchers are using measures that do not reflect changes in sleep in comparison to a pre-injury baseline, making it difficult to triage the need for further investigation, and to track recovery over time. There exists a need for a condition specific patient-reported outcome measure (PROM) to evaluate sleep following TBI. To meet this gap, the Sleep and Concussion Questionnaire (SCQ) was developed as a means to describe and quantify changes in sleep and wakefulness in response to a brain injury, and, to guide the need for further investigation and management. As with any measure, the validation process is fundamental to the development and evaluation of a measurement instrument. Throughout its development, the SCQ has undergone preliminary examination of construct and content validity by clinicians and researchers with expertise in sleep and brain injury, as well as by individuals with history of TBI and sleep disorders, and without sleep disorders, and, those without history of TBI. It has also undergone testing of criterion and discriminant validity with a prospective sample of > 200 patients with concussion. However, it had not yet undergone examination of convergent validation against other objective and self-report measures of sleep.

Objectives: To examine the convergent validation of the Sleep and CQ in a sample of adults with symptoms chronic insomnia following a concussion.

Methods: Thirty-two adults (38.9 ± 15.1 years old), (F=20), mean time post injury 13.3±7.5 months and presenting with self-reported symptoms of chronic insomnia took part in this cross-sectional study. Measures included the Sleep and Concussion Questionnaire, the Epworth Sleepiness Scale (ESS), Insomnia Severity Index (ISI), and Polysomnography.

Results: Convergent validity was supported by significant correlations between the total SCQ score and the total score of the ISI (p=.006), SCQ subscale question ‘difficulty staying asleep’ and the total arousal index from the PSG analysis (p=0.035) and SCQ subscale question ‘frequency of naps’ and the ESS (p=0.002).

Conclusions: These findings provide evidence that the SCQ is a valid self-report instrument for describing and measuring changes in sleep following brain injury and guiding further evaluation.
No Tract-Based Diffusion Imaging Correlate of Paediatric Post-Concussion Syndrome: A Bayesian Analysis Approach

Jesse Shapiro1,2, Tim Silk1,3,4, Michael Takagi1,2, Vicki Anderson1,2,5
1School of Psychological Sciences, University of Melbourne, Melbourne, Australia, 2Murdoch Children's Research Centre, Melbourne, Australia, 3School of Psychology, Deakin University, Melbourne, Australia, 4Department of Paediatrics, University of Melbourne, Melbourne, Australia, 5Psychology Service, Royal Children's Hospital, Melbourne, Australia

Background and Objectives: Post-concussion syndrome (PCS) is a continuation of concussive symptoms beyond the typical recovery period of 4 weeks for children and adolescents. Although the factors which contribute to the ongoing post-concussive symptoms are unknown, white matter microstructural integrity has been associated with the development of PCS in adults. Many studies into white matter microstructural change in paediatric PCS suffer from low power and heterogenous sampling. This study uses a Bayesian analysis approach to compare white matter microstructural integrity between children with ongoing PCS symptoms and those who have recovered at a two-week timepoint in twenty different white matter tracts. The aim of the present study was to examine white matter microstructure changes in concussion in a paediatric sample and to explore whether these changes are associated with PCS symptomology. It was hypothesised that children in the delayed recovery group would demonstrate increased fractional anisotropy (FA)

Method: This analysis formed part of the Take CARe study. Forty-three children were recruited from the emergency department of the Royal Children’s Hospital and underwent magnetic resonance imaging and cognitive screening two weeks post-concussion. The Child PCSI was used to dichotomise participants into “normal” and “delayed” recovery groups. Diffusion imaging was pre-processed according to standard protocol. Mean FA values were calculated under 20 unique white matter tracts defined according to the JHU probabilistic tractography brain atlas. These mean FA values were then compared between normal and delayed groups under each white matter tract were compared using Bayesian independent sample analyses.

Results: Posterior probabilities indicated uncovered support for the null hypothesis, that there is no significant differences in mean FA values between normal and delayed groups, across 13 of the 20 unique white matter tracts. Analyses of the remaining tracts suffered from insufficient power to give support to either hypothesis.

Conclusions: Findings from this study indicate that it is unlikely that PCS symptomology is caused by underlaying white matter microstructural damage in a paediatric sample.
Delivering Concussion Evidence to the Community: A Digital Solution

Cathriona Clarke¹, Simone Darling¹, Franz Babl¹,²,³, Gavin Davis¹, Peter Barnett¹,²,³, Alison Crichton¹, Michael Takagi¹, Gabi Ceregra⁴, Sanji Kanagalingam⁴, Patrick Clifton⁵, Peter Harcourt⁵,⁶, Vicki Anderson¹,²,⁷
¹Murdoch Children’s Research Institute, Melbourne, Australia, ²The Royal Children’s Hospital, Melbourne, Australia, ³Department of Paediatrics, University of Melbourne, Melbourne, Australia, ⁴Curve Tomorrow, Melbourne, Australia, ⁵Australian Football League, Melbourne, Australia, ⁶Melbourne Law School, University of Melbourne, Melbourne, Australia, ⁷School of Psychological Sciences, University of Melbourne, Melbourne, Australia

Background and Objectives: Concussion is not well understood in the community. 70% of parents do not recognise signs of concussion, and 93% are not aware of return-to-play guidelines (Haran et al. 2016). Furthermore, parents, coaches and non-specialised medical professionals are often unfamiliar with recovery strategies following a head knock, and what symptoms should be considered abnormal. This is a critical gap in knowledge given that 40% of children will experience delayed symptoms following the incident. Return-to-activity guidelines have been adopted by frontline care and major sporting codes; however, their existence is not widely known, and the content is not easily digested by the community.

Method: Gold-standard guidelines were translated into a smartphone application consisting of 1) a sideline concussion check (McCroy et al., 2017; Echemendia et al., 2017), and 2) psychoeducational step-by-step guide for returning to school/sport (McCroy et al. 2013; 2017; Davis et al. 2017) covering the stages a) rest at home, b) return to school, c) return to physical activity, d) return to organised sport. The app was launched by the Australian Football League within its junior community leagues.

Results: Data show a high percentage of those who used HeadCheck for a sideline check also initiated the recovery component of the app. A smaller proportion of users completed recovery. User feedback was positive.

Conclusion: Preliminary results suggest that uptake of international guidelines can be increased by providing content in a digital, readily accessible, user-friendly smartphone application. Concurrent validity is currently being assessed through a comparison of HeadCheck to standard practice in front-line care.
Managing Continence to Improve Independence and Reduce Cost of Care for Clients with an ABI (<65 Years) Undergoing Staged Community-Based Brain Injury Rehabilitation

Angelita Martini¹, Katie Beros¹, Annelize Prinsloo¹
¹Brightwater Care Group, Osborne Park, Australia

Activities of Daily Living for many individuals with an acquired brain injury (ABI) are highly dependent on staff intervention. Reliance on assistance for personal care often causes embarrassment and loss of dignity for the individual. Therefore, minimising involvement of staff through improved management of continence may be beneficial in both reducing the cost of care and improving independence and quality of life of these individuals.

This project aimed to increase the independence of residents with an ABI, decrease their cost of care and improve quality of life through improved continence management. This was done by investigating, reviewing and implementing new continence interventions to support independence; identify opportunities for change in current practice; and determine any changes in quality of life.

A purposive sample of n=16 clients under 65 years, with an ABI (including TBI) undergoing staged community-based brain injury rehabilitation were included in the study. Data was collected at 4 time points at 4 weekly intervals and included episodes of care per client (defined as all direct care provided for an individual client during a 24-hour period). Data included continence assessments (1 client and 1 staff/family); and outcome measures monitoring changes in independence (Functional Independence Measure and Functional Assessment Measure, FIM+FAM), quality of life (Quality of Life after Brain injury, QOLIBRI), cost (Northwick Park Care Needs Assessment, NPCNA), and service delivery/practice (Staff survey, Document analysis, and Observation). Data was analysed using non-parametric testing due to small sample size.

Data was stratified by age (23-64yo), gender (62% male), type of injury (Stroke 69%, Trauma 19%, Hypoxia 12%), length of stay (23-149 weeks), time since injury (0.7-29 years), and functional status. Preliminary results from time points 0, 1 and 2 for the NPCNA have shown a reduction in care time (from 757 to 570 hours per week) and cost (of between 17 and 55%). Analysis is due for completion in December 2018.

Preliminary analysis of data has also found the need for a multidisciplinary approach to continence and toileting management, a lack of knowledge of continence issues, significant decrease in cost of care and positive impact of research on practice. This is significant for understanding practitioner role, and recognising the importance of individualised interventions to optimise independence and quality of life within this complex practice area.

To date, this study has highlighted the need for health services to consider continence in planning treatment and rehabilitation services, and the need for new interventions and strategies to facilitate independence to improve quality of life of people with and ABI.
Methodological Challenges in Measuring Self-Reported Change after a Cognitive Rehabilitation Program – The Paradox of Cognitive Rehabilitation and the Role of Confounding Factors and Measurement Errors

Line Eide¹, Hildegun Snekkvik¹, Per-Ola Rike¹
¹Sunnaas Rehabilitation Hospital, Drøbak, Norway

Objectives: The valid confirmation of a positive change in health status due to cognitive interventions is at the core of rehabilitation. However, to measure positive change with change scores on rating measures include complex statistical and clinical considerations due to confounding factors collectively known as error of measurements. Among factors that may invalidate or influence self-rating responses in longitudinal studies of persons with acquired brain injuries, are awareness deficit, and psychosocial factors, which in turn influence mental health, self-esteem and quality of life. This study investigates treatment outcomes after a cognitive rehabilitation program, and explores factors associated with determination of change.

Methods: Design and participants: In this consecutive follow-up study, 35 participants, 24 men and 11 females, were recruited as they enrolled in the hospital’s cognitive rehabilitation program, 16 with traumatic brain injury, 16 with stroke and 3 with brain tumor. Education level was 13.9 (2.9) years, median duration of illness was 547 (293-965) days and 60 % (n=21) held a valid driver’s license. 26 % (n=9) were part-time employed, 74 % (n=24) were on sick-leave/disability benefits. 23 % (n=8) had a premorbid psychiatric diagnosis.

Intervention: A 5-week multidisciplinary standardized treatment program based on the ACRM Cognitive Rehabilitation Manual, including 1-week follow-up after 6 months.

Measurements: Questionnaires were administered pre-intervention and at 6 months follow-up, and included the Cognitive Failure Questionnaire (CFQ), Hopkins Symptom Checklist (HSCL-25), Rosenberg’s Self-Esteem Scale (RSES) and Life Satisfaction Questionnaire (LiSat-9).

Results: At follow-up, 61 % reported positive changes on the RSES, 59 % on LiSat9, while only 41 % had positive changes on the CFQ and 39 % on the HSCL-25. Thus, no significant simple changes on the measures from pre-intervention to follow-up were observed, and no effects of age, gender, diagnosis or duration of illness were detected. Intercorrelations between LiSat-9, RSES and HSCL-25 were strong (>0.6) at follow-up. The associative strengths between RSES and LiSat-9 and HSCL-25 developed from moderate (0.4-0.6) to strong correlations (>0.6). Those with a valid driver’s license reported significantly more cognitive failures at follow-up (p=0.019).

Conclusions: Judging the outcomes after cognitive rehabilitation is complex in longitudinal studies where numerous confounding factors may influence multiple levels of change, i.e., cognitive and psychosocial factors, awareness deficit and test-retest accuracy on the outcome measures. Further, the study highlights the challenge of increasing patients’ symptoms awareness for better post-treatment adaption, while preserving mental health and avoiding consolidation of an injury identity, which may influence outcome. Because many factors are beyond the influence of a rehabilitation program, future studies need not only emphasize cognitive rehabilitation and self-understanding, but also include potential confounders when estimating the effect of rehabilitation.
Links Between the Level of Consciousness and Swallowing: What Can We Learn from Patients in Altered States of Consciousness?

Evelyne Mélotte1,2,3, Sabrina Delhalle4, Olivia Gosseries1,2, Audrey Vanhaudenhuyse5, Jean-François Kaux3, Aude Lagier4, Charlène Aubinet1,2, Audrey Maudoux4,5, Didier Ledoux6, Steven Laureys1,2

1GIGA-Consciousness, University of Liège, Liège, Belgium, 2Coma Science Group, Neurology Department, University Hospital of Liège, Liège, Belgium, 3Physical and Rehabilitation Medicine Department, University Hospital of Liège, Liège, Belgium, 4Otorhinolaryngology Head and Neck Surgery Department, University Hospital of Liège, Liège, Belgium, 5Sensation and Perception Research Group GIGA Center, University and University Hospital of Liège, Liège, Belgium, 6Intensive Care Unit Department, University Hospital of Liège, Liège, Belgium

Introduction: The aims of this study were to document the extent and characteristics of dysphagia in patients with disorders of consciousness (DOC) and to evaluate the link between consciousness and different components of swallowing.

Method: We collected and analyzed 10 criteria in link with oral-feeding, respiratory status and Fiberoptic Endoscopic Evaluation of Swallowing (FEES) in 103 DOC patients (43 women; mean age 39±13 years) admitted consecutively to the University Hospital of Liège (Belgium) for a one-week multimodal assessment of consciousness. The inclusion criteria were: to have had a coma and severe acquired brain injury, to have performed a FEES, and to have a diagnosis of DOC (unresponsive wakefulness syndrome (UWS)¹ or minimally conscious state (MCS)²) confirmed by at least 5 assessments with the Coma Recovery Scale-Revised³ and by positron emission tomography (presence or absence of metabolic activity in the fronto-parietal network bilaterally). We performed a univariate logistic regression between several swallowing related parameters and consciousness diagnosis (UWS or MCS). Logistic regression was adjusted for age, time since insult and etiology.

Results: Thirty-one patients were UWS (13 females, 11 with traumatic etiology, 16 post-anoxic and 4 others; 25±23 months post-insult) and 72 were MCS (30 females, 43 from traumatic brain injury, 12 post-anoxic and 17 others; 40±34 months post-insult). Compared with MCS patients, UWS patients had more frequently a tracheotomy still in place (68% UWS vs 24% MCS, p=0.002), pharyngo-laryngeal secretions (60% UWS vs 28% MCS, p=0.032), salivary aspiration (39% UWS vs 13% MCS, p=0.039) and the absence of an efficient oral phase (lip prehension, lingual propulsion and the absence of buccal stasis after swallowing) (0% UWS vs 62% MCS, p=0.003). The other observed parameters (i.e., the presence of an exclusive enteral-feeding, poor sensibility in the pharyngo-laryngeal area, hypertonia of the jaw muscles, basic oral phase of swallowing and thick/liquid aspiration) were not significantly influenced by the level of consciousness in our cohort.

Conclusion: Some components of swallowing correlate with the level of consciousness in our population of patients with DOC, particularly the efficacy of the oral phase of swallowing. This criterion should be considered as a sign of consciousness, and consequently, it should be taken into account in the diagnosis of DOC. The study also emphasizes the severity of dysphagia in DOC population and highlights the importance of correctly managing these disorders.

Pediatric brain injury, well-recognized in child neurodevelopment, could involve perinatal atmospheric incompatibilities. Epidemiological studies associate early environmental exposures with neuropsychiatric outcomes, yet the conceptualization of perinatal neurotrauma, as an etiological factor, has been underestimated and understudied.

The fetal brain may lack resilience to exposures which contribute risky downstream effects. Plausibly, perinatal neurotrauma could involve fetal diffuse axonal injury. A constellation of interacting factors as exposure mechanisms could confer risks which disrupt neural networks, triggering a neuropathological cascade of events leading to long-term functional impairments.

Studies suggest perinatal exposure to synthetic oxytocin (e.g. sOT), a neuropeptide-based agent, routinely utilized in childbirth intervention, may impact the still-developing fetal brain in ways which are poorly understood. Attention Deficit Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD), demonstrate steadily rising prevalence, an established association with perinatal sOT, puzzling male susceptibility and undetermined causation; genetics alone are inefficient to account for these outcomes. Logically, early environmental influences, principally related to complex intrapartum dynamics, can traumatize the fetal brain, impacting future behavioral and cognitive capacities in children.

Putative neuropathophysiological models include: (1) Hypoxia and ischemia during childbirth could imply poor fetal tolerance to intrapartum dynamics. Decelerated heart rate, meconium stain, nuchal cords, oligohydramnios, low Apgar scores, prolonged labor and overlapping complications can pose obvious neurological consequences for the offspring; (2) Epigenetic triggering during fetal distress may effectively “flip a genetic switch,” especially in familial predisposition to neuropsychiatric disorders; (3) Neurological kindling effects during perinatal exposure to agents may arise from targeted hyperstimulation of oxytocin receptors. A chemically kindled fetal brain could disturb endocrine homeostasis, triggering long-standing neuroendocrine and subsequent behavioral effects. Rodent models suggest excitotoxicity and neuroinflammatory reactions may be involved; (4) Neural insults from pressure of hypertonic uterine contractions, amplified during sOT-intervention, may imprint neural convolutions on the malleable fetal brain. Cortical topographical alterations evolve as the brain develops, possibly fostering behavioral and cognitive profile variances observed in neuropsychiatric disorders like ADHD/ASD; (5) Disharmonious synchronicity of epidural anesthesia and sOT may oversaturate fetal neuroreceptors, influenced by dose-dependent thresholds; (6) Maternal adiposity/high BMI pose risks as diminished uterine contractibility warrants chemical intervention to expedite childbirth; (7) GABA downregulation, linked to perinatal sOT, is associated with anxiety disorders, commonly comorbid in neuropsychiatric profiles; (8) Blood-Brain Barrier/Placental Permeability may compromise fetal neuroprotection as insulation from environmental exposures.

A perinatally burdened fetal brain could shape its neurodevelopmental trajectory. The emerging role of perinatal neurotrauma represents a timely lens through which to freshly consider prevalent...
neurodevelopmental disorders challenging children across academic, behavioral and psychosocial domains of functioning. Undeniably, further research is warranted to disentangle specific mechanism(s) inherent in these outcomes, as a matter of child public health.

Evidence-based perinatal risks will be reviewed, relevant research cited and discussed in depth.
Nociception Coma Scale Revised with Personalized Painful Stimulus May Improve Pain Management in Non-Communicative Patients with Disorders of Consciousness

Rita Formisano¹, Marianna Contrada¹, Marta Aloisi¹, Giulia Ferri¹, Sara Schiattone¹, Marco Iosa¹, Maria Buzzi¹

¹IRCCS Fondazione Santa Lucia, Rome, Italy

Introduction: Persons with disorders of consciousness (DoC), such as Vegetative State (VS)/Unresponsive Wakefulness Syndrome (UWS) and Minimally Conscious State (MCS) may perceive pain without being able to communicate their discomfort. Nociception Coma Scale (NCS) in its revised form (NCS-R) has been proposed to assess nociception in coma survivors with DoC.

Objective: Aim of the present study was to compare, in non-communicative patients with DoC, results obtained with the standard pressure on fingernail bed versus personalized painful stimuli, as indicated by professionals and caregivers involved in their care and rehabilitation, and measured with the Italian version of NCS-R.

Materials and Methods: Twenty-one patients admitted to post-acute rehabilitation after severe brain injury with VS/UWS and MCS were included in the study. Responsiveness and pain perception were assessed by Coma Recovery Scale-Revised (CRS-R) and NCS-R with standard stimulus (NCS-R-SS) and personalized stimulation (NCS-R-PS), at admission and discharge. Statistical analysis was performed with the nonparametric Friedman test for comparison of both total NCS-R-SS and NCS-R-PS scores and sub-total scores.

Results: NCS-R at admission showed that 9 of 21 patients (42.8 %) had higher scores in response to personalized stimulus compared to standard stimulus.

Discussion: The preliminary results obtained in the present study suggest that NCS-R-PS may disclose pain perception in a larger number of non-communicative patients with DoC, compared to NCS-R-SS. Validation of NCS-R in Italian language will be pursued and the use of personalized stimuli seems advisable.
The Glasgow Outcome Scale Extended-Revised (GOSE-R) including Minimally Conscious State correlates with Coma Recovery Scale-Revised (CRS-R)

Rita Formisano¹, Marianna Contrada¹,², Giulia Ferri¹, Sara Schiattone¹, Marco Iosa³, Marta Aloisi¹
¹Post-Coma Unit, IRCCS Santa Lucia Foundation, Rome, Italy, ²PhD Program in Behavioral Neuroscience, Sapienza University of Rome, Rome, Italy, ³Clinical Laboratory of Experimental Neurorehabilitation, IRCCS Santa Lucia Foundation, Rome, Italy

Introduction: The 40 years of application of the Glasgow Outcome Scale (GOS) and of its extended version (GOSE) inspired the recent proposal of a Glasgow Outcome Scale Extended-Revised (GOSE-R), to include the Minimally Conscious State in the Vegetative State category, more recently defined as Unresponsive Wakefulness Syndrome.

Aim of the study is the comparison of GOSE-R through correlation with widely used scales for the evaluation of disorders of consciousness (DoC), such as the Coma Recovery Scale-Revised (CRS-R).

Methods: We enrolled 25 patients (16 M and 9 F), with a mean age of 42.2±13.8, consecutively admitted to the Post-acute Rehabilitation Unit of Santa Lucia Foundation, diagnosed with severe brain injury of different etiologies, prolonged DoC and a chronicity of 106.7±87.4 months.

Results: The correlation between CRS-R scores and GOSE-R scores resulted very high (R=0.895, p<0.001), with a coefficient of determination R²=0.801.

Discussion: GOSE-R could promote and facilitate long-term follow up studies on larger populations of persons with severe brain injury and DoC.
Purpose: In 2010, Massachusetts enacted legislation with regulations for the identification, treatment, and return-to-activity targeting public and private middle and high school student athletes with mTBI or other brain injury. School Nurses (SNs), Licensed Athletic Trainers (ATs) and Athletic Directors (ADs) play pivotal roles responding to students with head injury and managing their recovery. To assess implementation of the law, the Massachusetts Department of Public Health (MDPH) has conducted focus groups and surveys with these stakeholders.

Methods: Focus groups with ADs were conducted in March of 2018. Based on the results of these groups, a survey instrument was developed with participation from investigators at the Boston Medical Center Injury Prevention Center, brain injury researchers at the Boston University School of Medicine, ADs, and injury prevention experts at the MA Department of Public Health. In November 2018, the link to the electronic survey was sent to all AD members of the MA Interscholastic Athletic Association, the MA ADs professional organization.

Results: While the survey is currently in the field (November 2018), 125/377 responses have been received to date. Preliminary analyses indicate that: the mean rating on a 0-10 scale on importance of the law for student safety was 9.15 (with 10 being “very important”); the mean rating on a 0-10 scale of the law’s impact on workload was 1.4 (with 0 being “not at all”); 86% of respondents reported that their school had a concussion management team consisting of the ADs, ATs, SNs, and guidance counselors (GCs); 75% of ADs reported that they were informed “always” (26%) or “often” (49%) when a student athlete experienced a mTBI in a venue other than extracurricular sports; 97% endorsed that “all” or “most” of SNs were “very knowledgeable” about the law and regulations; 33% endorsed that “all” or “most” of teachers were “very knowledgeable” about the law and regulations; 60% endorsed that “all” or “most” of GCs were “very knowledgeable” about the law and regulations; 80% endorsed that “all” or “most” of the students’ physicians were “very knowledgeable” about the law and regulations; and 62% endorsed that “all” or “most” of students’ parents were “very knowledgeable” about the law and regulations; 67% endorsed that student athletes with concussion “often” (6%) or “sometimes” (61%) misrepresent their mTBI symptoms to accelerate return-to-play; and, 69% perceived that student athletes with concussion “often” (13%) or “sometimes” (56%) misrepresent their mTBI symptoms to avoid academics.

Conclusions: ADs perceive the sports concussion legislation as very important to student safety and positively assess implementation of the law and associated regulations. More effort is needed to increase understanding of the law among some stakeholders, including teachers, parents, and physicians.
Migration and Mental Status

Antje Büttner-Teleaga\textsuperscript{1,2}
\textsuperscript{1}Institute of Cognitive Science / Woosuk University, Samney-up, South Korea, \textsuperscript{2}Department of Psychiatry, University Witten-Herdecke, Witten, Germany

Introduction: Last year, about 1 million refugees came to Germany. Many of the refugees are accommodated in makeshift accommodation. Many doctors and nurses are involved in support activities and the health care of these immigrants. The participating sleep physicians, psychologists and nurses have a good insight into the life situation.

In addition to the general medical conditions, the sleep medical conditions are also rather bad and necessarily improvable. Especially, we sleep-medically trained experts know what health consequences may have worse, non-restful sleep on mental and physical health.

Narrow spatial conditions, poor acoustic and light-related conditions, poor bedding conditions and possible posttraumatic stress disturbances increase sleep disturbances and sleep disorders and can trigger them. In a study about psychiatric diagnoses in asylum seekers, sleep physician Prof. K. Richter from Nuremberg has found that in addition to posttraumatic stress disorders, insomnia is one of the most common diagnoses (Health Care, Nov. 2015 77: 834-838).

Because learning is important for the integration of migrants, the basics of learning must also promote. According to the findings of sleep medicine, this also includes undisturbed and restful sleep. Therefore, accommodation of migrants housing conditions should be established, which take care for a relaxing and undisturbed sleep.

1. Relationship between Migration and Sleep Disorders
2. Influence of PTSD, Depression and Anxiety on Sleep
3. Chronobiology and Sleep Disorders in Refugees and Peoples with Migration background
4. Pathophysiology in Sleep of Refugees and Peoples with Migration background
5. Treatment possibilities in Refugees and Peoples with Migration background

Methods: In our actual study, we could include 33 participants from different countries: 17 was women (51.52 %) and 16 was men (48.49 %). The participants were examined by psychiatric anamnesis and sleep anamnesis; they even were tested with different sleep questionnaires.

Findings: In our population, we found 32 patients with PTSD (96.96 %), mostly coupled with Depression and/or Panic disorder. 32 patients of our patients are suffering under Insomnia (96.96 %), 25 have had Nightmares (75.75 %), 6 Sleep Apnea Syndrome (18.18 %), 2 Restless Legs Syndrome (0.06 %) and one of them have had Pavor nocturnus, Somnambulism, Hypnotic Hallucinations and / or Sleep Wake Rhythm Disorder (0.03 %).

Summary: We can conclude that migration is an important factor, which influenced the mental status and the good sleep in refugees and resulted in many different psychiatric and sleep disorders.
Assessment of Training Needs for Better Appropriation of Best Practices in the Management of mTBI in the Emergency Department: A Web-Based Survey

Elaine de Guise1,2, Hélène Audrit1,2, Jessica Julien1,2, Jean-Marc Chauny4, Isabelle Gagnon5, Marie-Eve Lamontagne6, Natalie Lesage7, Alexandra Bwenge8, Nicolas Elazhary3, Mitra Feyz10, Pierre Frémont5, Christian Garneau7, Maryse Godin10, Jocelyn Gravel11, Bernard Mathieu12, Eric Mercier7, Simon Tinawi10, Méllisa Tremblay13, Jean-Marc Troquet10, Nancy Tzé10, Catherine Truchon14

1 Université de Montréal, Montréal, Canada, 2 CRIR, Montréal, Canada, 3 Research Institute MUHC, Montréal, Canada, 4 CIUSSS Nord de l’île de Montréal (HSCM), Montréal, Canada, 5 McGill University, Montréal, Canada, 6 Université Laval, Québec, Canada, 7 Hôpital de l’Enfant-Jésus du CHU de Québec, Québec, Canada, 8 Association Québécoise des Médecins du Sport et de l’Exercice (AQMSE), Montréal, Canada, 9 Université de Sherbrooke, Sherbrooke, Canada, 10 McGill University Health Center, Montréal, Canada, 11 CHU Ste-Justine, Montréal, Canada, 12 AMUQ, Montréal, Canada, 13 CIUSSS Saguenay Lac St-Jean, Saguenay, Canada, 14 INESSS, Québec, Canada

Introduction: In recent years, the number of people with mild traumatic brain injury (TBI) evaluated in emergency departments has grown. Although research efforts have attempted to identify best practice recommendations for mild TBI management, transfer of these into clinical practice remains an obstacle in many settings with limited access to the relevant information/knowledge for a variety of reasons. It is therefore essential to determine an effective means for emergency staff to access information about mild TBI and apply best care practices for the benefit of these patients. The goal of this project was to identify the needs and expectations of emergency staff regarding training in mild TBI management.

Methodology: A cross-sectional web-based study was conducted using a self-report online survey that targeted all doctors and nurses from three emergency rooms in the province of Quebec, Canada. The medical coordinators of these sites were contacted and transferred by email the electronic survey link to all doctors and nurses of their respective site. Practitioners (doctors and nurses) completed this electronic survey sent one time between January and March 2017. Its purpose was for clinicians to identify the best means of knowledge transfer for mild TBI management that would be easily applicable to the current context of emergency department reality. Following this survey, interviews were conducted in these three settings to clarify the parameters of the tool to be developed.

Results: A total of 150 clinicians answered to the survey (72.4% nurses, 25% doctors, 2.6% students) and 8 participants were interviewed (6 doctors and 2 nurses). Most of the participants (47.5%) wanted a mobile application on mild TBI as an educational tool that would be available at all times (20%). A total of 32.8% of participants mentioned that they would estimate having less than 5 minutes to consult such an application. After the first assessment to consult such an application, a total of 38.3% of the participants reported they would review the app after the first assessment of the same patient and 36.2% report that they would review the app after the assessment. A total of 74.8% report that they will use this app via a smart phone. They indicated that the application should contain information on appropriate recommendations for emergency care (68.3%), diagnostic criteria (67.2%), assessment tools (59.6%), decision-making algorithms (59.2%), and poor prognostic factors (57.4%).

Conclusion: The results of the present survey and individual interviews will guide the development of a mobile application to support emergency clinicians addressing the needs identified in the survey and further clarified in the individual interviews. Information quickly available on a smart phone including diagnostic
criteria, assessment tools, decision making algorithms, prognostic factors and recommendations should be included in a mobile application on mild TBI.
The Time Course of Behavioural Impairment in Mice Following Mild Traumatic Brain Injury

Miranda Mellerup1,2, Lisa Gazdzinski3, John Sled1,2, Anne Wheeler1,2
1The Hospital for Sick Children, Toronto, Canada, 2University of Toronto, Toronto, Canada

Background: Mild traumatic brain injury (mTBI), which includes concussion, represents about 80-90% of TBI cases and causes highly variable physical, cognitive, and behavioural symptoms. While in the majority of these cases post-concussive symptoms are transient, 10-15% of patients with concussion experience persistent symptoms for at least 3 months, leading to a diagnosis of post-concussive syndrome. It is not known what differentiates those who recover quickly from symptoms from those who develop post-concussive syndrome.

Objective: The objective of this study was to describe the time course of behavioural impairment in a mouse model of mTBI.

Methods: mTBI was induced in 8 weeks old C57BL/6J mice using a closed-skull Controlled Cortical Impact model, and behavioural assessments were conducted using a cross-sectional study design at 3 days, 6 weeks, 12 weeks, and 18 weeks post-injury to characterize the time course of impairment. At each time-point, the open field and light/dark tests were used to assess anxiety-like behaviours, the tail suspension test was used to assess depressive-like behaviours, the Y maze was used to assess spatial working memory, and the pre-pulse inhibition test was used to assess sensorimotor gating. 2-way ANOVA was used to determine the effect of group (mTBI or sham) and time on performance in each test, and t-tests were used to compare performance between groups at each time-point.

Results: No differences were observed between mTBI and sham mice at any of the time-points tested in the open field test, light/dark test, tail suspension test, and pre-pulse inhibition test. However, 2-way ANOVA revealed that mTBI mice had significantly fewer successful arm alternations in the Y maze compared to shams animals (F(1,111)=3.79, p=0.05). Although the interaction between group and time did not reach significance (F(3,111)=1.50, p=0.22), comparing performance between groups at each time-point indicated that at 3 days post-impact mTBI mice performed worse than the sham animals (t(25.76)=-1.84, p=0.08). This deficit between mTBI and shams diminished as time post-impact increased (6 weeks t(25.10)=-1.64, p=0.11; 12 weeks t(27.73)=0.47, p=0.65; 18 weeks t(24.70)=-0.50, p=0.62).

Conclusions: These results demonstrate that our TBI model inflicts a mild injury, with few detectable behavioural differences compared to sham animals. However, mTBI mice do appear to have a working memory deficit immediately following injury, an important cognitive symptom often associated with concussion. Future work will focus on using magnetic resonance imaging, electron microscopy, and histology to further understand the brain changes underlying the time course of behavioural impairment and recovery in mTBI mice.
Follow up of Acquired Severe Pediatric Brain Injury Patients with the Pediatric Evaluation of Mental Status (PEMS) and the Correlation Between the PEMS and IQ at Discharge of the Rehabilitation Center

Maria Flavia Dorrego, Rodrigo Sosa, Cecilia Gonzalez, Paulina Carullo, Mónica Ferrea, Silvia Intruvini

Introduction: The cognitive assessment of children and adolescents with severe brain injury during the post-acute rehabilitation period is a challenge. It requires a brief cognitive assessment without ground effect that allows designing treatment goals and regular assessment.

An adaptation of the Geriatric Evaluation of Mental Status (GEMS) was conducted as an inpatient cognitive assessment battery for acquired pediatric brain injury patients entering the rehabilitation center. The battery focused on domains that are particularly compromised following severe brain injury: orientation, attention, memory, executive functions, language, viso perception and viso construction. It was named Pediatric Evaluation of Mental Status (PEMS).

Objective: To examine the clinical utility and sensitivity to recovery of the PEMS in pediatric patients with TBI and stroke and to evaluate the predictive value of the PEMS for IQ at discharge.

Subjects, Materials and Methods: A retrospective chart analysis of patients (age range: 5 – 17) who were assessed with PEMS at admission and discharge: 22 patients that had suffered severe TBI and 7 strokes were included.

The PEMS contains a brief assessment of personal and temporal orientation, attention, memory, executive functions, naming, following commands and viso construction. It allows monthly re-assessment, identify strengths and weaknesses and helps to design goals treatments.

The admission and discharge PEMS were correlated with IQ evaluation at discharge.

Results: PEMS showed significant cognitive improvement between first assessment (X: 2,4 months taken from injury to admission to rehabilitation or emergence of minimum state of consciousness) and discharge (X: 4,9 months). Longitudinal changes in both stroke and TBI patients were significant (p <0,05). There was a direct correlation between the IQ and PEMS’ scores at discharge (p<0,05). As well as a salient correlation between the initial PEMS’ scores and discharge IQ (p <0,05).

Conclusion: The PEMS provides preliminary evidence of clinical utility and sensitivity to recovery of cognitive impairments caused by acquired brain injury and its potential clinical utility to predict cognitive performance at discharge.
Use of a Multimodal EEG-Based Biomarker for Concussion Identification, Prognosis and Management

Leslie Prichep¹,², Saloni Kanakia¹, Bo Liang¹, Arnaud Jacquin¹

¹BrainScope Company, Inc, Bethesda, United States, ²New York University School of Medicine, New York, United States

Background: Prompt, accurate, objective assessment of concussion is crucial, particularly for children/adolescents and young adults. While there is currently no gold standard for the diagnosis of concussion, the importance of multidimensional/multimodal assessments has recently been emphasized. The goal of this study was to address the need for an objective multimodal biomarker to aid in the assessment of concussion at time of injury and the tracking of recovery.

Methods: Concussed athletes (N=177), matched controls (N=187) and healthy volunteers (N=204) represented a convenience sample of male and female subjects between the ages of 13 and 25 years, enrolled at 29 Colleges and 19 High Schools in the US. Subjects were tested at time of injury and at multiple time points during recovery. Assessments included EEG, neurocognitive tests and standard concussion assessment tools. In the absence of a consensus for the diagnosis of concussion, a subpopulation of those who sustained a head injury and were not returned to play for at least 13 days (prolonged recovery group) was used to indicate those who were concussed at time of injury. A multimodal classifier was derived (using a Genetic Algorithm methodology) to identify concussed subjects with prolonged recovery compared to those with short recovery or controls, using quantitative EEG, neurocognitive and vestibular measures. The output of the classifier algorithm was expressed as an enhanced multimodal Brain Function Index (eBFI) and was mapped to a percentile scale which expressed the index relative to non-injured controls for ease of interpretation.

Results: At time of injury eBFIs were significantly different between controls and concussed subjects with prolonged recovery, showing return to non-concussed levels at return-to-play plus 45 days. For the combined concussed population, and for the short recovery subjects, a more rapid recovery was seen.

Conclusions: This multivariate, EEG-based, multimodal, objective index of brain function impairment can potentially be used, to aid in diagnosis, assessment, and tracking of recovery from concussion.
Machine Learning-Based Multi-Variant Analysis: Mammalian Hair Follicle Transcriptomic Biomarker Identification for mTBI-Inducing Exposure Condition Classification

Jing Zhang\textsuperscript{1}, Yushan Wang\textsuperscript{2}, Thomas Sawyer\textsuperscript{2}, Christopher Martyniuk\textsuperscript{3}, Valerie Langlois\textsuperscript{4}

\textsuperscript{1}University of Western Ontario, London, Canada, \textsuperscript{2}Defense Research and Development Canada, Suffield, Canada, \textsuperscript{3}University of Florida, Gainesville, United States, \textsuperscript{4}Institut national de la recherche scientifique, Quebec City, Canada

Due to the regular use of explosive devices during modern warfare, blast associated traumatic brain injury (TBI) has become a leading medical condition among the active service members and veterans. Moreover, mild traumatic brain injury (mTBI) induced by shockwave generated by primary blast from a remote location presents a challenge for timely and accurate diagnosis. Our previous studies have demonstrated the viability of mammalian-hair follicle used as a source for transcriptomic biomarker discovery. With the rapid advancement in the utility of data science in biomedical research, it is now possible to extract more information from the transcriptome profiling data. As such, the present study applies machine learning-based feature selection and predictive modelling methods to the hair follicle gene expression profiling data using a rat mTBI model. The objective is to identify genes that could be used to build a predictive model for classifying subjects into exposure groups under specific single-pulse shockwave intensity, i.e. 0, 15, 25, and 30 psi. While primarily focusing on hair follicles, we also used the blood data for comparison. Specifically, gene expression dataset was subject to tissue- and exposure intensity-specific differentially expression analysis via linear fitting and empirical Bayes significance test. Based on the gene level statistics, gene features with statistically significant changes in expression level were subject to a two-step recursive Random Forest-Feature selection (rRF-FS) pipeline for both tissues. Upon rRF-FS, a Partial Least Square-Discriminant Analysis (PLS-DA)-based predictive modelling process was carried out on the selected genes. Clustering analysis techniques such as Principal Component Analysis (PCA), PLS and hierarchical clustering were used to better characterize and evaluate the performance of the feature selection and predictive modelling. Without feature selection and predictive modelling, given the variability in expression profiles among exposure groups, it is not a surprise that supervised hierarchical clustering with differentially expressed probesgenes failed to completely cluster samples according to the shockwave intensity. The results showed that rRF-FS selected 11 probes in which eight were fully annotated, such as fam2, tpt1 and crabp1; whereas 30 probes were selected for blood with 22 fully annotated genes, including dmta2, prp2 and polr3g. Both PCA and PLS clustering showed substantially improved exposure group separation for the two tissues. Notably, hair follicle required less probesgenes to reach an optimal PLS-DA model comparing to blood. In summary, with machine learning-based feature selection and predictive modelling, the present study furthers our research on using hair follicle transcriptomic biomarker discovery for shockwave intensity-specific mTBI diagnosis.
Increased Divorce Rates Following Traumatic Brain Injury: Results from a Nationwide Register-Based Study

Anne Norup1,2, Marie Kruse3, Pernille Langer Soendergaard1,2, Fin Biering-Sørensen4

1Department of Neurology, Rigshospitalet, University of Copenhagen, Copenhagen, Denmark, 2Department of Psychology, University of Southern Denmark, Odense, Denmark, 3Danish Centre for Health Economics, Odense, Denmark, 4Clinic for Spinal Cord Injuries, Rigshospitalet, University of Copenhagen, Copenhagen, Denmark

Background: Traumatic brain injury (TBI) has wide ranging consequences for the individual acquiring the injury, but also for the surrounding family, as TBI poses significant burden on the survivor and on the significant other. The emotional burden on the closest family members have been documented several times during the last decades. However, only few studies have tried to address if the injury can lead to higher rates of divorce or separation, as has been the clinical anecdote in the field.

Objective: To investigate if acquiring a TBI increases the risk of divorce.

Methods: Initially, a TBI population was defined in nationwide Danish patient registers (LPR) by ICD10 codes DS020, DS021, DS027-DS029, DS061-DS071, DS097, DT020, DT040 and DT060. All patients registered with these codes and a contact to Danish hospitals during 2007-2015 were identified. A control group was compiled by means of propensity score matching. The controls could not have had a TBI, but they could have had other diseases. The TBI population (n=18,325) was compared to the control group (n=89,145) in relation to several outcomes, one of them being marital status. Married couples (TBI-group, n= 6,023) within the TBI-population and the control group (control group n= 32,424) were identified, and the risk of divorce within 1-3 years after TBI was investigated using logistic and linear regression models. The analysis was adjusted for age, gender, municipality and if the couple had children living at home at the time of injury.

Results: Within the married TBI group, a higher risk of divorce was found compared to the matched control group within 1-3 years after injury (OR= 1.45, 95% CI= 1.27-1.64, p<0.0001). Younger age was associated with a higher risk of divorce, as the age group 30 – 60 years had a significantly higher OR compared to the age group above 60 years of age (OR= 4.64, 95% CI=4.02-5.17, p<0.0001). No conclusive results were found as to the impact the patient’s gender. However, children living at home seemed to have a protective effect.

Conclusions: Increased divorce rates among couples living with the consequences of TBI emphasizes the effect of the injury on the significant other and the strain that the injury poses on the marital relationship. These findings indicate the need for developing specific interventions addressing changes in the marital relationship to help married couples to adjust to the new life situation.
Pregnancy and Neonatal Outcomes Among Women with Traumatic Brain Injury

Rachel Adams¹,², Ilhom Akobirshoev³, Monika Mitra³

¹Institute for Behavioral Health, Heller School for Social Policy and Management, Brandeis University, Waltham, United States, ²VHA Rocky Mountain Mental Illness Research Education and Clinical Center, Aurora, United States, ³Lurie Institute for Disability Policy, Heller School for Social Policy and Management, Brandeis University, Waltham, United States

Background: Studies have found biological and psychosocial differences following a traumatic brain injury (TBI) for women compared to men. Small-scale studies have found that women who have had a TBI are more likely to experience amenorrhea, irregular cycles, and have fewer live births compared to women without a TBI. Yet, there have been few studies of pregnancy outcomes among women following TBI, potentially limiting informed clinical care for women with TBI. The purpose of this study was to evaluate pregnancy and neonatal outcomes among women with TBI using data from the Nationwide Inpatient Sample of the Health Care and Cost Utilization Project (HCUP-NIS) - the largest all-payer, publicly available U.S. inpatient hospital discharge database.

Methods: Using HCUP-NIS data from 2007-2014, we identified women with a delivery-related hospital admission. From this group, we identified women with a TBI diagnosis on hospital discharge records (n=3,056) and compared them with a randomly selected sample of women without a TBI (n=64,660). Pregnancy complications and outcomes included gestational diabetes, preeclampsia, placental abruption, labor induction, and cesarean delivery. Neonatal outcomes included preterm birth, low birth weight, stillbirth, and fetal distress. Additional outcomes included length of maternal and neonatal delivery hospitalization. We modelled risk for each outcome among deliveries to women with TBI, compared to women without TBI, using multivariate logistic regression for binary outcomes and multinomial logistic regressions for categorical outcomes. The main models included maternal age, race/ethnicity, health insurance, median income within patient’s ZIP code, hospital bed-size, region, and year of delivery. Next, we re-ran the models adding in health comorbidities: number of Elixhauser comorbidities, substance use diagnoses, and mental health diagnoses.

Results: After adjusting for sociodemographic and hospital characteristics, deliveries among women with TBI were associated with an increased odds of placental abruption (OR=2.50, 95% CI: 1.96 - 3.18, p<0.05), cesarean delivery (OR=3.39, 95% CI: 3.14 – 3.65, p<0.01), and stillbirth (OR=2.02, 95% CI: 1.46 – 2.81, p<0.01). Women with TBI also had significantly longer duration of hospital stays during delivery compared to women without a TBI. Results were slightly attenuated after adjusting for health comorbidities but remained significant.

Conclusions: This study provides the first examination of pregnancy complications and outcomes among U.S. women with TBI using a large population-based sample. The odds for adverse birth outcomes, including placental abruption, cesarean delivery, stillbirth, and longer hospital stays, were significantly greater among women with a TBI, even when models controlled for health comorbidities. These findings indicate that obstetricians and midwives who care for women with TBI should be aware of potential elevated risk for adverse birth outcomes and underscore the need for future research to inform the development of clinical interventions aimed at improving pre-natal care for pregnant women who have sustained a TBI.
Sensitivity Analysis of a Finite Element Head Model to Skull Material Properties in the Study of Traumatic Brain Injury

Hesam Moghaddam\(^1\), Mariusz Ziejewski\(^2\), Ghodrat Karami\(^2\)

\(^1\)Northern Arizona University, Flagstaff, United States, \(^2\)North Dakota State University, Fargo, United States

Traumatic brain injury (TBI) occurs as result of a sudden trauma to the brain due to impacts or the rapid movement of the head caused by falls, accidents, sports contacts, and physical assaults. TBI can lead to long-term cognitive, physical, and neurological impairments and hence should be prevented. While head kinematics can be experimentally estimated - to a good extent - using dummy heads, assessment of tissue responses of the brain in terms of the intracranial pressure, shear stresses, and strains is technically and morally challenging. Accordingly, due to complications of experimental tests, computational methods such as finite element analysis (FEA) have extensively been used in the last decade to study the injury mechanisms associated with TBI. However, the fidelity of these models is still a concern when conclusions are to be drawn based on numerical results. One major aspect of each computational work is the implementation of accurate material models which can mimic the real behavior of biological tissues. Skull protects the brain against injury by attenuating the transferred load to the intracranial space upon an impact to the head. Several material properties have been used for skull in the literature in the context of impact induced TBI. These studies have used a wide range of densities and Young’s moduli for the skull; however, they have used different head models and loading conditions. Our study aims to investigate the sensitivity of a FE head model to skull material properties. To this end, North Dakota State University Finite Element Head Model (NDSUFEHM) was exposed to an identical impact using three different sets of material properties in terms of density and Young’s modulus taken from the well-substantiated impact TBI studies. A frontal impact scenario was developed by impacting the head moving at 2.5 m/s against a rigid wall 45 degrees about its horizontal plane. Time histories of ICP and shear stress at the location of maximum value were recorded and compared for all three material properties sets. Our primary results predicted noticeable differences among pressure and shear responses both in terms of the peak values and their pattern. Our results suggested the need for a unique set of skull properties in order to improve the biofidelity of FE models.
ABI and Addiction/Mental Health Collaborative

Jessica Trier, Kathi Colwell, Dawn Downey, Judy Gargaro

Queen's University, Kingston, Canada, Providence Care Hospital, Kingston, Canada, Ontario Neurotrauma Foundation, Toronto, Canada

Background: Southeastern Ontario (SEO) is a large, predominantly rural area with an incidence of Traumatic Brain Injury (TBI) (excluding concussion) over the most recent 6 fiscal years of 920: 11.3% had a mental health diagnosis at the time of the TBI. An implementation survey relating to a Guideline for rehabilitation of adults with moderate-to-severe TBI released in 2016, indicated that two high priority best practice recommendations relating to collaboration and continuity of care in TBI and mental health and/or addiction issues, were not fully implemented in this region.

Intervention: A 20-member, multi-sector (rehabilitation, mental health, addictions, corrections and women’s shelter) and lived experience working group met over several months to develop a mechanism for addressing the complex, unmet needs of adults in this region with moderate-to-severe ABI complicated by mental health/addiction issues. The working group developed the referral process, inclusion and exclusion criteria, consent process and forms, discussion format, and performance indicators. It was decided to develop a Collaborative in each of 3 sub-areas and this Collaborative has been piloted in one of the sub-areas with data collection relating to process, outcome and sustainability.

Outcomes: The Collaborative’s purpose is to develop capacity to address complex, unmet needs using a shared-care model incorporating discussion about sequential/concurrent care. The SEO ABI System Navigator coordinates monthly “rounds,” with 7 Collaborative members, including Physiatry, Psychiatry, Addictions Medicine, and community service providers, to address unmet needs of people meeting specified criteria including presence of a high-risk situation defined as “individuals or families facing a number of risk factors that affect multiple areas and in all likelihood will lead to something bad happening, and happening soon.” The discussion was to review only those clients who give consent and to monitor the number of clients who do not consent. Baseline data was gathered over an 8-week period. Providers identified 30 people meeting the inclusion criteria: 80% male; 53% urban, 17% rural, 17% incarcerated; 67% required supported accommodation, 37% required psychosocial intervention, 30% required addiction service; barriers to care through usual means were client refusal (50%), no psychiatrist (23%), and long waiting lists (23%).

The SEO ABI System Navigator is tracking performance indicators related to volume of referrals and unmet needs, referral timeframes, percentage of needs met, barriers to meeting needs, and use of healthcare system and patient flow in SEO.

Benefits of the Collaborative include:
• Enhanced provider understanding of services, mandates, roles, and admission criteria
• Enhanced collaboration amongst service providers
• Enhanced understanding of how best to identify and work with people with ABI
• Better communication amongst service providers about how best to meet the needs of people with ABI
• Improved continuity and efficiency of care
The CENTER-TBI Registry: The epidemiology of Traumatic Brain Injuries (TBI) Patients Presenting to 55 European Hospitals

Carl Marincowitz, Fiona Lecky¹, Olubukola Otisile¹, Andrew Maas², David Menon³

¹University of Sheffield, Regent's Street, United Kingdom, ²University of Antwerp (UZA), Antwerp, Belgium, ³Division of Anaesthesia, University of Cambridge, Cambridge, United Kingdom

Background: TBI is an important European public health currently lacking robust epidemiological information. The Collaborative European NeuroTrauma Effectiveness Research in TBI (CENTER TBI) study, aims to describe standardised TBI epidemiological parameters with a "registry" approach

Method: Prospectively recorded demographic, physiological, injury and outcome data were collated from the clinical records of TBI patients presenting to 55 participating centres across 18 European countries from 2015 to 2017.

Patients were stratified into; the “ER stratum” where TBI patients were evaluated and discharged from the ED post-computed Tomography (CT), the “admission(ADM) stratum” where patients were admitted to hospital post CT but not to intensive care and the “ICU stratum” where TBI patients were admitted directly from ED or other hospital to the Intensive Care Unit.

Findings: 18,879 TBI patients were enrolled in the registry. 48% (9087) in the ER, 34% (6490) in the ADM, and 17% (3302) in the ICU stratum.

The median age was 55 years (IQR 32-76) overall however, patients in the ADM strata were older (64 years (IQR 40-81)). Patients were predominantly male (60.4% (95% CI 59.7-61.1)) overall and within each stratum.

Low level falls were the commonest injury mechanism overall (38.5% (95%CI 37.8-39.2) however, Road Traffic Collisions were commonest in the ICU strata (36.0% (95%CI 34.4-37.7). Patients presented with a median Glasgow Coma Scale (GCS) of 15 (IQR 14-15)). ICU stratum patients presented with lower conscious levels (median GCS (IQR 12 (4-15)). 71.4% (95%CI 70.8-72.1) of all registry patient CT scans were normal except in the ICU stratum where 80.7 % (95% CI 79.4-82.1) were abnormal. Survival to hospital discharge was 95.4% (95% CI 95.1-95.7) overall - lower in the ICU stratum (81.0% (95%CI 79.6-82.3).

Conclusion: Traumatic Brain Injury presents to hospitals in Europe as two diseases i) low energy TBI resulting from ground level falls in conscious older patients predominates in admissions ii) high energy TBI occurs most commonly in younger male patients with impaired consciousness at presentation indicating probable admission to critical care.
Practicing Person Centred Care with Community Based Brain Injury Programs - Gaps and Opportunities

Christine MacDonell
CARF International, Tucson, United States

Person centred care is a buzz word around the world in health and human services. The actual practice of person centred care is one that takes a thorough review of an organization's philosophies and practices from leadership to front line staff. The foundation of The 10 Guiding Principles of Person Centred Care will be reviewed and practical examples of gaps and opportunities in each will be addressed from an Irish Community based provider.

Without the understanding and implementation of these 10 Guiding Principles from both the clinical and business side of a provider, person centred practice is literally words on a page.

The session will focus on debunking "myths" about what person centred practices mean to an organization and give practical examples of potential opportunities to improve these practices in your organization.
Parents-Child Relationships as A Moderator of Executive Functioning After Early Childhood mTBI

Emeline Wyckaert¹, Élizabel Leblanc², Gabrielle Lalonde³, Jocelyn Gravel⁴, Annie Bernier⁵, Miriam Beauchamp⁶
¹Université De Montréal, Montréal, Canada, ²Université De Montréal, Montréal, Canada, ³ABCs. Developmental Neuropsychology Laboratory, Montréal, Canada, ⁴CHU Sainte-Justine, Montréal, Canada, ⁵Grandir Ensemble Laboratory, Montréal, Canada, ⁶ABCs. Developmental Neuropsychology Laboratory, Montréal, Canada

Pediatric traumatic brain injury (TBI) is one of the leading causes of mortality and disability with mild TBI (mTBI) accounting for 80–90% of all treated cases (Cassidy et al., 2004). Recent epidemiological data reveal that the risk of mTBI is extremely high during early childhood (i.e., before the age of 6 years; Faul et al., 2010). Due to the vulnerability of the developing brain during this period, sustaining TBI could alter the development of executive functions (EF), which are in an intense period of maturation (Anderson et al., 2006). EF refer to higher-order cognitive processes and overarching self-regulatory abilities that underlie flexible goal-directed behavior, such as working memory and planning (Garon et al., 2008). The development of EF can also be influenced by social factors such as the family environment; for example, the quality of parent-child relationships has been identified as a proximal antecedent of child EF (Bernier et al., 2012). This study investigated whether variations in the quality of parent-child dyadic interaction after mTBI sustained during early childhood predict EF performance 18 months post-injury.

Eighty-four children aged 24 to 66 months (M=55.66; SD= 11.04) were recruited into 2 groups: children with accidental mTBI (N=48) and a control group of children with orthopedic injuries (N=34). Three dyadic components (harmonious communication, mutual cooperation, emotional ambiance) of parent-child relationships were assessed during two 10-minute interaction sequences (free play, snack time) using the Mutually Responsive Orientation (MRO) scale 6 months post-injury (Kochanska et al., 2005), and then averaged into a global MRO score. At 18 months post-injury, children were assessed on spatial working memory (Spin the Pots) and planning (Tower of Hanoï). The results were then averaged into a global EF score. Regression analyses in a moderator model (Hayes, 2015) were conducted, controlling for child sex and age.

The results revealed that over and above the covariates, MRO uniquely and positively predicted working memory and planning performance in the TBI group (β=.38, p=.02), respectively evaluated by the Spin the pots (β=.33, p=.05) and the Hanoï tower (β=.30, p=.05) tests. In contrast, EF score was not predicted by MRO in the control group (β=.19, p=.24) and showed no significant links with working memory (β=.09, p=.41) and planning performance (β=.09, p=.35).

These results suggest that the quality of parent-child dyadic interactions moderates child EF performance 18 months after early mTBI. Better quality parent-child relationships may improve EF by providing children with opportunities to stimulate EF through enriched interactions (Lewis et al., 2009) and promoting the internalization of regulatory strategies that are core features of EF (Bronfenbrenner et al., 1983; Bernier et al., 2012).
TBI as a Chronic Condition: Development of a Community Advisory Board to Explore Knowledge, Attitudes and Experiences in a Culturally Diverse Population.

Michelle Smith¹, Olga Garduño-Ortega¹, Tamara Bushnik¹
¹NYU Langone Health, New York, United States

Objectives: The purpose of this study is to understand the long-term impact of Traumatic Brain Injury (TBI) on individuals and their caregivers utilizing a community-engaged, three-phase approach. Employing principles of Community-Based Participatory Research (CBPR) a 10-member Community Advisory Board (CAB) was developed in phase one. The CAB meets monthly to provide vital contextual information including sociocultural factors in order to inform study recruitment, data collection, and tool development. Through an ongoing, iterative process between the research team and CAB members, important themes, topics and solutions were developed, refined and implemented.

Methods: A web-based survey was distributed to CAB members to gather organization-specific information about populations served, top concerns faced by their community members, and assess awareness of TBI among the community members they serve. Additionally, two study team members individually coded the minutes from the 9 CAB meetings held to date and consolidated themes and topics in an excel document in order to further examine issues of importance for the research study as discussed with CAB members.

Results: Results of the survey (N=8) identified 71.4% of CAB members as community-based organizations, followed by health centers or clinics, and academic institutions. Populations served included those with varied immigration status and Limited English Proficiency (LEP). Concerns frequently expressed by means of this survey identified community issues such as limited access to adequate healthcare, cognitive therapies, support services, and employment services. While TBI was not reported as a significant concern for community members, subsequent CAB discussions revealed a lack of knowledge and a need for education about TBI, especially among the high-risk populations they serve (i.e. construction workers and the elderly). Activities stemming from this first survey shaped additional discussions in later CAB meetings. Themes coded from these meetings include further identification of high-risk populations and an emphasis on ensuring clear communication about the study to the target population, including special focus on low-literacy and LEP populations. Additionally, creation and refinement of study materials, such as, focus group guides for later phases of the study were discussed resulting in the development of themes, topics and probing guides. Furthermore, themes for educational workshops targeted to community members in response to the lack of knowledge about TBI was a recurring theme in CAB meetings.

Implications: As more scientific evidence classifies TBI as a chronic condition, rather than an isolated occurrence, it is important to address the barriers to education about TBI in community settings to increase understanding and improve quality of life and psychosocial adjustment after injury. Implementing and maintaining a community-based participatory approach ensures that the voices of the target population are heard throughout the research process and may improve relevancy of outcomes.
Suicide and Traumatic Brain Injury among Individuals Seeking Veterans Health Administration Services between Fiscal Years 2006 to 2015

Lisa Brenner\textsuperscript{1,2,3}, Rachel Sayko Adams\textsuperscript{2,4}, Trisha Hostetter\textsuperscript{2}, Claire Hoffmire\textsuperscript{1,2}, Kelly Stearns-Yoder\textsuperscript{1,2,3}, Jeri Forster\textsuperscript{1,2}

\textsuperscript{1}University of Colorado, Aurora, United States, \textsuperscript{2}VHA Rock Mountain MIRECC, Aurora, United States, \textsuperscript{3}Marcus Institute for Brain Health, Aurora, United States, \textsuperscript{4}Brandeis University, Waltham, United States

Background and Objective: According to the US Department of Veterans Affairs 2018 National Suicide Data Report, in 2016, the suicide rate among Veterans was approximately 1.5 times greater than that among civilian adults, after accounting for age and gender. Similar to population-based studies with civilians, having a history of traumatic brain injury (TBI) has been associated with increased risk of death by suicide among Veterans, yet there have been fewer systematic studies. The primary objective of this study was to examine the association between receiving a TBI diagnosis and subsequent risk of death by suicide among those using Veterans Health Affairs (VHA) services between fiscal years 2006 to 2015. The secondary objective was to examine whether TBI was associated with suicide method (firearm versus other) among Veterans who used the VHA.

Setting: Veterans who received health care at the VHA during fiscal years 2006 to 2015 (n = 1,403,249).

Participants: All Veterans with a TBI diagnosis in VHA electronic medical records during, or prior to, the study window (n=215,610), compared to a 20% random sample of VHA patients without a TBI diagnosis (n=1,187,639).

Design: Retrospective, cohort study. Cox proportional hazards models were fit accounting for time-dependent measures (e.g., psychiatric diagnoses, Charlson/Deyo Comorbidity Score), other chronic conditions, and demographics (age, gender) for those with TBI compared to those without. Additional models were fit to evaluate the impact of TBI severity (mild, moderate/severe) on the association between TBI and suicide and to examine the association between TBI and suicide method (firearm versus other).

Main Outcome Measures: Death by suicide and method of suicide were obtained from the National Death Index.

Results: The hazard of suicide was 2.19 times higher for those with TBI (95% CI=2.02-2.37) compared to those without TBI. TBI was still significant after accounting for psychiatric conditions and other covariates (HR=1.71; 95% CI=1.56-1.87). Considering TBI severity, moderate to severe TBI compared to no TBI remained significantly associated with an elevated hazard of suicide after adjustment (HR=2.45; 95% CI=2.02-2.97), as well as mild TBI compared to no TBI (HR=1.62 95% CI=1.47-1.78). Additionally, moderate to severe TBI was significantly associated with an increase in the odds of suicide by firearm among decedents (OR=2.39; 95% CI = 1.48-3.87).

Conclusion: History of TBI is associated with an elevated risk for suicide among VHA patients. Firearm safety could be an effective upstream prevention approach within this patient population.
Sensitivity and Specificity of a Multimodal Approach for Concussion Assessment in Youth Athletes

Tiffany Toong¹, Katherine Wilson¹, Shannon Scratch¹,²,³, Anne Hunt¹,²,³, Carol DeMatteo⁵, Nick Reed¹,²,³

¹Concussion Centre, Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, ²Department of Occupational Science and Occupational Therapy, University of Toronto, Toronto, Canada, ³Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada, ⁴Department of Pediatrics, University of Toronto, Toronto, Canada, ⁵School of Rehabilitation Science, McMaster University, Hamilton, Canada

Background: Current international consensus endorses a multimodal approach to concussion assessment. However, the psychometric evaluation of clinical measures used to identify post-concussion performance deficits remains limited, particularly in the pediatric population.

Objective: To explore the sensitivity and specificity of a multimodal approach (cognition, balance and strength) compared to individual clinical measures for the assessment of concussion in youth athletes at symptomatic and asymptomatic time points following concussion.

Methods: A prospective, longitudinal cohort study with matched non-injured controls was used. Youth athletes (N=945), ages 10-18 years, completed baseline assessments using clinical measures of cognition (ImPACT), balance (BioSway), upper and lower body strength (grip strength, standing long jump), and post-concussion symptoms (Post-Concussion Symptom Inventory). Forty-seven youth athletes sustained a concussion and were retested at two time points: 1) symptomatic (balance and upper body strength); and, 2) asymptomatic (cognition, balance, upper and lower body strength). Forty-seven age- and sex-matched non-injured control participants from the original baseline sample were retested on the same clinical measures at these same time points.

Results: At the symptomatic assessment, BioSway (Sens=40%, Spec=90%) and grip strength (Sens=64%, Spec=70%) measures individually and when combined, were both significantly sensitive and specific to declines in performance from baseline. At the asymptomatic time point, the battery of combined clinical measures of cognition, balance, and strength showed an overall higher discriminatory ability compared to each individual measure alone, however, this was not shown to be statistically significant for cognition. Using a clinically relevant 90% CI, the combined measures of BioSway + grip strength (Sens=44%, Spec=87%) and BioSway + grip strength + ImPACT (Sens=47%, Spec=81%), demonstrated the greatest ability to differentiate between youth athletes with a concussion versus non-injured controls at the asymptomatic time point.

Conclusions: Clinical measures of cognition, balance, and upper and lower body strength were sensitive and specific to declines in performance following a concussion in youth athletes. This study further supports the use of a multimodal assessment to manage concussion in youth athletes, particularly when self-reported post-concussion symptoms resolve. Findings may be helpful to guide clinical decision making and standardized approaches to assessment following a concussion in youth athletes.
Cognitive-Communication Skills After Traumatic Brain Injury: A Pilot Study of Language Comprehension

Marjaana Raukola-Lindblom1, Heini Jokinen1, Riitta Vartiainen2, Linda Ljungqvist3, Timo Kurki4,5, Olli Tenovuo6,7, Kati Renvall1,8

1Department of Psychology and Speech-Language Pathology, University Of Turku, , Finland, 2Specialized Speech and Language Services Riitta Vartiainen Ltd., Helsinki, Finland, 3City of Turku, Welfare division, Psychosocial services, Turku, Finland, 4Department of Radiology, University of Turku, , Finland, 5Terveystalo Medical Center, Turku, Finland, 6Department of Neurology, University of Turku, , Finland, 7Turku Brain Injury Centre, Turku University Hospital, , Finland, 8ARC Centre of Excellence in Cognition and its Disorders, Macquarie University, Sydney, Australia

Background: Cognitive-communication disorders are common in TBI. It is estimated that they occur in 80-100 % of people with TBI (MacDonald, 2018). They include difficulties in speaking, understanding, reading, writing, conversation skills and participation. These deficits result from underlying cognitive impairments in attention, memory, executive functions, linguistic skills and information processing. Not rarely, persistent communication difficulties may greatly affect the everyday life after a TBI. Language comprehension plays an essential role in functional communication.

The aim of our current research is to find out what kind of cognitive-communication disorders patients with TBI have and how these disorders are connected with DTI (diffuse tensor imaging) measures of white matter tracts. All participants will be evaluated by a speech-language pathologist, psychologist, and neuroradiologist (DTI-imaging) during one month. We are currently collecting data of 50 cases with moderate – severe diffuse TBI and 30 healthy controls.

Objectives: This abstract presents a subgroup where language comprehension data is already available.

Method: Language comprehension data of eight participants (1 male and 7 female) with TBI, aged 25-53 (M = 35) years was used. The control group consisted of 10 healthy participants matched by age, education and gender. All participants were administered a battery of subtests of language comprehension. The groups were compared with t tests across the comprehension measures. All eight participants with TBI were also compared individually to the healthy control group using the Crawford-Howell’s modified t test to study possible individual variation in the performance and to compare different individual profiles.

Results & Conclusion: Language comprehension performance was reduced in sentence repetition and storytelling subtests for the TBI participants compared to the control group. Speed of performance was slower in most of the tasks for TBI participants. It seems that reduced speed of information processing may have influence on language comprehension. The updated results from all available subjects will be presented in the congress.
Predicting the Need for Supervision Following Traumatic Brain Injury

Arielle Resnick1, Irene Ward2, Erin Donnelly1, Jacquelyn Candaras1, Marisa King2, Justine Mamone-Lucciola1, Stefanie Migliaccio1, Allison Miller3, Anthony Lequerica2

1Kessler Institute for Rehabilitation, Saddle Brook, United States, 2Kessler Institute for Rehabilitation, West Orange, United States, 3Kessler Institute for Rehabilitation, Chester, United States

Introduction: An estimated 3.2 to 5.3 million individuals are living in the United States with long-term disability resulting from a Traumatic Brain Injury (TBI). Following a TBI, individuals often experience changes in cognitive, motor, sensory and emotional functioning, and this may result in the need for continuous supervision and assistance from caregivers to perform daily skills. Being able to predict supervision needs early-on may help caregivers plan for the future. The objective of this study was to determine the relative contribution of motor and cognitive aspects of functional status to predict the need for supervision at one-year post-TBI.

Methods: A local Traumatic Brain Injury Model System (TBIMS) database was analyzed. Participants were consecutive admissions to a Northeastern rehabilitation facility with moderate to severe TBI who consented to participate in a larger longitudinal study on TBI outcomes. The Functional Independence Measure (FIM™) Instrument at admission and discharge, and the Supervision Rating Scale (SRS) at 1-year follow-up were completed for all participants. A hierarchical regression was conducted with the Supervision Rating Scale as the dependent variable. FIM™ Motor and FIM™ Cognitive scores at discharge were entered with the following covariates: age, injury severity measured as the number of days in post-traumatic amnesia, level of education completed prior to TBI, and pre-injury limitation.

Results: 402 participants, between 16 to 94 years old, comprised this sample. FIM™ Motor at discharge was entered in Step 1. The model was significant in predicting SRS scores at one year post-injury, $R^2=0.38$, $F(4,397)=61.5, p<0.001$. The addition of FIM™ Cognitive at discharge in Step 2 accounted for a significant portion of the variance over and above the other variables, $\Delta R^2=0.054, F(1,396)=38.2, p<0.001$. Inspection of the squared semi-partial correlation indicated that the variance uniquely accounted for by FIM™ Motor in Step 1 was reduced from 14.9% to 5.4% when FIM™ Cognitive was added to the model.

Conclusion: Functional cognition predicted the need for supervision at 1-year post injury, accounting for unique variance over and above the contribution of motoric aspects of functional status controlling for age at injury, pre-morbid functional limitations, and injury severity. Despite the association between aspects of cognitive functioning and burden of care after discharge, motor functioning often dominates the decisions around length of stay determinations in acute inpatient rehabilitation facilities. This highlights the importance of a comprehensive approach to discharge planning that provides education and resources to caregivers.
How Do Individualized Active Rehabilitation Programs Impact Vestibular-Oculomotor Symptoms in Youth with Persistent Post-Concussion Symptoms? A Preliminary Investigation

Caroline Uyeno¹, Dayna Greenspoon¹, Tiffany Toong¹, Christopher Gupta¹, Nick Reed¹, Anne Hunt¹
¹Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada

Introduction: Previous studies have found that as many as 60% of athletes experience vestibular-oculomotor dysfunction post-concussion, resulting in symptoms such as dizziness, headaches and nausea. Near point of convergence, a measure of oculomotor function, has been shown to be impaired in many individuals when measured post-concussion and may be associated with headaches in both concussed and non-concussed populations. There is a growing body of literature that supports the use of active rehabilitation programs in concussion recovery. These programs typically include low to moderate intensity aerobics in combination with other physical activities (e.g. coordination or stretching), relaxation and/or education. However, the impact of these programs on vestibular-oculomotor symptoms and function has not yet been explored.

Purpose: The purpose of this study is to explore the impact of a six-week active rehabilitation intervention on vestibular-oculomotor symptoms in youth with persistent concussion symptoms.

Methods: The Vestibular/Ocular Motor Screening (VOMS) was administered as part of the assessment battery in a prospective quasi-experimental repeated measures study. The aim of the larger study was to evaluate the impact of an individualized six-week active rehabilitation intervention (low intensity exercise, sport coordination drills, relaxation, education and support) in youth with persistent post-concussion symptoms. The intervention was individualized so that youth were able to complete their program without symptom exacerbation. Vestibular function and oculomotor skills were addressed as tolerated within each individualized program. Vestibular-oculomotor symptoms were assessed pre- and post-intervention (Weeks 0 and 6). A total VOMS score was calculated at each assessment time point based on the sum of all provoked symptoms across all VOMS subtests. Individual scores for each of the VOMS subtests were also calculated. Data collected at Week 0 and Week 6 were analyzed using descriptive statistics and the Wilcoxon signed rank test for non-parametric data to understand relationships between VOMS subtests and symptom provocation.

Results: Twenty-six youth (N=19 female; Age (mean/range) =14.15/9-17 years; days post-injury (mean/range) =16/18-1249 days) participated in this study. A significant decrease (p=.015) in total VOMS score was found post-intervention. The vertical vestibular ocular reflex subtest was associated with statistically significant reductions in headache (p=.031), nausea (p=.041), and fogginess (p=.035) symptom provocation post-intervention. There were no statistically significant changes found in average length of near point convergence or symptom provocation post-intervention.

Conclusion: This study offers preliminary support that individualized active rehabilitation programs may be associated with reductions in vestibular-oculomotor symptoms in youth with persistent concussion symptoms. Clinically, there may be value in using an assessment of vestibular-ocular function to more specifically target these symptoms when individualizing active rehabilitation interventions and to measure post-intervention changes. Finally, near point of convergence may not be a useful measure of change following concussion. Further study is warranted.
Suicidal Risk in the First Year After Traumatic Brain Injury: Results from a Canadian Prospective Cohort

Marie-Christine Ouellet, Simon Beaulieu-Bonneau, Véronique Massicotte, Catherine Banville, Andréanne Martin, Camille Blouin, Bonnie Swaine, Josée Savard, Marie-Josée Sirois, Alexis Turgeon, Lynne Moore

Centre Interdisciplinaire de Recherche en Réadaptation et Intégration Sociale, Québec, Canada, École de psychologie, Université Laval, Québec, Canada, Centre de recherche du CHU de Québec-Université Laval, Québec, Canada, École de réadaptation Université de Montréal, Montréal, Canada

Objectives: Traumatic brain injury (TBI) is known to be associated with increased rates of psychopathology and suicidal risk. The objectives of this study were: (1) to document suicidal risk at three time points in the first year after TBI (4, 8 and 12 months) according to injury severity and psychiatric history; and (2) to explore the association between suicidal risk and the presence of mood, anxiety, and substance use disorders in the first-year post-injury.

Methods: The sample consisted of 227 adults, (24% women, mean age = 41.3 ± 15.2 years) having suffered TBI (mild: 50%, moderate/severe: 50%) who were hospitalized in a Level I trauma center in Quebec, Canada. Semi-structured interviews were administered in-person or by phone 4, 8- and 12-months post-injury, including the Mini International Neuropsychiatric Interview for DSM-IV to assess the presence of ongoing or past Axis I disorders and suicidal risk (four-level severity: none, mild, moderate and high).

Results: For objective 1, across all time points, the proportion of mild suicidal risk varied between 10% to 14%, moderate risk varied from 2% to 5%, and severe risk varied from 3% to 4%. A generalized estimating equation (GEE; TBI severity X psychiatric history X time) on suicidal risk (presence/absence of at least mild suicidal risk) revealed that the main effect of psychiatric history was significant, \( \chi^2 (1, N= 579) = 5.78, p =.016 \), indicating that individuals with a psychiatric history (mood, anxiety, or substance use disorder) are more likely to present at least mild suicidal risk in the first year post-TBI than those without a psychiatric history. The main effects of Time or of TBI Severity were not significant, nor were any of the two-way interactions. For objective 2, individuals with a suicidal risk were found to be more likely than those without a suicidal risk to meet criteria for a concomitant mood, anxiety, or substance use disorder, at all three assessments (4 months: 49% vs. 18%, \( \chi^2 (1, N= 203)= 16.8, p <.001 \), Cramer’s V=.29; 8 months: 55% vs. 15%, \( \chi^2 (1, N=192) = 28.0, p < .001, V=.38 \); 12 months: 71% vs. 13%, \( \chi^2 (1, N=185) = 49.4, p <.001, V=.52 \). The most common concomitant disorders were major depression, generalized anxiety disorder, post-traumatic stress disorder and panic disorder.

Conclusions: The presence of a suicidal risk of at least mild severity is relatively prevalent in the first year post-TBI, independently of injury severity. Post-TBI suicidality is not only linked to depression but also to anxiety and stress-related disorders. A comprehensive assessment of pre-existing and ongoing psychiatric problems with gold-standard tools is essential to subsequently allow a close monitoring of more vulnerable individuals. Furthermore, active prevention of suicide is warranted following TBI regardless of injury severity.
Examining Associations between Concussion History and Heart Rate Variability in Collegiate Female Athletes

Margaret Hall¹, Heather Edgell², Holly Echlin², Tracy Meloche³, Lauren Sergio³, Magdalena Wojtowicz² ¹Colby College, Waterville, United States, ²York University, Toronto, Canada

Objective: Heart rate variability (HRV), the variation in the time interval between heart beats, has been shown to be a valid method to monitor physiological functioning, particularly in sport injuries such as concussions. Prior research has shown that HRV is affected in the acute phase of a concussion but returns to baseline levels following recovery. The purpose of this study was to examine whether concussion history, sport type, and other health variables would impact HRV metrics at baseline as well as post-season.

Method: 29 female varsity athletes between 18 and 25 years of age completed self-report measures on health (medical history, menstrual cycles), mental health (history of psychological and developmental disorders), concussion, and sport history. Respiration and pulse rate were collected from participants in the supine position using the BIOPAC System at baseline and post-season. A five-minute selection of pulse rate, which has been previously found to be a viable option instead of heart rate from an ECG, was analyzed using LabChart software to determine values of time domain and frequency domain measures of HRV.

Results: There were no significant differences in any HRV measures in the concussion history group compared to the no concussion history group. Similarly, there were no differences in HRV for collision sport athletes (ice hockey) compared to limited contact sport athletes (soccer, volleyball, basketball) in pre-compared to post-season. At baseline, LF and the LF/HF ratio were lower in athletes on birth control (BC) compared to those not on BC (p < .05). HF was higher in athletes on BC compared to those not on BC (p < .05). Lower median RR (ms) was observed in the pre-season compared to the post-season; however, this difference was not statistically significant (p = .058). Additionally, lower LF (nu) was observed in the post-season compared to the pre-season; however, this difference was not statistically significant (p = .077).

Conclusions: These findings suggest that there are tendencies for lower sympathetic control of HR and lower resting HR in the post-season, likely due to cardiovascular training associated with playing a season of sport. In addition, differences in HRV measures were observed in association with birth control, suggesting that birth control may decrease sympathetic control and increase parasympathetic control of HR. Further research is necessary to understand potential relationships between autonomic control and concussion history.
Predicting Recovery after Mild Traumatic Brain Injury

James Booker¹, Rajiv Singh², Saurabh Sinha², Kishor Choudhari², Jeremy Dawson³
¹Sheffield Institute of Translational Neuroscience, Sheffield, England, ²Sheffield Teaching Hospitals, Sheffield, England, ³University of Sheffield Management School, Sheffield, England

Background: Mild Traumatic Brain Injury (MTBI) is often treated as a homogenous group in current practice. Stratifying patients more accurately may result in the implementation of more effective, individualised treatment. This study aimed to identify prognostic indicators of recovery one-year following MTBI.

Methods: Using a prospective, observational study design, a large MTBI population (N = 596) was recruited following admission to the Emergency Department. Data was collected at brain injury clinics between August 2011 and July 2015. Functional recovery at one-year was assessed using the Glasgow Outcome Scale-Extended (GOSE).

Results: A follow-up rate of 92% was achieved. The most common aetiologies of MTBI were falls (n = 222) and road traffic collisions (n = 154). Distribution of Glasgow Coma Scale (GCS) was 15 (n = 363), 14 (n = 156) and 13 (n = 77). Multinomial logistic regression of the GOSE found that psychiatric history (p < 0.001), alcohol intoxication (p = 0.011), assault (p = 0.022) and GCS < 15 (p = < 0.001), led to worse outcome. An abnormal CT scan was not a predictor of functional recovery.

Conclusion: Our findings indicate that after MTBI, patients with previous psychiatric history, GCS < 15, aetiology of assault and alcohol intoxication result in worse long-term outcomes. Future work into developing a full prognostic model for MTBI may help to tailor individual treatment and improve long-term outcomes.
BrainSTEPS-Return to Learn Concussion Management Team Training Intervention Course and Toolkit: An Effective Academic & Symptom Progress Monitoring Model for to Support Student Recovery for All Schools Across Pennsylvania and Colorado

Brenda Eagan-Johnson¹, Janet Tyler²
¹The BrainSTEPS Program, Pittsburgh, United States, ²Colorado Department of Education, Denver, United States

Striking a balance between the need for rest to promote recovery yet keeping up with academic content is the greatest struggle for students and teachers following concussion. School staff who understand concussion and regularly implement symptom-based academic supports, promote student recovery and lessen symptoms caused by cognitive over-exertion.

Pennsylvania’s Statewide BrainSTEPS Brain Injury School Consulting Program originally created the internationally recognized Return to Learn Concussion Management Team (RTL CMT) intervention training model in 2013 to assist students returning to school after experiencing a concussion. The RTL CMT model was revised in 2017 based on stakeholder feedback and newly available research, in conjunction with Colorado’s Department of Education, who adopted the full BrainSTEPS model statewide in 2016. Schools (public, charter, private, cyber, parochial) in both Pennsylvania and Colorado now have access to the online RTL CMT intervention training model and regional BrainSTEPS Teams for ongoing support. The RTL CMT training is a 5.5 hour online, asynchronous module-based training course. To date, over 2,000 teams have been trained. The RTL CMT model supports all students, both athletes and non-athletes. This model is easily accessed by school personnel, is extremely well-received in both states, and is showing promising results regarding increases in knowledge and efficacy.

This two-state model was created by educators to ensure school personnel are empowered to support students with concussions. RTL CMTs serve as the 1st layer of student support following concussion at the school-building level by implementing immediate academic adjustments for the initial 4-6 weeks and regularly monitoring academics and symptoms to justify all educational decisions. Students who do not recover between 4-6 weeks are referred to the higher level regional BrainSTEPS Consulting Teams for protracted support.

Students are monitored using a carefully curated electronic Concussion Monitoring Toolkit that includes an academic monitoring tool, a symptom monitoring tool, various individualized teacher academic supports letters, two state Department of Education endorsed Return to Learn Protocol, and more. RTL CMTs evaluate data from Academic and Symptom Monitoring Tools weekly to make decisions regarding the need to increase or decrease academic supports. Collected academic and symptom data is required to implement, adjust, and end concussion academic supports as well as to validate the need for more intensive, formal educational supports over time. Having supportive school staff who understand the nuances of concussion and school issues ultimately promote the emotional health and well-being of concussed students during recovery. Furthermore, RTL CMTs promote communication and collaboration between parents, students, health care providers and teachers. This model enables the concussed student to remain in school during recovery due to supportive school staff processes. The presenters will discuss how this model is easily replicable in other states and countries. Collected data will be shared with attendees.
Case Studies: How Late Term Effects of Treatment Impact Children in School After Treatment for CNS Tumors

Sharon Grandinette

Exceptional Educational Services, Redondo Beach, United States

This session will follow the path of 2 children diagnosed and treated for CNS tumors and the impact that late effects of treatment had on their neurological functioning as it relates to their education, as well as their physical, social and emotional functioning. Strategies for collaborating with treating neuro-oncologists and physicians to assure successful school reintegration and supports will be included.
Self- and Informant-Reported Subjective Complaints in Older Adults with Traumatic Brain Injury: Preliminary Data from A Longitudinal Cohort Study

Simon Beaulieu-Bonneau1,2, Claire Vallat-Azouvi3,4, Philippe Azouvi4,5, Marie-Christine Ouellet1,2,6
1Université Laval, Québec, Canada, 2Centre interdisciplinaire de recherche en réadaptation et intégration sociale, Québec, Canada, 3Université Paris 8, Saint-Denis, France, 4Hôpital Raymond Poincaré, Garches, France, 5Université de Versailles Saint-Quentin, Versailles, France, 6Centre de recherche du CHU de Québec-Université Laval, Québec, Canada

Objectives: The incidence of traumatic brain injury (TBI) is rapidly increasing in older adults, yet the consequences of such injuries on elderly persons and their caregivers are still understudied. The objectives of this project were (1) to document self- and informant-reported subjective complaints in older adults with TBI including discrepancies in perception of problems, and (2) to explore the link between discrepancies and self-reported cognition, depression, and anxiety.

Methods: This project is part of an on-going longitudinal cohort study on mental health after TBI in the elderly. Participants were elders who sustained a TBI and were hospitalized in a Level I trauma center in Québec, QC, Canada, and relatives who were the primary non-professional support providers of the injured persons. The preliminary sample included 25 elders with TBI (mean age = 72.9 ± 5.9 years; 26% women; 46% mild, 30% complicated mild, 23% moderate/severe TBI) and 17 relatives (mean age = 64.2 ± 13.9 years) who completed the four-month questionnaire. The main outcome measure was the Brain Injury Complaint Questionnaire (BICoQ), a 25-item instrument (with self- and informant-reported versions) measuring the presence/absence of a wide range of cognitive, behavior, fatigue/sleep, mood, and somatic problems. Both elders and relatives also completed the MOS Cognitive Functioning Subscale (MOS-COG) and the Hospital Anxiety and Depression Scale (HADS).

Results: Four months post-TBI, injured older adults reported, on average, 7.3 ± 5.7 complaints on the BICoQ. The most common complaints were slowness (68% of sample), fatigue (52%), increased sleep (52%), need for calm (52%), and concentration problems (48%). For the 15 pairs of older adults and relatives who both completed the BICoQ, the correlation between the two versions was high (r = .71, p = .003). For 27% of the items overall, the relative reported the symptom as present while the injured elder reported the symptom as absent, suggesting a lack of awareness by the patient, whereas the opposite pattern was observed for only 10% of the items. Memory problems were endorsed by relatives but denied by older adults with TBI in 46% of cases. A higher number of item discrepancies between self- and informant versions of the BICoQ was significantly associated with poorer cognitive functioning on the MOS-COG in the elders with TBI (r = -.52; p = .046), and higher anxiety symptoms on the HADS in the relatives (r = .59; p = .021).

Conclusions: Subjective complaints are common in older adults four months after TBI. While there is a strong association between the number of problems reported by injured elders and close relatives, discrepancies are common, especially for memory problems. The perspectives of both elders and relatives should be considered when assessing symptoms, as discrepancies may suggest the presence of other problems.
The Influence of Hormonal Contraceptives on Concussion Outcomes in Collegiate Athletes: Data from the NCAA-DoD CARE Consortium

Jacob Kay¹, Andrew Lapointe², Thomas McAllister³, Michael McCrea⁴, Steven Broglio², R. Davis Moore¹, CARE Consortium Investigators

¹University of South Carolina, Columbia, United States, ²University of Michigan, Ann Arbor, United States, ³Indiana University School of Medicine, Indianapolis, United States, ⁴Medical College of Wisconsin, Milwaukee, United States

Introduction: Research indicates that sex may moderate concussion recovery, with females appearing to experience poorer outcomes than males. It has been hypothesized (hormonal withdrawal hypothesis) that greater withdrawal of sex hormones in women leads to poorer outcomes. Based on this hypothesis, female athletes taking hormonal contraception should exhibit better recovery profiles as their hormone levels are artificially stabilized. Accordingly, the purpose of this study was to longitudinally examine the relation between hormonal contraceptives (HC) and concussion outcomes. We hypothesized that athletes taking hormonal contraceptives would exhibit faster recovery times, less severe clinical symptoms, and better neurological status and cognitive health, than athletes not taking hormonal contraceptives.

Methods: During the 2014-2017 academic years, data were collected from 30 NCAA universities and military service academies as part of the Concussion Assessment, Research, and Education (CARE) Consortium. Baseline assessments were completed prior to the beginning of the sport season for all athletes. Athletes were re-assessed 24-48 hours post-concussion, and again when they were granted unrestricted return-to-play. Length of recovery was defined as days between injury and unrestricted return-to-play. Clinical symptoms were measured using the Sport Concussion Assessment Tool (SCAT) symptom checklist, mental health was measured using the Brief Symptom Inventory-18 (BSI-18), neurological status was measured using the Standardized Assessment of Concussion (SAC), and cognitive function was measured using the ImPACT computerized test battery. Females who sustained a concussion were separated into those who were (HC+; n=50) and were not (HC−; n=50) taking hormonal contraception. Participants were matched on age, sex, body mass index, sport contact level, and concussion injury characteristics.

Results: No group differences in length of recovery were observed (p > .05). Analyses revealed main effects of group for concentration (SAC; p = .04), verbal memory (ImPACT; p = .03), and cognitive efficiency (ImPACT; p = .01); suggesting that across all timepoints females on hormonal contraceptives exhibited better concentration, working memory, and cognitive efficiency. No significant interaction effects were observed.

Conclusions: The current results indicate that hormonal contraceptives do not influence recovery time or outcomes following concussion. However, our results indicate that hormonal contraception may confer a general cognitive benefit, irrespective of injury status.
The Effect of Vestibulo-Ocular Dysfunction on Clinical Recovery Times Following Pediatric Concussion

Elizabeth Teel\textsuperscript{1}, Christine Beaulieu\textsuperscript{1}, Debbie Friedman\textsuperscript{1}, Lisa Grilli\textsuperscript{1}, Luke Hong\textsuperscript{1}, Stephanie Mackenzie\textsuperscript{1}, Isabelle Gagnon\textsuperscript{1}

\textsuperscript{1}McGill University, Montreal, Canada

Background: High rates of vestibulo-ocular (VO) dysfunction are reported following pediatric concussion. However, VO assessments are often not part of routine clinical care and most available research is cross-sectional. Therefore, the effect of VO deficits on total recovery and rehabilitation times in pediatric populations is unknown. Objectives: To determine if individuals with VO dysfunction have longer clinical recovery and rehabilitation times than individuals with no VO deficits. Design: Prospective cohort. Setting: Specialty concussion clinic at a tertiary care pediatric hospital.

Participants: Ninety-eight children and youth (56 males, 42 females, age= 14.28 ± 2.18) presented to the mTBI clinic between June and October 2018. Intervention: The Vestibular/Ocular Motors Screening (VOMS) is a brief assessment of the following domains: (1) smooth pursuit, (2) horizontal and vertical saccades, (3) convergence, (4) horizontal vestibular ocular reflex, and (5) visual motion sensitivity. Patients rate headache, dizziness, nausea, and fogginess symptoms on a scale of 0 (none) to 10 (severe) before and after each domain. Physiotherapists performed a clinical examination, including the VOMS, on all patients at their first clinic visit. VOMS findings were abnormal if the clinician observed gross VO dysfunction (e.g. nystagmus, posture) or if the patient self-reported symptom exacerbation. Rehabilitation exercises (e.g. physical activity, vestibular, etc.) were prescribed as indicated by the clinical examination. Patients were followed longitudinally until full discharge, which occurred when children had symptom resolution, full return to school, and successful completion of an exertion protocol. Outcomes

Measures: Time to full clinical recovery (days between concussion and discharge) and total rehabilitation time (days between rehabilitation initiation and discharge). Analysis: Cox proportional hazard models analyzed the effect of VO dysfunction on clinical recovery and rehabilitation times. Individuals who dropped out of the clinic prior to full discharge were censored at the date of their last clinic visit. Age, sex, post-injury symptoms, and concussion history can significantly delay recovery; statistical models controlled for these covariates.

Results: A total of 25 (25.5%) children and youth presenting to the clinic (abnormal VOMS= 38.7 ± 40.3 days post-injury, normal VOMS= 28.0 ± 46.3 days post-injury; p=0.45) had at least one abnormal finding on the VOMS. Abnormal VO findings were associated with significantly longer clinical recovery (p=0.006; Hazard Ratio: 2.37, 95% CI: 1.28-4.41) and rehabilitation time (p=0.03; Hazard Ratio: 1.97, 95% CI: 1.08-3.62).

Conclusions: Abnormal VO findings were associated with significantly longer clinical recovery and rehabilitation times. No significant differences were found for time to presentation to clinic, suggesting that longer overall recovery for individuals with VO dysfunction are driven by the length of rehabilitation necessary to reach resolution of post-concussion deficits. Earlier identification of VO deficits and rehabilitation referrals may speed recovery timelines and improve quality of life following pediatric concussion.
The Effect of Sex, Age, Concussion History, and Symptom Severity on Anti-Saccades in Children and Youth with mTBI

Dakota Treleaven1, Elizabeth Teel1, Christine Beaulieu2, Debbie Friedman2, Lisa Grilli2, Luke Hong2, Stephanie Mackenzie2, Isabelle Gagnon1,2

1McGill University, Montreal, Canada, 2McGill University Health Centre, Montreal, Canada

Background: Mild traumatic brain injury (mTBI) is a prevalent injury in pediatric populations that can result in subjective symptoms and objective balance and cognitive deficits. Emerging research has detailed the effect of mTBI on visual outcomes, with poorer performance observed following mTBI. Of particular interest is anti-saccadic eye movement, which requires high-level cognitive function as inhibitory pathways are required to complete anti-saccade assessments. Previous research has shown sex, age, concussion history, and post-concussion symptom severity influences clinical balance and cognitive testing post-injury, but the influence of these factors on anti-saccadic eye movement in children with mTBI has been unexplored.

Objective: To determine if sex, age, concussion history, or symptom severity influence anti-saccadic eye movements in children and youth with mTBI.

Design: Prospective cohort.

Setting: Specialty concussion clinic in a tertiary care pediatric hospital. Participants: A total of 80 patients (Males: 33, Females: 47; age: 14.3 ± 2.2) presented to the clinic between June and October 2018 and were being provided treatment at the time of testing.

Intervention: Sex, age, concussion history, and symptom severity were gathered during clinical intake. Anti-saccadic eye movement was captured using the Saccade Analytics’ Advanced Nystagmus SystemTM by flashing a target in a dark field on the horizontal meridian. Patients were directed to ignore the flashed target and orient as quickly as possible to the mirror image, approximately the same distance on the opposite side of the meridian. Each patient completed twelve repetitions of the anti-saccade assessment.

Outcomes Measures: Mean directional accuracy (%), response time (ms), and acquisition error (°) generated from the anti-saccade assessment.

Analysis: Categorical outcomes (sex and concussion history) were analyzed using independent sample t-tests. Continuous outcomes (age and symptom severity) were analyzed using linear regression. Log transformations were performed on continuous variables as needed to meet the assumption of normality.

Results: Age was significantly related to acquisition error (F(1,77)=8.93, p=0.004) and directional accuracy (F(1,77)=4.09, p=0.05), with older participants having better accuracy and fewer errors than younger participants. No significant findings existed between age and mean reaction time (F(1,77)=3.71, p=0.06). Sex (p>0.55), concussion history (p>0.21), and symptom severity (p>0.59) were not significantly related to any anti-saccade outcome.

Conclusions: Age was significantly related to anti-saccade outcomes. Older children had improved performance over younger children, with similar findings reported in healthy cohorts. Age, concussion history, and symptom severity are known to influence a number of clinical post-concussion assessments, which limits their utility. These factors were not related to anti-saccadic outcomes and may enhance the
clinical usefulness of eye movement assessments in pediatric mTBI care. Future studies should continue to characterize eye movement dysfunction in children and youth with mTBI and track the evolution of these deficits over time.
Pathways to Recovery: Developing Community Partnerships and Solution-Focused Interventions to Link Marginalized and Underserved Individuals to Brain Injury Rehabilitation.

Gillian Murray1, Claire Sitarz1
1Mossrehab, Philadelphia, United States

Many healthcare professionals and survivors are unaware of the impact of Traumatic Brain Injury and how to access available funding resources and treatment within their communities. Persons with TBI are often referred to healthcare providers who lack experience in treating TBI, resulting in an interruption in the continuum of care or leading to misdiagnosis. There are certain marginalized populations who appear to be more vulnerable to TBI than others. This innovative program targeted two marginalized populations: individuals receiving services for intimate partner violence and individuals re-entering the community after incarceration. The purpose of this program was to train other professionals to screen and identify individuals with a history of TBI within their respective populations. The program goals were two-fold: develop community partnerships with agencies serving these populations and assist in linking their client populations to TBI treatment. Professionals affiliated with these agencies received psychoeducation about TBI, training on how to screen for TBI, and information on linking appropriate individuals to available funding for TBI rehabilitation. Additionally, the program provided Certified Brain Injury Specialists to meet with individuals at agency sites to assist in applying for funding for brain injury rehabilitation. The process and results of this program will be discussed.
Establishing the Test-Retest Reliability of Contralateral Auditory Suppression of Transient Evoked Oto-Acoustic Emissions in A Cohort of Normal Healthy Individuals for the Purpose of Developing an Evaluation Tool for Concussion

Indika Mahawattage

1University of Prince Edward Island, Charlottetown, Canada

In clinical practice, transient evoked otoacoustic emissions (TEOAE) are used to assess hearing impairments in several cohorts. The TEOAE can be evoked in the healthy cochlea by presenting a brief auditory stimulus in the form of a series of clicks. Similarly, TEOAE signals can be suppressed in the ipsilateral ear by presenting an alternative sound to the contralateral ear through stimulation of either the medial olivocochlear (MOC) reflex or acoustic reflex (AR). The suppression effect resulting from the introduction of a contralateral auditory stimulus is called the CASTEOAE. In individuals that suffer a brain injury, such as a concussion, the neuronal pathways that enable CASTEOAE may be disturbed which in turn will restrict the ability to invoke the contralateral suppression effect. Moreover, since a person performing the test cannot manipulate TEOAE signals, the technique could provide an objective measure of concussion status and severity.

This study was designed to measure the test-retest reliability of the CASTEOAE as the first step in establishing the CASTEOAE phenomenon as an evaluation tool for concussion assessment. A convenience sample of 30 healthy individuals, 16-40 years of age completed the CASTEOAE test on two separate occasions, using a 14-day between test interval. The MOC reflex was activated using broadband noise = 60 dB SPL in the contralateral ear. The Acoustic Reflex was activated by combining a stimulus click rate of 60 dB SPL in the ipsilateral ear while concomitantly presenting a broadband noise of 80 dB SPL to the contralateral ear. The test was conducted across 5-octave bands for each ear. Test-retest reliability was estimated with the intraclass correlation coefficient procedure using a one-way random effects model for n=30, k (trials)=2. Confidence intervals for the intraclass correlation coefficients (ICC) and measures of homogeneity of variance were also calculated for each condition.

Reliability estimates for CASTEOAE test scores were calculated for the TEOAE scores with and without contralateral suppression of the MOC reflex and separately for the Acoustic Reflex. ICCs for the MOC reflex ranged from 0.6 (left ear @1000 Hz) to 0.95 (right ear @ 4000 Hz), and 0.75 (left ear @1000 Hz) to 0.97 (right ear @ 4000 Hz) for the AR. These data suggest that the MOC and AR reflexes were each significantly repeatable upon test and retest in the sample. In addition, the suppression effect of the acoustic reflex was greater than MOC reflex; and each participant showed unique TEOAE distribution patterns across the 5 frequency 1/2octave bands, which were consistent over time. The results support the use of the CASTEOAE test as a reliable non-invasive approach to evaluate the functional status of the auditory system and also as a clinical tool to assess concussion injury.
Feasibility of Ballistic Strength Training in Sub-Acute Stroke: A Randomized, Controlled, Assessor-Blinded Pilot Study

Gavin Williams¹, Genevieve Hendrey³, Ross Clark⁵, Anne Holland³
¹Epworth Hospital, Richmond, Australia, ²The University of Melbourne, Melbourne, Australia, ³La Trobe University, Bundoora, Australia, ⁴Caulfield Hospital, Caulfield, Australia, ⁵University Sunshine Coast, Sippy Downs, Australia

Aim: To establish the feasibility and effectiveness of a six-week ballistic strength training protocol in people with stroke.

Design: Randomized, controlled, assessor-blinded study.

Method: Consecutively admitted inpatients to sub-acute rehabilitation with a primary diagnosis of first ever stroke with lower limb weakness, functional ambulation category score of ≥3, and ability to walk ≥14m were screened for eligibility. Thirty participants (11% of those screened) with mean age of 50 (SD 18) years were randomized to usual care or ballistic strength training three times per week for six weeks. The primary aim was to evaluate feasibility, and outcomes included recruitment rate, participant retention and attrition, feasibility of the exercise protocol, therapist burden and participant safety. Secondary outcomes included measures of mobility, lower limb muscle strength, muscle power, and quality of life.

Results: The median number of sessions attended was 15/18 and 17/18 for the ballistic and control groups respectively. Earlier than expected discharge home (n=4) and illness (n=7) were the most common reasons for non-attendance. Participants performed the exercises safely, with no study-related adverse events. There were significant (p<0.05) between-group changes favoring the ballistic group for comfortable gait velocity (95% confidence interval CI: 0.08 to 0.52m/s), and muscle power, as measured by peak jump height (95% CI: 3 to 13cm) and peak propulsive velocity (95% CI: 17 to 112cm/s).

Conclusion: Ballistic training was safe and feasible in select ambulant people with stroke. Similar rates of retention and attrition suggest that ballistic training was acceptable to patients. Secondary outcomes provide promising results that warrant further investigation in a larger trial.
Impaired Ankle Joint Mechanics During Running Can Be Resolved in People with Traumatic Brain Injury

Gavin Williams¹,², Anthony Schache²
¹Epworth Hospital, Richmond, Australia, ²Melbourne University, Melbourne, Australia

Objectives: 1) To compare lower-limb joint mechanics during running for people with traumatic brain injury (TBI) to equivalent data obtained from a group of healthy controls (HC); and 2) To determine if deficits identified in biomechanical variables during running for people with TBI were responsive to a six-month period of rehabilitation.

Methods: Running analysis was conducted for 12 people with extremely-severe TBI who were attending a large metropolitan rehabilitation hospital for mobility limitations, and a comparative sample of 10 HCs at baseline and six-month follow-up. Main Measures: Average power absorbed and generated at the hip, knee and ankle joints during stance.

Results: Compared to HCs, participants with TBI at baseline ran with greater average power absorption at the hip (-0.27 W/kg vs -0.61 W/kg; p<0.05), reduced average power absorption at the knee (-2.03 W/kg vs 1.02 W/kg; p<0.05) and reduced average power generation at the ankle (2.86 W/kg vs 2.06 W/kg; p<0.05). Only average power generation at the ankle improved following six months of rehabilitation for the participants with TBI (2.06 W/kg vs 2.79 W/kg; p<0.05).

Conclusion: In this cohort of participants with TBI, recovery of running and high-level mobility was related to an improvement in ankle joint mechanics.
Lower-Limb Angular Velocity During Walking at Various Speeds

Gavin Williams¹,², Ben Mentiplay³, Ross Clark⁴, Michelle Kahn¹,⁴, Megan Banky¹,⁴

¹Epworth Hospital, Richmond, Australia, ²Melbourne University, Melbourne, Australia, ³La Trobe University, Bundoora, Australia, ⁴University of Sunshine Coast, Sippy Downs, Australia

Aim: Although it is well established that lower limb joint angles adapt to walking at various speeds, limited research has examined the modifications in joint angular velocity. To examine lower limb joint angles and angular velocities in a healthy population walking at various gait speeds.

Method: Thirty-six healthy adult participants underwent three-dimensional gait analysis while walking at various speeds during habitual and slowed walking. The peak joint angles and angular velocities during important phases of the gait cycle were examined for the hip, knee and ankle in the sagittal plane. Data were grouped in 0.2m/s increments from 0.4m/s to 1.6m/s to represent the range of walking speeds reported in studies of people with gait impairments.

Results: For joint angles and angular velocities, the shape of the gait data was consistent regardless of the walking speed. However as walking speed increased, so did the peak joint angles and angular velocities for the hip, knee and ankle. The largest angular velocity occurred when the knee joint extended at the terminal swing phase of gait. For the ankle and hip joint, the largest angular velocity occurred during the push-off phase.

Significance of the findings to allied health: This study examined how lower limb joint angular velocities change with various walking speeds. This data can be used as a comparator for data from clinical cohorts and has the potential to be used to match clinical assessment and treatment methods to joint angular velocity during walking.
A Histopathological Study of Pontosubicular Neuron Necrosis: Consideration of Neuronal Cell Death in Perinatal Brain Damage

Masayuki Itoh

National Center of Neurology and Psychiatry, Kodaira, Japan

Background: Perinatal hypoxic–ischemic brain damage is a major cause of neuronal and behavior deficits, in which the onset of injury can be before, at or after birth, and the effects may be delayed. Pontosubicular neuron necrosis (PSN) is one of perinatal hypoxic–ischemic brain injury and its pathological peculiarity is neuronal apoptosis. In this study, we investigated whether apoptotic cascade of PSN used a caspase-pathway or not, and whether hypoglycemia activated apoptosis or not.

Methods: Sections of the pons of PSN with and without hypoglycemia were stained using terminal deoxynucleotidyl transferase-mediated deoxyuridine triphosphate nick end labeling (TUNEL) and immunohistochemistry for glial fibrillary acidic protein (GFAP), Bcl-2, Bcl-x and activated caspase 3. Additionally, we performed immunoblot analysis of Bcl-2, Bcl-x and activated caspase 3.

Results: TUNEL-positive cell was closely associated with the presence of karyorrhexis. Under combination of karyorrhectic and TUNEL-positive cells, number of apoptotic cells in premature brains was significantly more than in mature brains.

Conclusion: Hypoxic–ischemic brain injury was considered to easily lead to apoptosis in premature infants. Moreover, as this pathophysiology, caspase-pathway activation contributed to neuronal death from caspase-immunoexpression analyses. PSN with hypoglycemia showed large number of apoptotic cells and higher expression of activated caspase 3. The result may be more severe with the background of hypoglycemia and prematurity complicated by hypoxia and/or ischemia.
Cognitive Reserve and Age Predict Cognitive Recovery Following TBI

Jennie Ponsford1,2, Elinor Fraser1,2, Marina Downing1,2, Kathryn Biernacki2,3, Dean McKenzie2
1School of Psychological Sciences, Monash University, Clayton, Australia, 2Monash Epworth Rehabilitation Research Centre, Epworth Healthcare, Richmond, Australia, 3Centre for Molecular and Behavioral Neuroscience, Rutgers University, Newark, United States

Background and Objectives: Cognitive impairments are common and disabling after TBI. Whilst numerous studies have examined predictors of outcome including cognitive performance at a single time-point after injury, little is known of factors associated with cognitive recovery. This longitudinal study examined the association of age, IQ and PTA duration with cognitive recovery 2-5 years following TBI.

Methods: 107 individuals with mild to severe TBI, Mage 44.38 years, Meduc 14.04 years, MPTA = 21.66 days and MIQ 109 were assessed early post-injury and reassessed an average 44.65 months post-injury. A matched healthy control group (n=63) with Mage 46.92 years, Meduc 13.34 years, and MIQ 107.21 completed measures once. Measures included the NART (premorbid IQ), Digit Symbol Coding (DSCT) (processing speed), RAVLT (memory) and Trail Making Test Part B (TMT-B) (executive function). Regression analyses were used to examine predictors of cognitive recovery.

Results: Participants with TBI performed significantly worse than controls on all measures (all p<.001), and age, PTA and IQ were significant predictors of performances on all tasks at initial assessment. Performances improved significantly in the TBI group at follow-up. Premorbid IQ was associated with gains on all measures, after accounting for initial performance (β = 0.35, p < .001), RAVLT (β = 0.22, p < .05), and TMT-B (β = −0.43, p < .001). Age was associated with gains on DSCT (β = −0.35, p < .001) and TMT-B (β = 0.28, p < .05). PTA duration was not significantly associated with cognitive recovery on any measure.

Conclusions: Findings support the contention that cognitive reserve and to a lesser extent age determine degree of long-term cognitive recovery following TBI.
Toward a Culture of Informed Everyday Ethics in Community ABI Services

Clare Brandys¹,², Diana Brouwer¹, Lisa Bolshin¹, Marnie Russell¹, Judy Moir¹, Marisa Chaves¹
¹Community Head Injury Resource Services, Toronto, Canada, ²University of Toronto, Toronto, Canada

Clinical work in community settings with clients who have sustained moderate-severe ABI can create ethical conflicts for the client and treatment team. Challenges arise in balancing clients’ wishes with risks inherent with cognitive and behavioural problems. Often, moderate-severe ABI affects memory, judgement, awareness, impulse control, and other abilities critical for sound decision-making. Complications relate to the nature of ABI itself, its sudden onset, chronicity, younger ages at injury, effects of the injury impacting the individual’s insight and personal identity, and reliance on multiple professionals and caregivers. Risks of poor decision making include financial, social, and other personal harms which can place professionals in conflict in carrying out responsible service.

Objective: A coherent model of ethical decision-making was sought by a multi-disciplinary team at Community Head Injury Resource Services. The model and the steps toward refining a process to address issues arising in community ABI practice are described.

Methods: The model of ethical decision-making described by the Community Ethics Network (Boulanger et al, 2014) was adapted for needs of the ABI population in community treatment. The process follows a structured framework and emphasizes discussion of relevant cognitive and behavioural issues, client and staff perspectives, and current context. This decision-making process involves four steps: 1) front-line staff identify ethical dilemmas, then 2) teams work together to analyze ethical principles, 3) weigh options, and 4) arrive at a solution. This model has been employed and refined at CHIRS over a four-year period and two reviews were undertaken to analyze its impact. The first was a pilot survey of users rating their outcome satisfaction and effectiveness of the process. The second review is an ongoing ethics needs assessment survey of front-line clinicians.

Results: An innovative model of Everyday Ethics for ABI community practice was developed. To date, a total of 78 ethical dilemmas have been reviewed using this model. This model follows the notion of “bottom up” ethical decision making, which encourages front-line staff’s involvement and more direct moral responsibility. Analysis of surveys reveals that CHIRS staff are highly satisfied with the outcome of the ethical decision-making process (90%) and view the process as effective (95%).

Discussion: Ethical issues in ABI community treatment are not typically “life and death”, but rather everyday dilemmas relating to behaviours or lack of behaviours in social, personal care, and community interactions. CHIRS decision making process has been an effective, objective tool in analyzing complex ethical situations and arriving at balanced decisions. Ongoing evaluation includes current surveys of CHIRS rehabilitation facilitators using the Clinical Ethics Needs Assessment (Hamilton Health Sciences, 2012). This evaluation process continues to inform our goal of increasing our culture of everyday ethics and improving education on ethical decision making.
Goal Management Training in Patients with Acquired Brain Injury – A 5-Year Follow-Up Study: Be Reminded to Use It or Lose It

Sveinung Tornås1, Marianne Løvstad1,2, Anne-Kristin Solbakk1,2,3, Anne-Kristine Schanke1,2, Jan Stubberud4
1Sunnaas Rehabilitation Hospital, Bjørnemyr, Norway, 2University of Oslo/Department of Psychology, Oslo, Norway, 3Helgeland Hospital/Department of Neuropsychology, Mosjøen, Norway, 4Lovisenberg Diocesan Hospital, Oslo, Norway

Objectives: Goal Management Training® (GMT) is a standardized compensatory cognitive rehabilitation intervention that relies on verbally mediated, metacognitive strategies for improving executive functioning (EF) in daily life. In a previous randomized controlled trial (RCT), patients with acquired brain injury (ABI) received either 16 hours of GMT or 16 hours of a psycho-educative active control condition; Brain Health Workshop (BHW). Goal Management Training came out as the superior intervention for improving self-reported EF, with effects lasting six months post-treatment. The aim of the present study was to determine five years outcome following GMT, hypothesizing that GMT still would be associated with improved EF in everyday living.

Methods: The five-year follow-up consisted of four questionnaires from the initial study, including the Behavior Rating Inventory of Executive Function (BRIEF-A) to assess EF in daily life. Of the 67 participants at six months follow-up, 49 (GMT n=20; BHW n =29) returned written consent and questionnaires (46% female, age 45.8 ± 10.9 years). Changes related to EF in daily life (i.e. BRIEF-A) were assessed at pre-treatment (T1), post-treatment (T2), six months follow-up (T3), and five-year follow-up (T4). As such, data were analyzed using a 2 X 4 mixed-design ANOVA that treated group (GMT, BHW) as a between-subjects factor, and Time (T1, T2, T3, T4) as a within-subjects factor. Significance level was set to p ≤.05.

Results: Preliminary data showed no significant group differences with regard to age (GMT: 44.5 (SD 12.6); BHW: 46.7 (SD 9.5)), sex (GMT: 43% female; BHW: 48% female), years of education (GMT: 13.5 (SD 2.6); BHW: 13.5 (SD 2.5)) and IQ (GMT: 107.7 (SD 12.7); BHW: 102.9 (SD 12.9). Furthermore, no significant treatment-related reduction in self-reported symptoms of executive dysfunction were observed on any of the three main indexes of the BRIEF-A.

Conclusions: Preliminary data from 49 patients receiving either GMT or an unspecific psychoeducational service indicated that the significant GMT-related improvements on perceived EF in everyday life that were observed at six months follow-up, were no longer present after five years. These findings indicate the importance of long-term follow-up of clinical interventions as part of evidence-based recommendations. Furthermore, the findings might suggest a need to explore the effect of “booster” sessions at regular intervals post treatment to maintain potential treatment gains.
Observing Saccadic and Anti-Saccadic Function Following mTBI Using Novel Technology: A Pilot Study

Adrienne Crampton¹, Elizabeth Teel¹, Christine Beaulieu², Debbie Friedman²,³, Lisa Grilli², Luke Hong², Stephanie Mackenzie², Isabelle Gagnon¹,²

¹McGill University, Montreal, Canada, ²The Montreal Children’s Hospital (McGill University Health Center, Trauma Centre), Montreal, Canada, ³Canadian Hospitals Injury Reporting and Prevention Program, , Canada

Background: Oculomotor (OM) abnormalities are frequent in children and youth with mild traumatic brain injury (mTBI), with rates reported as high as 60-90%. The diffuse nature of mTBI affects complex neural networks and various cortical and subcortical structures of the brain, many of which contribute to OM function. Particularly, saccades and antisaccades are OM functions contributing to versional ocular motility often affected post-mTBI. Though certain clinical assessments exist to evaluate these functions, there is a need for objective tools that can quantify OM changes in children to better understand their evolution, orient rehabilitation, and optimize overall recovery.

Objectives: To evaluate changes in saccadic and anti-saccadic function over the course of clinical recovery in pediatric mTBI patients using novel OM technology (Saccade Analytics’ Advanced Nystagmus System (ANS™)).

Design: Pilot cohort study with a pre-post design.

Setting: mTBI Program/Concussion Clinic at a tertiary care pediatric hospital.

Participants: Twenty-two youths (13.91 ± 2.09 yrs old, 10 males, 12 females) underwent visual assessment using the ANS™ upon admission and discharge to the clinic (time between admission and discharge assessment=35.36 ± 28.77days).

Intervention: The ANS™ tool (3D headset and associated software) was used to evaluate saccadic and antisaccadic function. Reflexive saccadic function was evaluated tool through a fixed-head acquisition of randomized flashed targets within the entire oculomotor range (vertical, horizontal, and diagonal targets). Participants were asked to orient to the flashed target as quickly as possible. Elements of antisaccadic function were captured through a flashed target in a dark field on the horizontal meridian. Participants are required to ignore the flashed target and orient as quickly as possible to the mirror image, approximately the same distance on the opposite side of the meridian. Twelve repetitions were completed during each assessment.

Outcome Measures: Mean saccadic latency and mean antisaccadic response time completed at admission (T1) and discharge (T2) evaluations.

Results: A total 15 (68%) participants improved their saccadic latency and 13 (59%) participants improved on anti-saccade mean reaction time over the course of clinical recovery. However, these results did not reach statistical significant for either mean saccadic latency (T1: 225.68 ± 15.93, T2: 220.72 ± 13.70; t21= 1.41; P=0.17) or mean antisaccadic response time (T1: 445.59 ± 95.64, T2: 420.95 ± 94.98; t21= 1.50; P=0.15).

Conclusion: Though there were no significant findings in this pilot study, the majority of individuals showed improvements on one or both variables of interest. This suggests that oculomotor function may change over
the course of clinical recovery in youth with mTBI. The use of the ANS™ tool allows quantification of OM changes thus enabling more precise observation. Further exploration of saccadic and antisaccadic function using this novel technology is warranted on a larger scale.
Subjective and Objective Burden and Psychological Symptoms in Close Relatives of Elderly Persons with Traumatic Brain Injury

Karèle Villeneuve1,2, Marianne Lévesques1,2, Simon Beaulieu-Bonneau1,2, Carol Hudon2,8, Elaine de Guise9,10,11, Marie-Josée Sirois3,4,6,7, Natalie Le Sage3,5, Marcel Emond3,6,7, Marie-Eve Lamontagne1,4, Marie-Christine Ouimet1,2,3

1Centre Interdisciplinaire de Recherche en Réadaptation et Intégration Sociale (CIRRIS), Québec, Canada, 2École de psychologie - Université Laval, Québec, Canada, 3Centre de recherche du CHU de Québec - Université Laval, Québec, Canada, 4Département de réadaptation - Université Laval, Québec, Canada, 5Département de médecine familiale et de médecine d’urgence - Université Laval, Montréal, Canada, 6Centre de recherche sur les soins et les services de première ligne de l’Université Laval (CERSSPL-UL), Québec, Canada, 7Centre d’excellence sur le vieillissement de Québec (CEVQ), Québec, Canada, 8Cervo - Centre de recherche, Québec, Canada, 9Département de psychologie, Université de Montréal, Montréal, Canada, 10Centre universitaire de santé McGill, Montréal, Canada, 11Centre de recherche interdisciplinaire en réadaptation du Montréal métropolitain (CRIR), Montréal, Canada

Objectives: Caregiver burden and distress are well documented in younger adults with traumatic brain injury (TBI) but not for elderly sustaining TBI (65 years and over). The objectives of this study were to: (1) describe subjective and objective burden and psychological symptoms (anxiety and depression) of close relatives of elderly persons with TBI four months post-injury, and (2) to explore if subjective burden is explained by age of the injured person, perceived social support, and subjective complaints relative to the injured elder.

Methods: Participants were 25 relatives of elders with TBI aged between 29 and 84 years (mean age = 65.3±13.6; 92% women; 56% spouses living with the injured elder; 20% children). Elders with TBI were aged 65-90 years and were admitted to a Level I trauma centre in Québec, Canada (32% mild, 44% complicated mild, and 24% moderate/severe TBI). The Zarit Burden Interview (ZBI) measured subjective burden. A checklist was used to assess objective burden (i.e., significant changes in activities or roles since the injury). Psychological symptoms of the close relative were assessed with the Hospital Anxiety and Depression Scale (HADS) using a cut-off>8 on either subscale to identify clinically significant symptoms. The participant’s perceived social support was measured with the Modified MOS Social Support scale. The Brain Injury Complaint Questionnaire (BICoQ) assessed a variety of problems and complaints observed by the relative regarding the injured person (e.g. memory, fatigue, motivation).

Results: Thirty-two percent of relatives presented mild-moderate subjective burden on the ZBI at 4 months post-injury and 8% presented moderate-severe burden. Almost all participants (91%) reported some form of objective burden (e.g. spending more time caring for their loved one or having less time for themselves). Regarding psychological symptoms, 16% of relatives presented significant depressive symptoms and 8% significant anxiety symptoms. In total 24% had either significant anxiety or depression. Subjective burden and psychological symptoms (total HADS) were strongly correlated (r=.62, p<.001). An exploratory multiple linear regression including the number of subjective complaints (BICoQ), age of the elder and social support significantly predicted subjective burden on the ZBI, (adjusted R²=.44). However, only the number of difficulties perceived in the injured elder (identified on the BICoQ) significantly contributed to predict subjective burden (β=.66, p=.001).

Conclusions: The present study shows that important proportions of close relatives of elderly persons with TBI report either anxiety or depression and perceive significant burden which is related to the injured elder’s ongoing issues. They take on new or increased responsibilities of support and care which are
essential to support the quality of life of the injured elderly person. Given the increasing incidence of TBI in the elderly, it is warranted to increase attention towards the wellbeing of their caregivers.
Physical Therapy Use Probabilities Across 10 Years After Moderate-To-Severe Traumatic Brain Injury

Nada Andelic1, Paul Perrin3, Helene Søberg2,4, Solrun Sigurdardottir5, Svein Berntsen6, Emilie Howe1,2, Mari Rasmussen1,2, Cecilie Røe1,2, Marit Forslund2

1Faculty of Medicine, University of Oslo, Oslo, Norway, 2Department of Physical Medicine and Rehabilitation, Oslo University Hospital, Oslo, Norway, 3Department of Psychology, Virginia Commonwealth University, Richmond, USA, 4Faculty of Health Science, Oslo Metropolitan University, Oslo, Norway, 5Department of Research, Sunnaas Rehabilitation Hospital Trust, Nesoddtangen, Norway, 6Department of Physical Medicine and Rehabilitation, Sørlandet Hospital, Kristiansand, Norway

Background: Traumatic brain injury (TBI) has physical consequences (e.g., loss of mobility, muscle strength, balance and walking ability) which often have long-term effect on daily functioning. Physical therapy (PT) plays an important role in the functional recovery and is frequently applied in the acute/sub-acute phases of injury. However, less is known about the use of PT in the later stages of injury and predictors of probability trajectories in a long-term perspective.

Aims: To examine probabilities and baseline predictors of PT use across 10 years after TBI.

Methods: Longitudinal observational study of 97 survivors who sustained moderate-to-severe TBI in 2005-2007 in the South-Eastern region of Norway. Socio-demographics and injury characteristics were recorded at baseline. PT use was recorded at 1-, 2-, 5- and 10-year follow-ups. Hierarchical linear modelling (HLM) was applied to examine PT use probabilities across the four time points. Time, gender, age, relationship status, education, pre-injury employment and occupation, cause of injury, GCS, duration of posttraumatic amnesia (PTA), CT findings (Marshall score), and injury severity score (ISS) were considered as predictors, as well as the interaction terms between time and the significant predictors.

Results: Overall, the use of PT deceased from 55 % at 1-year to 10 % at 10-year follow-up. The first HLM of PT use probabilities showed a significant cubic, or S-shaped, curve, suggesting a steep initial decrease up to 2 years after injury, plateauing, and then a final decrease. Gender, PTA, and CT severity score yielded statistically significant effects on participants’ PT use probability trajectories. Women (p = 0.003) and individuals with a longer duration of PTA (p < 0.001) had higher probability of PT use across the four time points. Finally, individuals with a higher CT severity score (more severe injury) had a lower probability of PT use (p = 0.02); however, on visual examination of the graph it seems this was a statistical suppressor effect due to low-to-moderate multicollinearity among the predictors devoid of substantive interpretation. A second HLM examined whether PT use probability trajectories could be predicted by the previously significant predictors (gender and PTA), as well as their interactions with cubic time. Neither of the interaction terms was statistically significant (all ps > 0.59), suggesting that PT use probabilities did not change differentially over time as a function of either these predictors.

Conclusion: This study presents a novel model for the probability of PT use following TBI. Findings can be applied to inform clinicians and decision makers on patients’ needs for PT from a long-term perspective.
Rehabilitation of Persons with Malignant and Non-Malignant Brain Tumours – Comparison of Rehabilitation Outcome

Klemen Grabljevec
University Rehabilitation Institute of Slovenia, Ljubljana, Slovenia

Introduction: Persons with brain tumours can experience a range of symptoms and disabilities, such as psychological problems, difficulties with mobility or self-care, relationship and work issues, which can substantially impact their quality of life. The mentioned symptoms may be amenable to interdisciplinary rehabilitation after surgical or other therapeutic interventions. However, the evidence base for this statement is unclear. At the University Rehabilitation Institute Ljubljana, we implemented a nationwide rehabilitation programme for persons after primary treatment of malignant and non-malignant brain tumours. The inclusion criteria for the programme is functional status described as 50 or more points according to Karnofsky scale and functionality deficits of the patient which demand a comprehensive, interdisciplinary and multiprofessional interventions.

Subjects and Methods: Medical files of 14 persons admitted for inpatient rehabilitation after primary therapy with non-malignant tumours and 18 persons with malignant tumours were reviewed. The primary parameters of observation were initial and discharge functional status with Functional Independence Measure (FIM) scale and Karnofsky performance scale, length of stay and location of discharge. We compared the parameters for patients in both groups. Study was approved by the hospital’s ethical committee.

Results: The most frequent types of tumour in group with non-malignant tumour were meningioma, pinealoma and ependymoma. Most frequent types of tumour in group with malignant tumour were glioblastoma, astrocytoma and glioma. Patients with malignant tumours were admitted to rehabilitation in shorter time after beginning of disease than those with non-malignant tumours (17.7 months vs. 25.4 months). There was not significant difference between groups in assessment on Karnofsky performance scale (55.0 vs. 57.4). The non-malignant tumours group had significantly better income / outcome score on FIM scale against group with malignant tumours (79.8 points / 94.6 points vs. 70.6 points / 75.5 points). Patients with malignant tumours were hospitalized significantly less time than patients with non-malignant tumours (24.5 days vs. 38.6 days). All patients with non-malignant tumours were discharged home without complications during rehabilitation. In group with malignant tumour 2 / 18 persons were transferred back to acute department due to complications.

Conclusion: Although there was no difference in Karnofsky scale assessment between both groups, the functional assessment of burden of care with FIM scale revealed an important difference between groups. The assessment of functional status before and after rehabilitation programme indicates worse rehabilitation potential in persons with malignant tumours. Rehabilitation goals of patients are adapted individually to a realistic level which is generally lower for patients with malignant tumours. Therefore, their goals are achievable in a shorter period of time what explains faster discharge of patients group with malignant tumours.
Are Effects of EEG Neurofeedback Specific to the Training Frequency: Case Study

Mario Simjanoski1, Ayse Unsal2
1McMaster University, Hamilton, Canada, 2Hamilton Health Sciences, Hamilton, Canada

EEG Neurofeedback is a form of biofeedback that involves learning how to self-control brain activity through operant conditioning principles (Boxtel, 2014). It is a non-invasive technique through which individuals can learn to affect the levels of energy for different EEG frequency bands. Although neurofeedback learning is a promising procedure, assumptions central to our theoretical understanding of the clinical applications of neurofeedback have not been carefully investigated (Gruzelier, 2014). The aim of this study is to examine the effects of a theta amplitude (4-7 Hz) inhibit protocol for amplitudes of adjacent bandwidths including delta, alpha, and beta. This is a single case study, wherein a participant who has suffered an Acquired Brain Injury (ABI) engaged in neurofeedback training over a course of consecutive days. The objective of the training was for the participant to demonstrate improvement in inhibition (decreased amplitude) of theta over the training period. We hypothesize that the individual will show reduced theta amplitude during the neurofeedback training, relative to the baseline amplitude within a session. We will also investigate the impact of theta inhibition training on amplitudes of other EEG frequencies (delta, alpha, and beta) across the training period, relative to the baseline amplitude at the beginning of each session. Furthermore, we will investigate potential changes in theta baseline amplitudes across sessions of the neurofeedback training, to determine if there are longer-lasting effects. Findings of the current study will shed light on how targeted inhibition of the amplitude of a specific frequency (theta) can affect other frequencies that were not targeted during neurofeedback, and also whether changes in baseline of the targeted frequency across sessions may be apparent.

Improvement of Post-Concussion Syndrome in Patients with Mild Traumatic Brain Injury After Combining Cognitive Rehabilitation and Psychological Care: A One-Year Experience

Mélanie Cogné1,2,3, Valérie Perdrieau2, Elodie Guillouët2, Aurélie Granger2, Hélène Defferrière2, Maryame Gatineau-Sailliant2, Emmanuelle Normand2, Clémence Lefèvre2, Philippe Decq4,5, Philippe Azouvi2,3

1Rehabilitation Unit, University Hospital, Rennes, France, 2Rehabilitation Unit, Raymond Poincaré Hospital, AP-HP, Garches, France, 3EA 4047 HANDiReSP, Versailles-Saint Quentin University, , France, 4Neurosurgical Unit, Beaujon Hospital, AP-HP, , France, 5Georges Charpak Human Biomechanics Institute, Arts et Métiers ParisTech René Diderot Paris 7, , France

Introduction: Mild Traumatic Brain Injury (mTBI) is a serious public health issue with an estimated 42 million people worldwide affected yearly. Most of mTBI patients have a favorable short-term recovery, but 10-20% are likely to develop post-concussion syndrome, defined by the association of physical, cognitive and psychological difficulties after injury. There is to date only limited evidence on the interventions’ effectiveness to improve outcome after mTBI. Our study aimed at evaluating the effect of combined cognitive rehabilitation and psychological care on post-concussion syndrome in mTBI patients at an early stage.

Methods: Each patient referred to our center due to post-concussion syndrome after mTBI (diagnosed using Rivermead Post Concussion Symptoms Questionnaire (RPCSQ) with at least 3 symptoms with a score ≥ 2) was included. Patients received psycho-education regarding mTBI, post-concussion syndrome and post-traumatic stress disorder (PTSD). An initial psychological and cognitive evaluation was also completed using Mayo Portland Adaptability Inventory-4 (MPAI-4), Brief Illness Perception Questionnaire (Brief-IPQ), PTSD CheckList Scale (PCL-S) and Hospital Anxiety and Depression Scale (HADS) for the psychological part; Montreal Cognitive Assessment (MoCA) for the cognitive part. Patients who showed cognitive and/or mood impairments were proposed a program combining cognitive rehabilitation and psychotherapy (mainly based on Cognitive Behavioural Therapy), 3 sessions each per week during 4 weeks. At the end of the program, a final psychological and cognitive evaluation was done. Patients were then followed-up during at least 6 months.

Results: From July 2017 to October 2018, 47 patients (18 women; mean age=37.30±14.00) on average 9 months after mTBI were evaluated. Out of these 47 patients, 26 were not included in the therapeutic program for the following reasons: non-stabilized psychiatric disorders, severe cognitive or motor impairments (n=6) or living place too far from our institution. Twenty-one patients were proposed to join the program, three dropped before the end, and 18 benefited from our entire program. Regarding these 18 patients, at the end of the program, there was no statistically significant improvement of the RPCSQ (24.87±17.54 versus 28.81±17.23, p=0.53) nor of the MoCA (23.25±7.45 versus 24.44±2.91, p=0.61), of the Brief IPQ (39.67±17.12 versus 49.28±14.55, p=0.08), nor of the PCL-S (39.22±19.82 versus 46.50±19.61, p=0.28). Nevertheless, based on the PCL-S cut-off of 44, 25% of patients suffering from a PTSD at the inclusion did not fulfill PTSD criteria at the end of the program. There were however significant improvements of the standardized MPAI-4 score (42.33±14.61 versus 50.44±8.04, p<0.05), and of anxiety and mood disorders (HADS sub-scores: 6.72±7.37 and 5.22±5.69 versus 11.11±5.02 and 8.61±4.63 respectively, p<0.05).

Conclusion: Although this was not a randomized controlled trial, the present results suggest that the combination of psychotherapy and cognitive rehabilitation on patients with mTBI and post-concussion...
syndrome seems useful to reduce psychological distress, but more data are needed to conclude about cognitive improvement.
Scaling Up: Online Training for Educators on TBI

Melissa McCart

1975, Eugene, United States

In the Classroom is a comprehensive web-based educational and training resource for educators. The program includes interactive learning modules that offer specific strategies and techniques for managing TBI-related academic, cognitive, behavioral, and social problems in the school setting. It includes printable forms, resources and practical tools for classroom use.

Results from a randomized control trial and a quasi-experimental study will be shared. Analyses of covariance (ANCOVA) were used to test efficacy with post-test study outcomes to analyze whether gains in TBI knowledge and TBI applied knowledge occurred. The results showed significant gains in knowledge, applied knowledge and educator efficacy.
Model of Resilience in Family Caregivers of Relatives with Neurotrauma (Traumatic Brain Injury or Spinal Cord Injury): A Multigroup Analysis

Malcolm Anderson¹, Grahame Simpson²,³, Maysaa Daher²,⁴, Kate Jones⁵, Peter Morey¹

¹Avondale College of Higher Education, Sydney, Australia; ²Brain Injury Rehabilitation Group, Ingham Institute for Applied Medical Research, Sydney, Australia; ³Liverpool Brain Injury Rehabilitation Unit, Liverpool Hospital, Sydney, Australia; ⁴Brain Injury Rehabilitation Directorate, Agency for Clinical Innovation, NSW Health, Sydney, Australia; ⁵Spinal Injury Unit, Royal Rehab, Sydney, Australia

Objective: In a previous study, we found mediating variables (resilience, self-efficacy, hope, social support) were strongly associated with both positive and negative psychological outcomes among family caregivers of people with traumatic brain injury (TBI). Building on these results, the comparability of the model between caregivers for relatives with TBI and family caregivers of individuals with Spinal Cord Injury (SCI) was tested.

Methods: Structural equation modelling with multigroup analysis was conducted in a cross-sectional sample to test a hypothesised model of resilience. A total of 181 family members were recruited (131 TBI, 50 SCI) from 6 specialist rehabilitation services in New South Wales and Queensland, Australia. Assessments comprised the Connor-Davidson Resilience Scale, Eysenck Personality Questionnaire, Ways of Coping Questionnaire, General Self-Efficacy Scale, Herth Hope Scale, Medical Outcome Study Social Support Survey; and four measures of psychological adjustment including Caregiver Burden Scale, Medical Outcomes Survey, General Health Questionnaire, and Positive and Negative Affect Scale.

Results: The model for the aggregated sample demonstrated a very good model fit ($\chi^2 = 47.42$, df = 39, $p = 0.167$, NFI = .962, IFI = .993, TLI = .985, CFI = .993, RMSEA = .035). The model accounted for 59% of the variance in resilience. Resilience was directly associated with caregiver positive affect and also played a protective role in relation to caregiver burden, as mediated through social support. Multi-group analysis showed neuroticism was significantly more influential on burden in family members supporting relatives with TBI than family members of individuals with SCI. Further, problem-focused coping was statistically more influential on positive affect in family members of individuals with TBI when compared to family members of individuals with SCI.

Conclusions: This is the first study to show neurological disability specific pathways underlying resilience and psychological adjustment in family caregivers of individuals with TBI or SCI. This study contributes to better targeting strength-based family support interventions.
The Contribution of Social Support in Predicting the Presence of Psychopathology Following A Traumatic Brain Injury

Amber Labow\textsuperscript{1,2}, Simon Beaulieu-Bonneau\textsuperscript{1,2}, Marie-Christine Ouellet\textsuperscript{1,2,3}

\textsuperscript{1}École de psychologie, Université Laval, Québec, Canada, \textsuperscript{2}Centre Interdisciplinaire de Recherche en Réadaptation et Intégration Sociale (CIRRIS), Québec, Canada, \textsuperscript{3}Centre de recherche du CHU de Québec, Université Laval, Québec, Canada

Context/Objective: Traumatic brain injury (TBI) is known to be associated with diminished social support. A large body of literature also acknowledges that social support is a protective factor against a number of physical and psychological health problems. The objective of this study was to verify whether social support measured in the first few months following TBI contributes to predict the presence of mental health disorders one to two years post-injury, while controlling for pre-injury psychopathology and sociodemographic variables.

Methods: Participants were adults aged 18-65 years having suffered from a mild to severe TBI and who were hospitalized at a Level I trauma centre in Canada. They were evaluated at six time points in the first four years following TBI. The current study included 163 individuals who completed an interview at the fourth assessment (two-year follow-up) (mean age = 41.17 ± 14.7 years; 74% men; 64% mild, 36% moderate/severe TBI). A validated self-report questionnaire assessed perceived social support (modified Medical Outcomes Study Social Support Survey; mMOS-SS) and a structured clinical interview assessed the presence of current and past (including pre-injury) Axis I psychopathology (Structured Clinical Interview for DSM-IV; SCID-IV). Disorders evaluated include major depression, adjustment disorder, anxiety and substance use disorders. A logistic regression analysis was performed to identify whether selected demographic and clinical variables predicted the presence/absence of any mental disorder two years post-injury. Five variables were included in the model: age, sex, TBI severity, pre-injury psychopathology and perceived social support at 4 months post-TBI (mMOS-SS total score).

Results: Complete data were available for 138 participants to perform the logistic regression. A comparison of the full to a constant-only model indicated that the model was statistically valid ($\chi^2 (4, N = 138) = 20.32$, p< .001). A moderate fit was observed (pseudo-R$^2$ Nagelkerke = 0.19). According to the Wald criterion, two variables contributed significantly to the prediction of the presence of mental health disorders two years post-injury: mMOS-SS total score at 4 months post-TBI (B = − 0.019, p= .041) and the presence of an Axis I disorder before the injury (B = 1.491, p< .001).

Conclusion: As previously shown, TBI survivors with pre-accident psychopathology are more vulnerable to presenting mental health disorders later on. Moreover, even when accounting for the effects of pre-injury psychopathology, age, and sex, perceived social support measured at four months post-TBI makes a unique contribution to predict the presence of mental health disorders one to two years after the injury. Since social support may serve as a protective factor against the development of psychopathology, early interventions targeting social interactions (e.g. social cognition, social skills training) to consolidate or preserve social support could help prevent mental health problems in TBI survivors.
Altered Subcortical Volume in Chronic TBI Revealed by Mega-Analysis: Results from the ENIGMA Military Brain Injury Working Group

Emily Dennis, Elisabeth Wilde, Carmen Velez, Maya Troyanskaya, Courtney Haswell, Heather Bouchard, Mary Newsome, Randall Scheibel, Artemis Zavaliangos-Petropulu, Benjamin Wade, Ann Marie Drennon, Gerald York, Erin Bigler, Tracy Abildskov, Brian Taylor, Carlos Jaramillo, Bressen Eapen, Heather Belanger, Kimbra Kenney, John Ollinger, Grant Bonavia, Rajendra Morey, Maheen Adamson, Xiaoian Kang, Inga Koerte, Martha Shenton, Harvey Levin, Sidney Hinds, William Walker, Paul Thompson, David Tate

1Brigham and Women’s Hospital/Harvard Medical School, Mountain View, United States, 2Department of Neurology, University of Utah, Salt Lake City, United States, 3University of Missouri-St. Louis, St Louis, United States, 4Michael E. DeBakey Veterans Affairs Medical Center, Houston, United States, 5Psychiatry, Duke University, Durham, United States, 6Imaging Genetics Center, Keck School of Medicine of USC, Los Angeles, United States, 7Defense and Veterans Brain Injury Center, San Antonio, United States, 8Alaska Radiology Associates, Anchorage, United States, 9Department of Biomedical Engineering, Virginia Commonwealth University, Richmond, United States, 10Polytrauma Rehabilitation Center, South Texas Veterans Health Care System, San Antonio, United States, 11Department of Physical Medicine and Rehabilitation, VA Greater Los Angeles Health Care System, Los Angeles, United States, 12James A. Haley Veterans Hospital, Tampa, United States, 13National Intrepid Center of Excellence, Walter Reed National Military Medical Center, Bethesda, United States, 14Defense and Veterans Brain Injury Center, VA Palo Alto, Palo Alto, United States, 15Department of Defense/United States Army Medical Research and Materiel Command, Ft Detrick, United States, 16Department of Physical Medicine & Rehabilitation, Virginia Commonwealth University, Richmond, United States

Traumatic brain injury (TBI) is one of the most common injuries among Active Duty Service Members (ADSM) and Veterans globally and is associated with long-term cognitive and behavioral health symptoms. Altered subcortical gray matter (GM) volume may contribute to poor outcomes after TBI. Reliable neuroimaging biomarkers of TBI and its clinical sequelae have been elusive, often due to small sample sizes for analysis. The Enhancing Neuro Imaging Genetics through Meta Analysis (ENIGMA) Military Brain Injury group aims to address this limitation through collaborative meta- and mega-analyses. 670 ADSM and Veterans between ages of 18 and 83 were enrolled in one of eight research projects. 362 participants reported a history of at least one TBI (316, 87%, male) and 308 did not have a lifetime history of TBI (243, 78.9%, male). T1-weighted magnetic resonance (MR) images were processed locally using FreeSurfer version 5.3 and volume estimates of the thalamus, caudate, putamen, hippocampus, amygdala, nucleus accumbens, globus pallidus, and lateral ventricles were extracted using a standard protocol (http://enigma.usc.edu). TBI versus non-TBI effect sizes were calculated across sites using random effects to control for site effects and including age, sex, education, and intracranial volume as covariates. Multiple comparisons correction was performed using the Bonferroni threshold (p=0.05/8=0.00625) Across all participants, we found a borderline effect of smaller left thalamic volume in TBI group (p=0.026). Among male participants, we found significantly smaller left thalamic volume in TBI group (t(557)=-3.0, p=0.0031). Among female participants we found a borderline effect of larger right amygdala in TBI group (p=0.047). There were borderline sex-by-diagnosis effects for the left and right thalamus and right amygdala (p between 0.012-0.046). There were also borderline age-by-diagnosis effects for the left thalamus and bilateral caudate (p between 0.011-0.043). Presence of on-going depression symptoms was assessed in a subset of participants using self-report measures. Using published clinical cutoffs, scores were converted to binary depression variables. Within the TBI group, we found borderline associations between elevated depressive symptoms and smaller bilateral caudate volume (40 with depression, 96 without depression, L p=0.030, R p=0.0081). These associations were not detected when examining depressive symptoms within the non-TBI group. Our preliminary report indicates that altered subcortical GM volume persists years after injury and may contribute to post-injury symptoms. There is mounting evidence that there are significant
sex differences in the TBI population, which our results support. Finally, we provide evidence suggesting distinct pathophysiology of TBI-associated depression in ADSM and Veterans - caudate volume loss was detected in post-TBI depression cohort only. Future studies including additional cohorts will be needed to verify potential sex differences and consider additional outcome variables such as cognitive function.
Relationship Between CT Head Findings and Long-Term Recovery in Children with Complicated Mild Traumatic Brain Injury

Laura Waller, Masaru Teramoto, Colby Hansen

University of Utah, Salt Lake City, United States

Background and Aims: Traumatic brain injury (TBI) is the leading cause of disability in children and young adults. A majority of TBIs are considered mild TBIs (GCS 13-15), with complicated mild TBIs (c-mTBI) being a subset of mild TBI with the addition of intracranial abnormality on neuroimaging. Many patients with c-mTBI will make a full recovery, however a group of patients continue to have long-term adverse outcomes. Identifying prognostic factors at the time of injury can help clinicians choose therapies and medical interventions to optimize recovery. Despite a movement to identify prognostic factors that can predict long-term functional outcomes after TBI, there continues to be a paucity of research in this area. The aim of this study was to investigate the association between CT head findings at the time of injury and recovery of patients with c-mTBI. We hypothesize that patients with isolated subarachnoid hemorrhage achieve the best outcome, extra-axial hematoma have better recovery than cortical contusion, subdural hemorrhage have worse outcomes than epidural hemorrhage, and that multiple imaging findings are associated the worst outcome.

Methods: A retrospective survey and chart review of pediatric TBI patients (age 5-18) and their parents were identified from 2010-2013 hospital data. Of the 285 survey responses, 77 children were classified as c-mTBI, and were analyzed for this study. Associations of imaging findings to degree (0-10 scales) and length (months) of recovery were analyzed using Fisher’s exact test.

Results: Overall, 48% (n = 37) of patients were reported to have completely recovered at the time of the survey. Close to half of patients (44%, n = 34) required more than three months for complete recovery, while 30% (n = 23) reported that they had yet to completely recover at the time of the survey. There were no significant differences in degree or length of recovery by extra-axial injury vs. cortical injury vs. subarachnoid hemorrhage, epidural vs. subdural hematoma, single hemorrhagic contusion size (≤ 5 mm vs. > 5 mm), single vs. multiple hemorrhagic contusions, depressed/complex vs. simple skull fractures, frontal contusions vs. contusions in other locations, and single vs. multiple findings (p > 0.05).

Conclusion: Contrary to our hypotheses, degree and length of recovery in pediatric patients with complicated mTBI may not be substantially influenced by imaging findings at the time of injury.
Changes in Brain Network Organization and Brain-Behaviour Relationships Following A 3-Month Intervention Program for Individuals with Chronic TBI

Leyla Brucar¹, Ivan Torres¹, William Panenka¹, Angela Mueller¹, Rebecca Kenny¹, Naznin Virji-Babul²
¹University of British Columbia, Vancouver, Canada

Introduction: We investigated the efficacy of the ABI Wellness interdisciplinary pilot program consisting of: BrainEx cognitive exercises, aerobic exercise, mindfulness meditation, and counseling on a group of individuals with chronic, mild traumatic brain injury (mTBI).

Objectives:
1. To evaluate the changes in EEG brain function in individuals with chronic, mTBI following a 3-month intervention program.
2. To evaluate cognitive and emotional changes and the underlying EEG correlates following the intervention.

Methods: Eight adults between the ages of 22 – 57 years with a history of persistent mTBI (between 1-5 years post injury) and nine healthy age- and sex-matched controls participated in this study. Five minutes of resting state EEG with eyes closed was recorded at baseline and post-intervention. Power spectral density and graph theoretical analysis were used to evaluate the differences from baseline to post-intervention and compared with controls. Cognition was evaluated using the NIH Toolbox Cognitive Battery and the Rey Auditory Verbal Learning Test (RAVLT). We also administered the Generalized Anxiety Disorder Scale and the PHQ-9 Depression scale. All measures were evaluated at baseline and post-intervention in participants with mTBI.

Results: Theta power decreased significantly over three frontal electrodes - Fp2 (p = 0.018), F8 (p = 0.018), and F10 (p = 0.025), and over the temporal T8 electrode (p = 0.050), post-intervention and approached the values of the healthy control group. Local clustering coefficient in the area associated with the (R) temporal right brain region also decreased significantly (p = 0.025). No significant changes were observed on the NIH Toolbox, although RAVLT learning trials 1-5 score increased from pre- to post-intervention (p = 0.017). We found a significant positive correlation between change in the Generalized Anxiety Disorder Scale and change in both Fp2 frontal theta power (r = .884) and F10 frontal theta power (r = .887) in individuals with mTBI. Change in the PHQ-9 Depression Scale was also significantly correlated with the change in F10 frontal theta power (r = .770). Regarding memory, change in RAVLT was correlated with change in clustering coefficient over the temporal right brain region (r = 0.526) and F8 frontal theta power (r = -0.526).

Conclusions: The results of this pilot study show evidence of change in EEG power, network organization and brain-behaviour relationships following an intensive intervention program. These changes suggest that individuals with chronic mTBI can benefit from targeted intervention and that these changes are associated with brain reorganization that reflect improvements in cognition and reduction in anxiety/depression.
When Will He Talk to Me? Mapping the Time Course of Recovery of Communication in Patients with Disorders of Consciousness Following Severe Brain Injury

Yelena Bodien1,2, Géraldine Martens1, Joseph Giacino1
1Spaulding Rehabilitation Hospital, Charlestown, United States, 2Massachusetts General Hospital, Boston, United States

The return of functional communication (FC) is one of the most anticipated milestones of recovery after a severe brain injury for both families and clinicians. However, the time course of recovery of communication in patients with disorders of consciousness after severe brain injury is unknown. Providing clinicians and caregivers with information concerning the time course to recovery of communication may facilitate therapeutic interventions and maintain realistic expectations. The Coma Recovery Scale-Revised is a bedside behavioral assessment that evaluates 23 items hierarchically-organized within 6 subscales interrogating auditory, visual, motor, verbal, arousal and communication functions. According to the CRS-R, intentional communication (IC) is characterized by the ability to discernably respond to at least two out of 6 situational “yes/no” orientation questions (regardless of accuracy) while FC requires 6 out of 6 accurate discernable responses. In this retrospective observational study, we analyzed the time course from injury to recovery of IC and FC in an inpatient rehabilitation setting. Inclusion criteria were: 1) 16 years or older, 2) admitted with no evidence of communication per CRS-R criteria, and 3) regained intentional and/or functional communication during inpatient rehabilitation. Patients were excluded if they were assessed with the CRS-R less than three times. Of the 323 patients screened, 64 (20%) patients never recovered IC or FC prior to rehabilitation discharge and were excluded. Among the 169 patients (median [IQR]: 52 [26 – 62.75] years old, 106 males, 91 TBI, 26 [21 – 33] days post injury on admission) who met all inclusion criteria, 91 (54%) transitioned to IC within 41 [34 – 54.25] days of injury and then progressed to FC at 55.5 [45 – 75.5] days, twenty patients (12%) directly transitioned to FC within 43 [31.75 – 63] days and fifty-eight (34%) transitioned to IC within 49 [36.5 – 78] days but failed to recover FC prior to discontinuation of CRS-R administration or discharge from rehabilitation. The etiology (i.e., traumatic [TBI] versus non-traumatic [nTBI]) did not significantly influence the time to recovery of communication (median time to IC: 41 days for TBI and 47 days for nTBI – W=311; p=0.225; median time to FC: 51.5 days for TBI and 59.5 for nTBI – W =1762.5; p=0.113). Overall, approximately 48% of patients admitted to inpatient rehabilitation with no evidence of communication will recover the ability to communicate reliably within two months of injury. These findings have important implications for clinicians involved in prognostic counseling, particularly in the acute care setting.
Relationship Between Fractional Anisotropy and Anti-Saccadic and Convergence Eye Movement in mTBI

Haruo Nakayama1, Yu Hiramoto1, Yuriko Numata1, Satoshi Fujita1, Nozomi Hirai1, Norihiko Saito1, Morito Hayashi1, Keisuke Ito1, Takatoshi Sakurai1, Kazuya Aoki1, Satoshi Iwabuchi1

1Toho University Ohashi Medical Center, Tokyo, 日本

Objective: To evaluate the relationship between fractional anisotropy and vestibular/Ocular-Motor Screening (VOMS) in concussion.

Methods: Diffusion tensor MRI included fractional anisotropy of the Brain and vestibular/ocular-motor screening were conducted on 10 patients with concussion who were diagnosed in Toho University Ohashi medical center sports-related concussion clinic from April 2017 to March 2018. Fractional anisotropy was extracted from 2 regions of interest in corpus callosum and corticospinal tract. Detailed vestibular/ocular-motor screening with an emphasis on anti-saccadic and convergence eye movement was also conducted. The FA values in the corpus callosum and the corticospinal tract were compared between the 2 groups of 6 patients (Group V) who failed either in VOMS and 4 cases (Group NV) who did not admit it.

Results: Mean FA values in the corpus callosum and corticospinal tract in the Group V were 0.70 and 0.56. Mean FA values in the corpus callosum and corticospinal tract in the Group NV were 0.43 and 0.49.

Conclusions: Our result suggests that the FA value of the corpus callosum did not explain the significant fluctuation of anti-saccadic and convergence eye movement. However, FA values in the corticospinal tract were shown to explain the fluctuation of anti-saccadic and convergence eye movement.
The Significance of Discussing Caregivers’ Experiences Which Were Not Treated Enough in the Medical Situation Due to Their Subjectivity: In the Process of Seeking How Caregivers Read Severely Brain Injured Children’s Own Will/Thought

Naoko Kameda1, Hiroshi Ietaka2, Tomomi Ikeda1
1Setsunan University, Hirakata City, Japan, 2Tohoku Medical and Pharmaceutical University, Sendai, Japan

Background/Aims: Fifteen% to 20% of the people in vegetative state were completely conscious (Monti et.al, 2010; Cruse et.al, 2011). Seventeen (39%) of 41 patients presumed to be in VS/UWS were found to be at least minimally conscious, and the active involvement of patients’ proxies and staff enriched the assessment (van Erp et.al, 2015). Although objective methods (ex. f-MRI, EEG) to detect consciousness has been developed, these objective data cannot tell us how caregivers should read slight movements of severely brain injured children. And then, due to a severely brain injured child’s slight movements with poor reproducibility, “sharing” caregivers’ experiences were necessary to read the child’s slight movements (Kameda & Suzuki, 2018). In this research, we aimed to describe the significance of discussions to share caregivers’ experiences in the process of seeking how caregivers read severely brain injured children’s own will/thought through their slight movements.

Methods: Six severely brain injured children (1 to 10 years old; Their brains were injured at 1 day-old to 3-year-old due to cerebral hypoxia and epilepticus) and their over 77 caregivers (families, nurses, pediatrician, teachers, etc.) participated in our research. Data was obtained by 61 3-4hr observation sessions by the side of each child and 5 15-45 minutes group interviews. We focused on sharing and discussing caregivers’ experiences. These data were interpreted by using phenomenological hermeneutic approach (van Manen, 1990)

Results: Five themes emerged as significance of discussing care for severely brain injured children among caregivers and a researcher. One caregiver said, “when I answered that I am aiming to give each child normal daily life in the care, you asked me what the normal daily life is. At that time, I really could not explain it. So, I asked other staff, but everyone could not explain like me Recognition of experiences is buried in the care and trying to verbalize of caregivers’ experiences were occurred. Discussions were occurred not only group interviews and observation sessions but also at rest time with/without a researcher. As the result of these discussions increasing attention to severely brain injured children), Experiencing together to read slight movements of the children were occurred, and these themes led to Understanding other caregivers’ interpretation about readings of children's slight movements. As the result, there were some changes. The biggest change was, a mother who used to visit her child only 1 time/ month changed to every day and played with her child by reading her child’s slight movements.

Conclusion: Our results recommends that researchers go into the wards in hospital and institution for facilitating sharing and discussing caregivers’ experiences which were not treated enough in the medical situation due to their subjectivity.
Understanding and Treating Cognitive-communication Deficits that Impact on Success in the Workplace following Traumatic Brain Injury

Jacinta Douglas\textsuperscript{1,2}, Christine Bracy\textsuperscript{1}, Pamela Snow\textsuperscript{1}, Lucy Knox\textsuperscript{1}, Carren De Maio\textsuperscript{1}

\textsuperscript{1}La Trobe University, School of Allied Health, Bundoora, Australia, \textsuperscript{2}Summer Foundation, Melbourne, Australia

Objectives: Return to competitive employment presents a major challenge to adults who survive traumatic brain injury (TBI). This paper details the results of two studies. The first was undertaken to better understand the nature of cognitive-communication behaviours that shape employment outcome by comparing the communication profiles of adults who return to and maintain employment with those who do not. The second used single case experimental design (SCED) to evaluate an intervention to improve communication coping strategies that focus on cognitive-communication difficulties in the workplace.

Methods: Forty-six dyads (46 adults with TBI, 46 relatives) participated in the first study. They were recruited into two groups based on the current employment status (employed, unemployed) of participants with TBI. Groups were matched on sex, age, education, psychiatric and substance abuse history, preinjury employment and occupation level, injury severity, and time postinjury. The La Trobe Communication Questionnaire (LCQ) (self-report and relative versions) was used to identify problematic cognitive-communication behaviours and their frequency of occurrence. Group comparisons on LCQ total scores were analysed using mixed 2x2 ANOVA (between factor: employment status; within factor: source of perception) and the cognitive-communication behaviour profiles across the two groups were compared. The participant in the second study was DA, a 37-year-old man who had sustained severe TBI when he was 23 years old. He participated in a 6-week treatment program targeting increased use of personally relevant productive coping strategies. SCED (A–B–A with follow-up using multiple probes) was applied to evaluate the effectiveness of the treatment. Percentage of non-overlapping corrected data (PNCD) was used to analyse the results.

Results: ANOVA yielded a significant group main effect ($p = .002$) and a significant interaction ($p = .004$) in study one. The employed group reported less frequent difficulties (self and relatives). Consistent with the interaction, unemployed participants perceived themselves to have less frequent difficulties than their relatives perceived, while employed participants reported more frequent difficulties than their relatives. Statistically significant differences indicative of more frequent problems in the unemployed group were evident on nine of the 30 individual items across comparisons on the relatives’ data. Problematic behaviours reflected impairments across the executive function domains of inhibitory control, task management and fluency and were associated with violations of the conversational principles of Relation, Manner, Quantity, and Quality. A large treatment effect was demonstrated in study two and maintained at 1 and 3-month follow-up. Positive change was particularly evident in the domains of inhibitory control and task management.

Conclusions: Cognitive-communication outcome and awareness of communication deficits play an important role in vocational rehabilitation following TBI. Direct intervention that focuses on coping with these difficulties in the workplace shows promising results with maintenance of positive change over time.
The Impact of Migraine History and Short Sleep Duration on Preseason Symptom Reporting in Adolescent Student Athletes

Jenkin Mok1, Douglas Terry2,5,6,7, Bruce Maxwell3, Ross Zafonte2,4,5,7,8, Paul Berkner3, Grant Iverson2,5,6,7, Magdalena Wojtowicz1

1York University, Toronto, Canada, 2Harvard Medical School, Boston, United States, 3Colby College, Waterville, United States, 4Massachusetts General Hospital, Boston, United States, 5Red Sox Foundation and Massachusetts General Hospital Home Base Program, Boston, United States, 6MassGeneral Hospital for Children™ Sports Concussion Program, Boston, United States, 7Spaulding Rehabilitation Hospital, Boston, United States, 8Brigham and Women’s Hospital, Boston, United States

Objective: The impact of poor sleep quality and reduced sleep duration on preseason baseline symptom reporting is well documented. Some studies have also reported greater baseline symptom reporting in student athletes with a history of migraine. However, the interaction between having a history of migraine and less sleep on baseline symptoms is presently unknown. The purpose of this study was to examine the relationship between sleep duration, migraine history, and baseline symptom reporting in student athletes.

Methods: From a baseline database of 30,738 athletes ages 13-18 who had not sustained a concussion in the past 6 months and completed relevant sections of ImPACT® (including the number of hours slept the night before), 19,077 individuals denied having developmental and health conditions (Controls; Age: M = 15.38, SD = 1.29; 48.1% female) and 2,192 reported having had treatment for migraines (Migraine; Age: M = 15.63, SD = 1.33; 48.7% females). Athletes completed the Post-Concussion Symptom Scale within ImPACT®. Athletes were divided into four groups based on their sleep duration the night before testing (≤5, 5.5-6.5, 7-8.5, and ≥9 hours). Mann-Whitney U-Tests were used to compare baseline symptom reporting between athletes with migraine history and controls, stratified by sex and sleep duration.

Results: Athletes with migraine history were more likely to be in the ≤5 hours of sleep group the night before preseason testing compared to athletes without comorbidities (girls: χ²(1)=34.48, p<.001; boys: χ²(1)=12.58, p<.001). Athletes with migraine history also reported greater symptom severity than controls when stratified by gender and sleep duration (all ps<.001). A similar pattern was observed even when excluding symptoms directly related to sleep, fatigue, and drowsiness (all ps<.001). In athletes who slept 5 or fewer hours, 73.4% of girls and 48.1% of boys with a history of migraine reported having a symptom burden resembling an ICD-10 diagnosis of postconcussional syndrome, compared to 46.9% of girls and 29.5% of boys without any comorbidities (girls: χ²(1)=14.13, p=<.001; boys: χ²(1)=10.06, p=.002).

Conclusions: Reduced sleep duration and migraine history, in combination, affect the severity of symptom reporting and confound baseline symptom reporting. It may be important to consider the effects of pre-existing health conditions, sex, and sleep duration when interpreting baseline symptoms.
Pre-Existing Diabetes Mellitus Contributes to The Exacerbation of Traumatic Brain Injury: An Experimental Study of Mice

Kazuhiko Kibayashi¹, Yuki Tatara¹
¹Department of Legal Medicine, Faculty of Medicine, Tokyo Women’s Medical University, Shinjuku-ku, Japan

Traumatic brain injury (TBI) can occur as a result of falls, traffic accidents, and blows. An assessment of severity is required to determine the treatment plan and to predict the prognosis of the patients. Age is a risk factor of TBI. Elderly patients with TBI sometimes have diabetes mellitus and hypertension as pre-existing co-morbid diseases. We supposed that TBI is exacerbated by pre-existing diabetes mellitus due to microcirculation dysfunction and prolonged inflammation. In this study, we investigated the change in brain function and extent of brain contusion after TBI in diabetic and non-diabetic mice.

Ten-week-old male KKAY (type 2 diabetic) and C57BL/6J (non-diabetic) mice were used in this study. A controlled cortical impact (CCI) device was used to induce TBI in each mouse (CCI model). Sham-operated (craniotomy without impact) and naive (did not undergo any operation) animals were used as controls. This study measured the volume of brain contusion using magnetic resonance (MR) imaging, which was performed using the Bruker Icon 1T MR imaging system. We then assessed changes in brain function using the neurological severity score (NSS) for motor function and cognitive deficits, learning and memory using the Morris water maze (MWM), depression/helplessness using the forced swim test (FST), and motor function using beam walking (BW). These experiments were performed from 1 to 112 days after surgery (n = 4–10 per timepoint for each group).

Brain contusion was produced in the ipsilateral cerebral cortex of the diabetic and the non-diabetic mice. Compared with those in the non-diabetic mice, the diabetic mice had significantly higher volumes of brain contusion based on the MR imaging and significantly greater deterioration in NSSs after TBI. There were no significant differences in MWM, FST, or BW performances between the diabetic and non-diabetic mice. Therefore, the results of this present study suggest that pre-existing diabetes increases contusion volume and deteriorates brain dysfunction. Exacerbation of TBI should be monitored in patients with diabetes mellitus.
tPCS and tDCS in a Patient in Minimally Conscious State: A Randomized Double-Blind Sham-Controlled Pilot Study

Alice Barra¹, Sepehr Mortaheb¹, Manon Carrière¹, Mariachiara Luisella Binda Fossati¹, Géraldine Martens¹,², Yelena Bodien², Leon Morales-Quezada³, Felipe Fregni³, Joseph Giacino², Steven Laureys¹, Aurore Thibaut¹,³
¹Coma Science Group, GIGA Research University of Liége, Liége, Belgium, ²Department of Physical Medicine and Rehabilitation, Spaulding Rehabilitation Hospital and Harvard Medical School, Boston, United States, ³Neuromodulation Center, Spaulding Rehabilitation Hospital, Harvard Medical School, Boston, United States

Introduction: Transcranial direct-current stimulation (tDCS) over the prefrontal cortex has shown to improve signs of consciousness as measured by the Coma Recovery Scale-Revised (CRS-R) in about 50% of patients in minimally conscious state (MCS) (1,2,3).

On the other hand, transcranial pulsed-current stimulation (tPCS) has been used to modulate cortical and subcortical neural connectivity within 6-10Hz (4). It was successfully employed to enhance motor and cognitive functions in healthy volunteers (5) and it is theoretically able to reach subcortical brain structures (6).

The aim of the present study is to evaluate and compare the neurophysiological and behavioural effects of tPCS and tDCS in patients with DOC. As the study is undergoing, we here present the results of one patient who underwent the entire protocol.

Methods: This is a randomized double-blind sham-controlled clinical trial encompassing 3 sessions of stimulation: active tPCS, active tDCS, and sham. tPCS was placed over the mastoids with a random frequency of 6-10Hz (2mA peak to peak for 20 min), whereas tDCS was placed over the prefrontal area (2mA for 20 min). Before and after each session we recorded 10 minutes of resting EEG and evaluated the patient with the CRS-R. EEG data were pre-processed and the power of signal was calculated for each frequency band: Delta (0-4 Hz), Theta (4-8 Hz), Alpha (8-12 Hz) and Beta (12-25 Hz). A non-parametric corrected cluster permutation test (7) was used to statistically compare the power maps before and after each session. Electrode clusters with p-value below 0.01 were considered as significantly different. The first patient included in this study was a woman of 71 years old in MCS, who had an aneurysm rupture, 13 months before her enrolment in the study.

Results and Discussion: An increase of Alpha and Beta power and decrease of Theta and Delta power was observed after anodal tDCS together with an increase of behavioural responsiveness as measured by the CRS-R.

After active tPCS, a significant increase was observed in Theta power consistently with the frequency of the stimulation (6-10Hz). However, this increase did not result in any measurable behavioural improvement. This absence of clinical improvement could be due to insufficient number of sessions or inadequate frequency of stimulation.

Conclusion: In conclusion, in the present case-report, tDCS and tPCS induced distinct neurophysiological and clinical effects. So far, as previously shown, tDCS seems to improve behavioural responsiveness of patients in MCS. On the other hand, tPCS should be explored in larger cohorts to understand if this type of stimulation can reach similar results as the ones observed for tDCS or if it could be effective in a subpopulation of patients only.
High Biocompatibility of Scaffolds Based on Hyaluronic Acid Glycidyl Methacrylate to Primary Hippocampal Cultures

Tatiana Mishchenko1,2, Elena Mitroshina1,2, Alisa Kuznetsova1, Olesya Shirokova2, Evgeny Khaydukov3,4, Andrey Zvyagin4,5, Maria Vedunova1

1Institute of Biology and Biomedicine, National Research Lobachevsky State University of Nizhni Novgorod, Nizhny Novgorod, Russian Federation, 2Central Scientific Research Laboratory, Privolzhskiy Research Medical University, Nizhny Novgorod, Russian Federation, 3Institute of Photon Technologies, Federal Scientific Research Center “Crystallography and Photonics” of the Russian Academy of Sciences, Moscow, Troitsk, Russian Federation, 4Centre of Biomedical Engineering, Institute of Molecular Medicine, I.M. Sechenov First Moscow State Medical University, Moscow, Russian Federation, 5ARC Centre of Excellence for Nanoscale Biophotonics, Macquarie University, Sydney, Australia

In the last decade, it has become clear that therapy against traumatic brain injury is more successful when it includes bioengineering techniques for morphological and functional brain tissue reconstruction. Engineering restoration of nervous tissue by three-dimensional constructs with a given architectonics is necessary not only for negation the induced pathological changes but also for stimulation endogenous neuroreparative processes in the damaged area. The most important requirement imposed on materials of scaffolds is the absence of toxic effects for the normal nervous tissue.

The aim of the investigation was to study a biocompatibility of self-designed scaffolds based on hyaluronic acid glycidyl methacrylate to primary hippocampal cultures.

Primary hippocampal cells obtained from C57BL/6 mouse embryos (E18) were cultured more than 14 days on scaffolds based on hyaluronic acid glycidyl methacrylate developed by micromolding technique. Morphological assessment was carried out during whole period of cultures cultivation. Viability test was performed day 14 of cultures development in vitro (DIV) by using specific fluorescent dyes propidium iodide (Sigma-Aldrich) and bisbenzimide (Sigma-Aldrich) which allow the visualization of the nuclei of dead cells and the total number of cells in culture. The features of metabolic functional activity of primary cultures were estimated with using calcium imaging technique and a confocal laser-scanning microscope Zeiss LSM 510 (Zeiss, Germany).

This study revealed that material of designed scaffold had no toxicity effect for the nervous system cells. The number of dead cells did not significant differ from the control group. Dissociated hippocampal cells were actively attached to the scaffold surface. Primary morphological assessment showed that neurons and glial cells had a typical structure and formed outgrowths during cultures development in vitro. The cells assembled into the cell conglomerates on scaffold surface. Calcium imaging data analysis revealed that the cultures cultivated on scaffolds show functional calcium activity. However, the number of cells exhibited calcium activity (25.2±11.6%) was significantly lower than in the control group. Changes in the oscillatory profile manifested in fivefold decrease in the frequency of calcium events (0.2±0.01 osc/min) and in the increase of the duration of calcium oscillations (12.6±1.2 s) are also noted.

Therefore, our study demonstrated that scaffolds based on hyaluronic acid glycidyl methacrylate have a high biocompatibility with the nervous system cells and could potentially use for development of new neurotransplant.
The reported study was funded by RFBR according to the research projects № 18-315-20003 and has been also prepared as part of the state projects «Provision scientific research» №6.6379.2017/8.9, 17.3335.2017/4.6 and 6.6659.2017/6.7.
Assessment of Visual Attention and Reaction Time Among Adolescents with Cognitive Impairments Prior to Driver’s License Training – A Descriptive Study of Healthy Adolescents’ Performances on A Computerized Test

Per-Ola Rike¹, Ingvil Laberg Holthe
¹Sunnaas Rehabilitation Hospital, Gjettum, Norway

Objectives: Visual attention capacity is critical for safe driving and is often impaired after a brain injury. Unfortunately, there is a lack of validated performance-based measures of visual inattention for adolescents with cognitive impairment suitable for assessing the cognitive health requirements for driving prior to driver’s license training. The objective of this study was to administer a test of visual attention and reaction time to healthy adolescents in order to provide reference data for clinical use.

Methods: Design and participants: A descriptive study of healthy adolescents aged 13-19 years, 77 males and 87 females, recruited from their respective public schools in the South-Eastern region of Norway.

Measures: A computerized test of visual attention and reaction time - Sunnaas Driving Test of Visual Attention and Reaction Time (SDTVART) was performed. SDTVART is recommended for use in driving assessments by the Norwegian Psychological Association, but only includes reference data for adults. SDTVART consists of two separate tests, the Tachistoscope Test (TT) and Reaction Time Test (RTT). The TT measures visual attention with two separate subtests, a simple and complex condition. A total of 54 target symbols are presented briefly on the screen in 18 trials, 23 in each hemifield and 8 in the central visual field for 300 and 500 milliseconds in the simple and complex subtest, respectively. The simple subtest contains only one target symbol while the complex subtest contains the same target symbol and two distractor symbols. In the Reaction Time Test the participants are instructed to press spacebar immediately when numbers randomly appear on the screen, generating output mean scores in the left, right and central visual field (in milliseconds).

Results: No gender or age differences were observed across test performance. All participants correctly identified all of the 54 symbols in the TT simple subtest, and median (q1, q3) in the TT complex subtest was 51 (48-53). Mean reaction response times on the RTT were 315.8 (33.1) milliseconds in the left hemifield, 312.5 (29.4) to the right and 309.4 (44.0) in the central visual field. The results for the TT subtests were similar to performances of young adults aged 18-30 years reported in the SDTVART test manual, while the RTT results were significantly slower than young adults.

Conclusions: SDTVART is a computerized test of visual attention and reaction time that is fast to administer. Adequate visual attention capacity is a prerequisite for safe driving, and SDTVART may be useful when assessing potential to drive among adolescents with cognitive deficits. A major advantage of the test is the measurement of potential hemi-inattention and neglect, often observed after lateralized brain injuries. The results may serve as reference data when estimating degree of driving-related impairments in a clinical population.
Quality of Life in A Population with Dizziness and Balance Problems Following Mild-Moderate Traumatic Brain Injury

Ingerid Kleffelgård1,2,3, Birgitta Langhammer2, Helene Lundgaard Søberg1,2
1Oslo University Hospital, Oslo, Norway, 2Oslo Metropolitan University, Oslo, Norway, 3University of Oslo, Oslo, Norway

Objectives: Dizziness and balance problems are common following traumatic brain injury, (prevalence: 30-80%), and might cause functional limitations, psychological distress, and have a negative impact on quality of life. The purpose of this study was to evaluate health-related quality of life (HRQL) in patients with dizziness and balance problems following a mild-moderate traumatic brain injury, and to explore the associations between HRQL and personal, injury related and post-injury functioning factors.

Methods: Baseline assessments of 64 patients (45 female, mean age 39.4 (13.0) years) included in an RCT evaluating the effect of vestibular rehabilitation for dizziness and balance problems were analyzed.

Personal factors (age, gender, social status, educational level, sick-leave status, co-morbidities), injury related factors (GCS, PTA, LOS, CT/MRI) and self-reported and performance based outcome measures were used for the assessments: Rivermead Post-concussion symptoms Questionnaire (RPQ), Vertigo Symptom Scale-short form (VSS-sf), Hospital Anxiety and Depression Scale (HADS), Balance Error Scoring System (BESS), High Mobility Assessment Tool for TBI (HiMAT). HRQL was measured with the QOLIBRI - Quality of life after brain injury (0-100 worst-best).

Preliminary univariate regression analyses were performed to explore the associations between HRQL and personal and injury related factors, and self-reported and performance-based functioning after TBI.

Results: The mean total QOLIBRI score was 53.2 (17.5). Scores on the subscales were: Cognition: 50.1 (21.8); Self: 45.4 (22.7); Daily life and autonomy: 48.5 (22.6); Social relationships 66.7 (22.6); Emotions: 60.4 (21.4); Physical problems: 51.4 (19.2).

Being on sick-leave was significantly associated with HRQL (Beta = -0.281, p = 0.03). No other personal or injury related factors showed significant associations with HRQL. Self-reported outcomes measuring post-concussion symptoms (RPQ) and vertigo symptoms had significant associations with HRQL (Beta = -0.762, p < 0.001 and Beta = 0.569, p < 0.001 respectively). Psychological distress (HADS) also had significant associations with HRQL (-0.766, p < 0.001). Significant associations were also found between HRQL and balance (BESS: Beta -0.243, p = 0.05), and mobility (HiMAT: Beta 0.350, p = 0.005).

Conclusions: The patients had a total score on the QOLIBRI, indicating reduced HRQL. At baseline it was significantly associated with sick-leave, post-concussion- and dizziness symptoms, psychological distress, and reduced balance and mobility. The results confirm the negative impact dizziness and balance problems have on HRQL following a mild-moderate TBI.

Trial registration: Clinical Trials # NCT01695577
Hippocampal-Dependent Relational Memory at Short and Long Delays in Individuals with Moderate-Severe Traumatic Brain Injury

Emily Morrow¹, Michael Dulas², Neal Cohen², Melissa Duff¹

¹Department of Hearing and Speech Sciences, Vanderbilt University, Nashville, USA, ²Beckman Institute, University of Illinois at Urbana-Champaign, Urbana-Champaign, USA

Long-term declarative memory deficits are well-established in patients with traumatic brain injury (TBI), with the prevalence of these impairments linked to the vulnerability of the hippocampus to injury mechanisms. Recent advances demonstrate that the hippocampus is not only involved in the encoding and subsequent retrieval of long-term relational memories, but also supports relational representations over short delays or no delays at all. The current study investigates the impact of TBI on relational memory at both long and short delays. Such data may advance our understanding of behavioral dysfunction and related outcomes in TBI, as relational memory deficits, at short and long delays, have been linked to disruptions in flexible and adaptive behavior.

Individuals with moderate-severe TBI and demographically matched healthy comparison participants (CP) completed a relational memory task for face-scene pairings. Study and test trials were intermixed so that participants were tested on face-scene pairings they had just studied, or face-scene pairings that were from several trials previous. For study trials, participants viewed a scene for two seconds, and then a face was superimposed for three seconds. On test trials, participants viewed a studied scene for two seconds, and then three previously studied faces were superimposed on the scene, and participants were asked to indicate the matching face. Critically, while all three faces were previously studied, only one was the correct match previously presented with that scene.

Consistent with the literature documenting long-term memory deficits in TBI, the TBI group performed well below the CP group in the long-delay condition. In the short-delay condition, CP’s performed uniformly at ceiling, while the group of individuals with TBI performed slightly more poorly. Interestingly, there was considerable variability among individuals in the TBI group at both the short and long delay, suggesting large inter-individual variability in the severity of hippocampal deficits.

These data suggest that relational memory impairment, even at short delays, is a notable feature of TBI, highlighting the impact of TBI on hippocampal function. Considerable variability in task performance in the TBI group suggests that this task may be sensitive to subpopulations of patients with differential relational memory abilities. In future work, we will relate these memory deficits at short and long delays to the nature of hippocampal pathology (e.g., subfield analysis) and to long-term outcome measures of real-world adaptive behavior in individuals with TBI.
Postural Neurologic Deficits after Decompressive Craniectomy for Traumatic Brain Injury: A Case Series of Sinking Skin Flap Syndrome

E. Ali Bateman1, Jordan VanderEnde1, Keith Sequeira1, Heather MacKenzie1

1Department of Physical Medicine & Rehabilitation, Western University, London, Canada

Context: Sinking Skin Flap Syndrome (SSFS) is a clinical syndrome in which a patient with a craniectomy develops objective neurologic abnormalities explained by the concavity of their skin flap and the pressure of the atmosphere on the underlying brain. Patients present with postural headaches and delayed neurologic deficits that localize to the craniectomy site where atmospheric pressure compresses the brain under the skin. These symptoms and signs are reversible when supine and after cranioplasty. SSFS is thought to be a rare complication of craniectomy after traumatic brain injury (TBI); however, evidence suggests SSFS is under-recognized, in part due to its diverse clinical presentation.

We present two patients who developed SSFS during inpatient multidisciplinary rehabilitation. As available, qualitative behavioural observation, manual muscle testing (MMT), Timed Up and Go (TUG), Berg, 6-minute walk test (6MWT), O-Log, SCATBI, MoCA and neuroimaging pre- and post-cranioplasty are presented.

Case 1: 72-year-old woman with a severe TBI requiring left hemicraniectomy. On admission to rehabilitation, TUG was 62sec, Berg 20/56, and SCATBI 4words/min. Postural headache, nausea and vomiting limited her participation. During rehabilitation, she deteriorated; consistently after 20min standing or 2hrs sitting, she developed headache, worsening MMT in the right arm and leg (from MRC 3-5 to MRC 2-3) and telegraphic speech. After sitting up for 6hrs, the patient became stuporous with GCS12. Infectious, metabolic, and epileptic causes were ruled out; she was diagnosed with SSFS and planned for cranioplasty. Neuroimaging showed paradoxical pressure on the brain from the skin over the left hemispheric craniectomy site. While awaiting surgery, the patient was restricted to head elevation <30degrees using a tilt wheelchair and bedrest; her O-log improved from 22/30 to 26/30. 48hrs post-cranioplasty, her speech was fluent, MMT was MRC 4-5, O-log 30/30, and she remained headache-free after sitting upright for 2.5hrs. Postoperatively, TUG was 31sec, Berg 28/56, and SCATBI 14words/min.

Case 2: 54-year-old man with a moderate TBI requiring right hemicraniectomy. On admission to rehabilitation, 6MWT was 247m, Berg 27/56, and MoCA 25/30. Postural headache limited participation and required multiple medications. During rehabilitation, the patient was noted to have postural left hemi-body neglect and left arm and leg weakness (MRC 3-4) after periods of 1-2hrs sitting upright. Structural, metabolic, and infectious causes for this presentation were ruled out. Neuroimaging showed paradoxical pressure on the brain from the skin over the right hemispheric craniectomy site. He was diagnosed with SSFS and planned for cranioplasty. Post-cranioplasty, the patient’s headaches completely resolved, and medications were discontinued. He no longer experienced postural left neglect or weakness. Postoperatively, 6MWT was 543m, Berg 56/56, MoCA 30/30.

Clinical Relevance: This case series highlights the diverse clinical presentation, diagnosis, and rehabilitation challenges associated with SSFS, and the benefit of cranioplasty in this condition.
Pediatric Traumatic Brain Injury – Neurocognitive and Psychosocial Outcome 6 Months Post-Injury

**Ingvil Laberg Holthe**, Hilde Margrethe Dahl, Sandra Eichler, Marthe Fjellheim Elseth, Mia Myhre, Nada Andelic, Marianne Løvstad

1 Sunnaas Rehabilitation Hospital, Nesodden, Norway, 2 Oslo University Hospital, Oslo, Norway, 3 University of Oslo, Oslo, Norway

**Background:** The most frequent cause of interruption to a child’s normal course of brain development, is acquired brain injury. Norwegian data regarding long-term outcomes following pediatric traumatic brain injury (pTBI) is limited and therefore vital in order to create and provide appropriate rehabilitation services. This study is one of the few Norwegian explorations of neurocognitive and psychosocial outcomes after pTBI and aims to contribute to a better understanding of this population.

**Method:** This pediatric sub-study is part of a larger European TBI project; Center-TBI. Recruitment took place January 2015 – December 2016. Participants were recruited from the South-Eastern Health Region of Norway. Fifty children aged 12 months to 15 years presenting to Oslo University Hospital (OUH) with verified TBI and CT scan performed within 24 hours were included. Acute medical and demographic data were collected shortly after inclusion. Assessment of neurocognitive and psychosocial symptom burden was performed 6 months post-injury, through neuropsychological testing and self- and parent reported questionnaires, included questions about premorbid symptom levels.

**Results:** The sample was skewed towards the severe end of the spectrum, with 64% of the injuries classified as mild, 22% moderate and 14% severe, based on Glasgow Coma Scale (GCS) scores. A substantial proportion of the mild injuries had intracranial abnormalities on CT/MRI, resulting in a subdivision of the mild group into uncomplicated (n=21) and complicated (n=11) mild TBI. The children with complicated mTBI displayed less favorable outcomes and had neuropsychological results similar to that of the moderate/severe group. Impairment in working memory was seen in the sample overall. Furthermore, 44% had clinically significant WISC-IV index discrepancies, which covaried with head injury severity (AIShead). Additionally, a 40% impairment rate appeared when quantifying neuropsychological impairment as a dichotomous variable, with the rate of impairment being highest in the complicated mild group. In the total sample, there was furthermore a significant increase in parent reported post-concussive symptoms (PCS) after injury. Family functioning and pre-injury symptom levels were correlated with PCS, measures of executive function in everyday life, and aspects of behavioral and emotional functioning at 6 months.

**Conclusion:** The findings demonstrate the heterogeneity that characterizes the pTBI population, in addition to illustrating how deficits may be elusive to detect at first glance, and that relative strengths may obscure actual impairment. Stratifying severity based solely on GCS might result in poor outcome prediction, as a too wide spectrum of injuries fall within the mild classification, underscoring the importance of integrating radiological findings in identifying children at risk for persistent symptoms after mild pTBI. Patients with significant intra-individual variation in neuropsychological performance may have an added risk of deficits going undetected, potentially resulting in sub-optimal treatment.
Surgery or no surgery? Developing a Prognostic Model to Ascertain Risk of Inpatient Mortality in Patients with Traumatic Brain Injury in Singapore

Ramanathan Kannan1, Woan Wui Lim2, Jerry Goo2, Daniel Lee2, Boon Leong Quah2, Gabriel Lu2, Boon Chuan Pang2, Eugene Yang2, Zhixu Ng2

1Lee Kong Chian School of Medicine, Nanyang Technological University, Singapore, 2Neurosurgery division, Trauma Services and General Surgery, Khoo Teck Puat Hospital, Singapore

Introduction: Traumatic brain injury (TBI) is a prevalent and debilitating condition. Given its importance, numerous prognostic models exist. However, there is a paucity of models that account for the effects of surgical intervention on mortality. This study aims to develop a prognostic model that accounts for the effects of surgical intervention on inpatient mortality.

Methods: Adult TBI patients from a single institution were retrospectively reviewed to identify predictors of inpatient mortality. Data from patients admitted between 2012 to 2016 was used to develop the model. Subsequently, the model was validated with data from patients admitted between 2017 to 2018. Univariate binary logistic regression was used to identify independent predictors of mortality and multivariate binary logistic regression was used to develop a model to predict inpatient mortality. Receiver operating characteristic (ROC) curve and its area under the curve (AUC) were used to understand the model’s accuracy.

Results: For model development, 1614 TBI patients were included. Eleven variables – age, male gender, pulse, systolic blood pressure, Glasgow Coma Scale and Injury Severity Score, skull fracture, absence of ventricles, brainstem involvement, ventilation requirement and surgical intervention were identified by multivariate analysis as significant predictors of outcome. A model was developed using these variables and a ROC was generated. The AUC was 0.936 (95% CI: 0.917, 0.954). When a cut-off value of 0.258 was imposed, its sensitivity was 70.2%, specificity was 94.9%.

To externally validate the model, it was applied on 566 TBI patients admitted between January 2017 to June 2018. A ROC was generated, and the AUC was 0.906 (95% CI: 0.865, 0.946)

Conclusion: A model that quantifies the risk of death with and without surgery will be of great clinical use. Hence, this model has significant potential in helping surgeons make clinical judgements that prioritise patients’ best interests. However, the effect of intervention is best studied in prospective studies. Hence, further studies are needed to validate this model prospectively and in the setting of another institution.
Huperzine A in the Treatment of Cognitive and Mood Deficits After Severe and Moderate TBI

Ross Zafonte¹, Joseph Giacino¹, Michael Bergin¹, Felipe Frengi¹
¹ Spaulding Hospital/ Harvard Medical School, Boston, United States

Huperzine A is a natural cholinesterase inhibitor derived from the Chinese herb Huperzia serrata, more commonly referred to as club moss. It has been used in China as a traditional medicine for the treatment of swelling, fever, inflammation, blood disorders, and schizophrenia, and it is approved in China for the treatment of Alzheimer’s disease (AD). The purpose of this study was to investigate Huperzine A in the treatment of individuals with moderate to severe TBI in order to improve cognition, mood, and quality of life. Traumatic Brain Injury (TBI) is a major public health issue, affecting approximately 1.5 million people each year in the United States, particularly veterans of war. This was a randomized, double-blind, placebo-controlled Phase II investigation of the effect of Huperzine A on memory function after moderate to severe TBI as compared to placebo. The safety and tolerability of Huperzine A was also examined. Measures of mood, pain, and subjective complaints of concussive symptoms served as covariates to address potential treatment confounders. The results of the study will be reported. Limitations, caveats, and next steps will be reviewed.
Patient and Injury Characteristics Are Associated with Attrition in Longitudinal Mild Traumatic Brain Injury Research

Harri Isokuortti1, Noah Silverberg2, Minna Wäljas3, Heidi Losoi4, Juha Öhman4, Grant Iverson5, Teemu Luoto4

1Neurology, Helsinki University Hospital and University of Helsinki, Helsinki, Finland, 2Division of Physical Medicine & Rehabilitation, University of British Columbia, Vancouver, Canada, 3Department of Neurosciences and Rehabilitation, Tampere University Hospital, Tampere, Finland, 4Department of Neurosurgery, Tampere University Hospital, Tampere, Finland, 5Department of Physical Medicine and Rehabilitation, Harvard Medical School; Spaulding Rehabilitation Hospital; & Red Sox Foundation and Massachusetts General Hospital Home Base Program, Boston, United States

Background: Attrition bias refers to the systematic influence of study participants who are lost to follow-up on estimates of disease trajectory or treatment effect. Attrition is common in longitudinal research and few studies have addressed the presence and impact of attrition bias on the field of mild traumatic brain injury (MTBI).

Objectives: The main objective is to examine the effects of attrition bias in the context of long-term MTBI outcome research.

Methods: An emergency department sample of patients (n = 75), aged 18-60 years, with no pre-morbid medical or psychiatric conditions or substance abuse, who met the World Health Organization Neurotrauma Task Force criteria for MTBI were enrolled in this prospective, follow-up study. This study was originally aimed at examining the presence of posttraumatic symptoms at 2 weeks (n=62), 1 month (n=62) and 6 months (n=59), 1 year (n=51), 2 years (n=36), 3 years (n=29), 4 years (n=28) and 5 years (n=27) post injury. Participants completed questionnaires during an outpatient visit at 2 weeks, 1 month, 6 months and 1 year. After that, the patients were asked to complete an internet-based questionnaire annually. Baseline risk factors for attrition were investigated by performing logistic regression analyses. Missing vs. complete follow-up data at each time point (from 2 weeks up to 5 years) was used as the dependent variable in the regression. Investigated risk factors included: (i) age, (ii) gender, (iii) high risk for heavy drinking (high scores [≥6] on AUDIT-C), (iv) violent etiology of TBI, (v) low education (<13 years of education), (vi) less severe TBI (GCS 15 vs. 14), (vii) low scores on the Injury Severity Score (ISS), and (iix) low post-concussion symptom burden on first follow-up visit.

Results: Violent etiology of TBI increased the risk for attrition at 1 month (OR 9.0, 95% CI 1.3-60.8, p=0.024), and at 1 year (OR 10.0, 95% CI 1.1-95.1, p=0.045). Low education increased the risk for attrition at 3 years (OR 3.0, 95% CI 1.1-8.2, p=0.032), 4 years (OR 2.7, 95% CI 1.0-7.4, p=0.050), and 5 years (OR 3.2, 95% CI 1.2-9.1, p=0.026).

Conclusions: The attrition rate (17-64%) in this 5-year follow up study was comparable to prior MTBI cohort studies. Most of the investigated patient and injury characteristics did not affect the risk of attrition. The only significant risk factors were violent etiology of TBI and low education. The rate of attrition grew as time from the injury increased.
The Relationship Between Team Climate Factors, Sport Type, and Concussion Reporting Intentions in Collegiate Student-Athletes.

Katherine Arbogast¹, Caroline Ketcham¹, Christopher Riegner¹, Eric Hall¹
¹BrainCARE Research Institute, Elon University, Elon, United States

Concussions are mild traumatic brain injuries that can present with physical, cognitive and emotional symptoms. Research suggests that as many as 50% of concussions go undiagnosed as current practice relies heavily on symptom reporting by the injured athlete for concussion diagnosis (Baugh et al., 2014). Therefore, it is important to address the sports culture and pressures surrounding concussion reporting behaviors from an athlete’s perspective. The primary objective of this study was to assess the influence of sports culture on intentions to report concussive symptoms in collegiate student-athletes. Online surveys were completed by 44 NCAA collegiate athletes (32 female; 12 male). Participants represented multiple sports that were categorized as contact (basketball, football, lacrosse, softball, soccer, volleyball) and non-contact (cross country, golf, tennis, track and field). Survey questions addressed team cohesion (MSCI, Yukelson et al., 1984), motivational climate (PMCSQ-2, Selfriz et al., 1992), coach climate (EDMCO, Duda, 2018), situational intent to report (Kroshus et al., 2014), and qualitative questions around reporting behaviors. Differences were found between contact and non-contact athletes in reporting intentions based on the situation, but no differences were found between genders. Non-contact athletes had greater intention to report in a championship game than non-contact athletes (p=0.02) and showed a similar trend for regular season games (p=0.08), however no differences were found between the contact-level groupings for a preseason practice and regular season practice. Coach climate was correlated with motivational climate (r=0.584, p<0.001) indicating that an empowering coaching climate fostered a positive motivational climate among student-athletes. Qualitative questions were analyzed into predominant themes. Themes related to the rationale of why student-athletes would not report concussion symptoms included wanting to stay in the competition; not wanting to have to go through the rehabilitation process; fear of losing a starting position; and not wanting to let the team down. Additionally, if symptoms were reported, student-athletes were more likely to report to their respective team athletic trainer rather than to a coach or a teammate. Interestingly, student-athletes were more likely to feel comfortable talking to their coaches about injuries compared to personal issues, but clearly concussive symptoms straddle that line. Implications of this study indicate the importance of addressing the driving force of withholding concussion symptoms and suggest that there are many team and individual factors that interrelate to contribute to these behaviors. An increased understanding of non-disclosure behaviors of student-athletes around concussion reporting will help in the management of the recovery process and the return to play progression implemented by sports medicine staff as well as contribute to the well-being of student-athletes and their perception of a positive team climate.
Parental Experience of Delivering Intensive Motor-Focused Intervention for Children with Hemiplegia in Partnership with Therapists

Jill Massey¹, Phoo Pyae Sone Win², Dereena Minehane¹, Ben Siegle¹, Christopher McKevitt², Anne Gordon¹

¹Guys And St Thomas' NHS Foundation Trust, London, United Kingdom, ²Kings College London, London, United Kingdom

Background: Parents can have a key role in working closely with therapists in co-delivery achieving evidence-informed goal-directed intensive rehabilitation intervention for children following brain injury. We provide a novel intervention in a statutory healthcare setting training and supporting parents to co-deliver individualised upper limb therapy to children with hemiplegia. This is an intensive programme, co-delivered by therapists and parents, typically delivered in 6-week blocks with parents delivering 3-4 sessions at home. Parents are trained by clinicians and coached throughout the intervention in sharing responsibility for intervention delivery to achieve the dosage and intensity. Little is known about parents’ experiences of co-delivering therapies.

Method: Following completion of an intervention block, parents are routinely invited to take part in video-recorded semi-structured interviews to reflect on their participation. Parents provide written informed consent to take part. Interviews are conducted by a staff member not involved in delivering the intervention, using a standard topic guide. A convenience sample of 13 interviews was selected for analysis. Interviews were transcribed in full and analysed inductively by authors not involved in the programme.

Results: Themes identified included: i) meeting the demands of intensive therapy co-delivery required various additional commitments to their everyday adult responsibilities but were deemed feasible and acceptable; ii) collaborative goal setting, planning and partnership with the therapists was considered to contribute towards successes in the child’s outcomes; iii) co-delivering therapy increased parents’ awareness of their child’s abilities and limitations, enhancing communication and rapport with the child; iv) participation in the programme required continuous engagement but parents noted fluctuations in engagement from both themselves and the child; parents reported achievements in the child that were often greater than anticipated, enhancing their motivation despite inconveniences; parents valued therapists’ role in building rapport as well as training them in delivery of the programme.

Conclusion: Therapists can engage with parents to enable and support them to co-deliver intensive therapy to their child. Parents reported positive experiences of participating in the programme despite the acknowledged challenges.
Virtual Reality in Cognitive Training

Martin Matre1, Truls Johansen1, Marianne Løvstad1,2
1Sunnaas Rehabilitation Hospital, Nesodden, Norway, 2University of Oslo, Oslo, Norway

Background: Virtual Reality is a way for humans to interact with computers. In immersive Virtual Reality, head-mounted displays and other devices are used to create presence, an experience of “being there” that is absent in non-immersive Virtual Reality such as desktop-based computer games. The technological improvements and an increased accessibility to immersive Virtual Reality (VR) has been substantial over the last few years. This has led to optimism among clinicians and researchers that this technology might be useful for cognitive training. There is an ongoing debate as to the efficacy of traditional computerized cognitive training. Many hopes that VR will overcome some of the limitations of the current cognitive training programs. E.g. with respect to patient motivation, ecological validity, and generalization of training effects.

Objective: The aim of the present study was to identify and review the existing research literature on VR in cognitive training.

Methods: A search was conducted in PubMed and PsychInfo, identifying articles with “VR or Virtual Reality and cognitive training or cognitive rehabilitation” in the abstract. As much of the research literature on cognitive training conflates immersive and non-immersive VR, using the term VR for both, the content of all the articles yielded by the search were scrutinized to isolate those in the former category. Only studies with cognitive tests as an outcome measurement were included, excluding studies where VR e.g. was used for specific skill training, psychotherapy or physical rehabilitation.

Results: The search yielded a total of 118 results. Of these, 8 articles met the inclusion criteria, and were examined in detail in terms of target population, experimental design, training program, technical equipment and outcome measures. The target populations varied from adolescents diagnosed with ADHD, elderly with memory impairment to patients with acquired brain injury such as stroke and traumatic brain injury. The training programs differed both in terms of content and intensity. The most recent study, from 2017, benefitted from the latest technology, vastly superior to that used in the oldest studies from 2002. Most of the studies focused on training of memory and executive functions. All studies concluded that VR can be an effective supplement to cognitive rehabilitation. Most of the studies were however severely methodologically flawed and had issues with design that made it difficult to draw strong conclusions. Small group sizes, lack of control groups and training programs similar to the outcome measurements, were among the chief problems identified.

Conclusions: While a potentially promising approach to cognitive rehabilitation and cognitive training, the present body of research on the subject is limited, both in quantity and quality. More and better designed studies are sorely needed to assess if and for whom this new technology might be an effective tool in rehabilitation.
Clinical Characteristics, Cognitive, Language and School Performance in Children and Young Adults Treated for Low-Grade Astrocytoma in the Posterior Fossa in Childhood

Ingela Kristiansen¹, Bo Strömberg¹, Per Frisk¹
¹Department of Women’s and Children’s Health, Uppsala University and Uppsala University Childrens’ Hospital, Sweden, Uppsala, Sweden

Introduction: Pilocytic astrocytoma is the most common brain tumour in childhood but knowledge concerning its long-term outcome is sparse. The aim of the study was to investigate if children treated for low-grade pilocytic astrocytoma in the posterior fossa had complications affecting physical health, cognition including executive function, language and academic performance. We also wanted to investigate if the patients had a specific cognitive profile, which can provide guidance in developing follow-up and intervention programs.

Methods: A descriptive single-centre study, where 22 children and young adults out of 27 eligible patients (81%) treated for pilocytic astrocytoma in the posterior fossa, with a mean follow-up time of 12.4 years (5–19 years) participated (14 adults, 2 only by telephone interviews and 8 children). The study included a review of medical records, an interview, neurological investigation, a neuropsychological investigation, tests of language function and screening tools for academic performance in Swedish and mathematics.

Results: Motor complications were most common, reported in 12 patients and mainly affecting fine-motor skills. Seven patients reported cognitive difficulties affecting performance in school. Preliminary results for intelligence tests (full-scale WISC and WAIS) show that all 20 participants have intelligence in the normal range; 5 had results above average, 9 average and 5 below average. One had a result in the normal range but an uneven profile. Nineteen patients completed a questionnaire on executive functions (BRIEF); 1 did not complete the questionnaire despite several reminders. Seventeen patients scored on the mean, and 2 scored above.

Further analyses of the neuropsychological- (including tests of executive functions) and language investigations as well as tests of academic performance will be performed and presented. This will include an analysis of the patient’s cognitive profile i e if there are specific areas where difficulties are more pronounced.

Educational support was given in the period immediately after treatment but not after primary school.

Conclusions: The long-term functional outcome for children treated for low-grade astrocytoma is favourable. However, some patients report neurological complications and learning difficulties, which are unmet in school. Preliminary results from intelligence tests indicate that 30% of the investigated patients had cognitive difficulties. The presentation will include all results on neuropsychological, language and academic performance.

For children treated for pilocytic astrocytoma in the posterior fossa, there is a need to identify those who need more thorough medical and cognitive follow-up programmes including interventions in school.
Clinical and Neurophysiological Prognostic Markers for Short-Term Outcome in Prolonged Disorders of Consciousness: A Multi-Center Longitudinal Study of the IBIA-Disorders of Consciousness-Special Interest Group

Salvatore Fiorenza¹, Alfonso Magliacano¹⁴, Antonello Grippò², Anna Maria Romoli², Rita Formisano³, Donatella Mattia³, Angelakis Efthymios⁴, Helena Cassol⁵, Aurore Thibaut⁵, Olivia Gossseries⁵, Enrique Noé⁶, Gianfranco Lamberti⁷, Sergio Bagnato⁸, Brian Edlow⁹, Camille Chatelle⁹, Nicolas Lejeune¹⁰, Michelangelo Bartolo¹¹, Vigneswaran Veeramuthu¹², Luigi Trojano¹³, Jlenia Toppi¹⁴, Séverine Blandiaux⁵, Orsola Masotta¹, Nathan Zasler¹⁵, Caroline Schnakers¹⁶, Anna Estraneo¹

¹Research Lab for DoC, Maugeri Clinical Scientific Institutes, Telesio Terme, Italy, ²IRCCS Don Gnocchi Institute, Florence, Italy, ³Fondazione Santa Lucia IRCCS, Rome, Italy, ⁴Neurosurgery Dept, University of Athens Medical School, Athens, Greece, ⁵Coma Science Group, GIGA Consciousness, University and University Hospital of Liege, Liege, Belgium, ⁶NEUORRH - Servicio de Neurorehabilitacion de Hospitales Vithas, Valencia, Spain, ⁷Neurorehabilitation and Vegetative State Unit "E. Viglietta", Cuneo, Italy, ⁸Fondazione Istituto G. Giglio, Cefalù, Italy, ⁹Neuroimaging of Coma and Consciousness Lab; Div. of Neurocritical Care and Emergency Neurology, Dept of Neurology, Boston, United States, ¹⁰CHN William Lennox, Liege, Belgium, ¹¹HABILITA High Complexity Clinic Institute of rehabilitation, Bergamo, Italy, ¹²Center of Excellence and Research in Neuroscience, Glenaeles Medini Hospital, Medini, Malaysia, ¹³Department of Psychology, University of Campania L. Vanvitelli, Caserta, Italy, ¹⁴Dept. of Computer, Control and Management Engineering, Sapienza University of Rome, Rome, Italy, ¹⁵Concussion Care Centre of Virginia, Department of Physical Medicine and Rehabilitation, Richmond, United States, ¹⁶Research Institute, Casa Colina Hospital and Centers for Healthcare, Pomona, United States

Background: Diagnostic accuracy and reliable prognostic assessment are challenging in patients after severe brain injury with Disorders of Consciousness (DoC).1-3 The Special Interest Group on DoC of the International Brain Injury Association launched a multi-center, longitudinal study on patients with prolonged DoC aiming at identifying clinical and neurophysiological findings with diagnostic and prognostic parameters. This project is part of the DoCMA* consortium.

Methods: Patients in prolonged unresponsive wakefulness syndrome/vegetative state (UWS/VS)⁴ or in minimally conscious state (MCS)⁵ were enrolled at ≤3 months after brain-injury in 12 neurological centres. Coma Recovery Scale-Revised (CRS-R), Noicceptive Coma Scale-Revised (NCS-R), Disability Rating Scale (DRS), EEG background activity and reactivity, somatosensory evoked potentials -SEP, and event related potentials -ERP, were collected at study entry. Clinical follow-up was performed at 6 months post-injury differentiating between improved (i.e. emerged from UWS/VS or from MCS) and not improved patients (i.e. unchanged diagnosis or death).

Results: 148 patients were included (45 women; age: 49.3±19.8 yo; UWS/VS=71, MCS=77; traumatic=55, vascular= 57, anoxic=36; time post-injury=65.6±39.1 days). At study entry, patients in MCS showed higher CRS-R and NCS-R total scores (p<.01) than patients in UWS/VS. EEG background activity (p<.001) and reactivity (p=.02) and presence of P300 on ERP (p=.007) was significantly different in patients with UWS/VS versus MCS, whereas the presence of the N20 on SEP did not differ across the diagnostic groups. Out of 139 patients who completed the follow-up, 70 (50.4%) improved and 69 (49.6%) did not at 6 months post-onset. Logistic regression analysis showed that lower age, male gender, shorter time post-injury, higher CRS-R total score and presence of EEG reactivity to eye opening were significantly associated with a good outcome (all p<.05), whereas etiology, clinical diagnosis, DRS total score, EEG background activity, acoustic reactivity and P300 on ERP at study entry were not associated with a better outcome.
Conclusions: Multimodal assessment could help clinicians in distinguishing patients in UWS/VS from patients in MCS and provide useful prognostic information for optimizing care pathways. Based on our findings, lower age, male gender, shorter time post-injury, higher CRS-R total score and presence of EEG reactivity to eye opening seem to be associated with better outcome. This multi-center project represents an international effort to create guidelines for standardization of diagnostic and prognostic procedures in patients with DoC.

Acknowledgements: *Funded by European Union’s Horizon 2020 programme (Marie Skłodowska-Curie grant 778234 - DoCMA project).

References:
A Multi-Centric Observational Study on Heterotopic Ossification in Severely Brain-Injured Patients with Disorders of Consciousness: Preliminary Data

Orsola Masotta1, Angelo Pascarella1, Vincenzo Loreto1, Luigi Trojano2, Rita Formisano3, Michelangelo Bartolo4, Hend Aabid4, Cecilia Perin5, Francesca Pistoia6, Marco Sarà7, Antonio Nardone8, Marta Berlusconi8, Silvia Marino9, Lucia Lucca10, Simona Gentile11, Roberto Piperno12, Emanuela Casanova12, Anna Maria Romoli13, Federico Scarponi14, Elena Patriarca15, Maria Chiara Carboncini16, Renato Avesani17, Nino Sant'Angelo18, Domenico Intiso19, Anna Rita Diana20, Felicita Pilia20, Gian Pietro Salvi21, Mattia Gambarin22, Silvia Premoselli23, Antonio De Tanti24, Michele Bertoni25, Daniela Biacchi25, Roberto Antenucci26, Anna Estraneo1

1UO Riabilitazione Intensiva e Laboratorio di Valutazione multimodale dei Disordini della Coscienza, ICS Maugeri, Telese Terme, Italy, 2Laboratorio di neuropsicologia, Università della Campania ‘Luigi Vanvitelli’, Caserta, Italy, 3Fondazione Santa Lucia, Roma, Italy, 4Dipartimento Riabilitazione, UGCA, HABILITA, Zingonia, Italy, 5Istituti Clinici Zucchi, School of Medicine Università Milano-Bicocca, Carate Brianza, Italy, 6Dipartimento di Scienze cliniche applicate e biotecnologiche, Università degli studi dell’Aquila, L’Aquila, Italy, 7Unità San Raffaele, Cassino, Italy, 8Unità Operativa di Riabilitazione Specialistica Neurologica/Unità Spinale, ICS Maugeri SPA SB, Pavia, Italy, 9IRCCS Centro Neurolesi “Bonino-Pulejo”, Messina, Italy, 10Istituto S. Anna, Crotone, Italy, 11Dipartimento Riabilitazione F.T. Camplani, Clinica Ancelle Carità, Crotone, Italy, 12Ospedale Maggiore-Casa dei Risvegli Luca De Nigris, Bologna, Italy, 13Don Gnocchi, Firenze, Italy, 14Dipartimento Neurologia, UGCA Ospedale S. Giovanni Battista, Foligno, Italy, 15Unità Risveglio-Ospedale San Giovanni Battista, Roma, Italy, 16Dipartimento delle Specialità Mediche SD Gravi Cerebrolesioni Acquisite, Azienda Ospedaliera Universitaria Pisana, Pisa, Italy, 17Ospedale Sacro Cuore Don Calabria, Verona, Italy, 18UO Riabilitazione, Fondazione San Raffaele Giglio, Cefalù, Italy, 19IRCCS “Casa Sollievo della Sofferenza”, San Giovanni Rotondo, Italy, 20Riabilitazione Ospedale AO Bratzu, Cagliari, Italy, 21U.F. Riabilitazione Neuromotoria, Istituto Clinico Quareghis, S. Pellegrino Terme, Italy, 22Ospedale riabilitativo di Marzana, Verona, Italy, 23SC Riabilitazione Neuromotoria Specialistica, PO Seregno, Azienda Socio Sanitaria Territoriale di Vimercate, Vimercate, Italy, 24Centro Cardinal Ferrari, Santo Stefano Riabilitazione, Fontanellato, Italy, 25Presidio di riabilitazione neuromotoria, Azienda socio sanitaria territoriale dei Sette Laghi, Cusasso al Monte, Italy, 26Medicina Riabilitativa Intensiva, Ospedale Castel San Giovanni, Castel San Giovanni, Italy

Introduction: Heterotopic ossification (HO) is an aberrant formation of lamellar bone in extra-skeletal soft tissues, usually developed around joints [1]. HO is one of the most disabling complications of severely brain-injured (sBI) patients [2,3]. Several possible risk factors (e.g. gender, age, paroxysmal sympathetic hyperactivity-PSH) have been described [1-3].

A monocentric study showed that HO occurs in 23.7% of prolonged BI patients with disorders of consciousness (DoC) [4]. However, no risk factors for HO are available. The present multicentre study aimed at identifying: 1) occurrence of HO in patients with prolonged DoC enrolled in 23 intensive neurorehabilitation Units; 2) possible risk factors.

Materials and Methods: Subjects: 253 BI patients (173 M, mean age: 56.7±17.8; time post-injury: 137.4±20.9 days) with DoC (VS=135, MCS=118) due to traumatic (n=77), anoxic (n=50), vascular (n=109) and mixed (n=17) aetiology.

Variable Collection: At admission: patients’ sex and age, time since injury and aetiology, clinical diagnosis, level of consciousness (by Coma Recovery Scale-Revised, CRS-R), disability (by Disability Rating Scale, DRS), clinical complexity (by Early Rehabilitation Barthel Index, ERBI), presence of ventilatory support and pressure sores. At 3 months after admission: presence of clinically evident HO (i.e. limited range of motion
and/or joint pain and/or local inflammation) confirmed by standard radiological and/or sonographic evaluation and occurrence of PSH.

Results: Thirty-one patients (12.2%) developed HO at 3 months after admission. Proportion of patients with HO did not differ from those without HO as a function of sex (M=11.6%, F=13.8%), age (54.4±16.2 vs 57.1±18.2), time post-injury (138.2 vs 137.3 days), clinical diagnosis (VS=15.6%, MCS=8.5%), CRS-R total score (7.1±4.3 vs 8.3±4.7), ERBI (-215.1±49.3 vs -198.0±54.5), presence of pressure sores (10.4% vs 13.8%), PSH (17.9% vs 10.2%), ventilatory support (4.5% vs 13.0%). Instead, there is difference between the 2 groups in aetiology (p=0.001), being more frequent in patients with mixed (29.4%) than traumatic (19.5%), anoxic (14.0%), or vascular aetiology (3.7%), and in DRS (8.3±0.7 vs 7.9±1.1, p=0.03).

Conclusions: The occurrence of HO is in line with previous observations investigating HO in BI patients [1-4]. HO was more frequent in patients with mixed aetiology. Moreover, HO tends to be present in VS patients with lower (but not significantly) mean CRS-R total score and (significantly) in patients with higher DRS category. Our findings suggest a possible relation between development of HO and level of consciousness and clinical disability status. We did not observe any possible association with known risk factors for occurrence of HO in BI patients with or without DoC [1-3], likely because of higher clinical complexity of patients with DoC.

References
3. van Kampen PJ et al. JHead Trauma Rehabil,2011;26:384-91.
Development of a Minimum Reporting Set for Rehabilitation Interventions Based on ICSO-R

Cecilie Røe, Helene Søberg, Nada Andelic, Marit Kirkevold, Boya Nugraha, Christoph Gutenbrunner

1Department of Physical Medicine and Rehabilitation, Oslo University Hospital Ulleval, Oslo, Norway, 2Institute of Clinical medicine, Faculty of Medicine, University of Oslo, Oslo, Norway, 3Research Centre for Habilitation and Rehabilitation Models & Services, Institute of Health and Society, Faculty of Medicine, University of Oslo, Oslo, Norway, 4Department of Rehabilitation Medicine, Hannover Medical School, Hannover, Germany, 5Faculty of Health Science, Oslo Metropolitan University, Oslo, Norway

Background and Aims: To develop the capacity and quality of rehabilitation services, we need a uniform language to describe and classify existing services. Recently, Gutenbrunner et al proposed the International Classification System for Service Organization in Health-related Rehabilitation (ICSO-R), describing provision (i.e. framework of the institution, resources and organization), funding (i.e., sources of income and refunding) and delivery (i.e. strategy, target group, aspects of time, intensity as well as team structure and mode of production) (J Rehabil Med 2015). These dimensions represent aspects at the meso level of services which may be useful for comparing and contrasting rehabilitation services as well as report and evaluate clinical trials. The classification has been tried out in international workshops and on national rehabilitation services and a modified version developed. The aim of the present project is to develop a minimum reporting set for rehabilitation services in order to improve the quality of reporting of clinical rehabilitation studies.

Material and Methods: The development of the reporting sets will be based on a Delphi process including literature review, international expert panel, field testing and a final consensus process including relevant users of the services.

Results: A literature review including randomized controlled trials in traumatic brain injuries (TBI) indicate that profit orientation and funding of the services is poorly described. Furthermore, important aspects of service delivery and provision may be described, but the type of information and descriptors applied vary largely across studies. This variation represents a significant barrier for knowledge synthesis regarding rehabilitation services. The protocol for the Delphi process and full-scale results will be presented at the congress.

Conclusion: Service provision and delivery in the field of rehabilitation is poorly described and minimum common reporting set is lacking. The development of a cross-culturally applicable reporting set will facilitate knowledge development and improvement of effective rehabilitation services across the different conditions in need of rehabilitation.

Hemorrhagic Shock Aggravates Traumatic Brain Injury: Evidence from PET Imaging Using 18F-Fluorodeoxyglucaric Acid in a Rat Model

Vibhudutta Awasthi\textsuperscript{1}, Hibah Awwad\textsuperscript{1}, Hailey Houson\textsuperscript{1}, Andria Hedrick\textsuperscript{1}, Alexander Mdzinarishvili\textsuperscript{1}, Kelly Standifer\textsuperscript{1}

\textsuperscript{1}University of Oklahoma Health Sciences Center, Oklahoma City, United States

Traumatic brain injury (TBI) is a major cause of death and disability worldwide. The primary damage to the brain in TBI is largely local which results in cortical contusion, vascular injury, hemorrhage, ischemia, and edema. However, the extent of tissue injury and recovery could be complicated if accompanied by hemorrhagic shock (HS) due to a significant blood loss. Even though TBI and HS are leading independent causes of trauma-related mortality and morbidity, complexity and lethality increases when the two injuries are combined. TBI-associated disturbances in cerebral metabolism, redox, ion homeostasis and decoupling of cerebral blood flow from metabolic demand are also pathological events that are aggravated by HS. We present a novel infarct-avid agent 18F-Fluorodeoxyglucaric acid (FGA) for positron emission tomography (PET) to evaluate a preclinical model of mild TBI+HS. Mild TBI was caused by controlled cortical impact (CCI) in Sprague Dawley rats, followed by rapid withdrawal of up to 35\%, 40\%, 45\%, or 50\% of circulating blood via a femoral artery catheter (n=4/group). Survival monitoring, blood pressure, hematology, and blood gases were examined at baseline and at 0 h, 6 h, and 24 h after TBI+HS. To determine FGA accumulation in tissue injury, FGA was injected i.v. (1 mCi) after 24 h of mTBI; 1 h later brain was quickly abscised for ex vivo PET and tetrazolium chloride (TTC) staining. Plasma samples were assayed for tumor necrosis factor (TNF)-\textalpha{}, interleukin (IL)-6, brain-derived nerve factor (BDNF) and Nerve growth factor (NGF) by enzyme-linked immunoassay. Neurobehavioral assessment was done by modified neurological severity score test (mNSS).

We observed an overall mortality of 33\% in mTBI+HS groups and found that the presence of HS significantly increased the mNSS score (1.0±1 in control, 4.3±0.8 in mTBI alone, and 6.9±1.6 in mTBI+50\% HS; p < 0.05). However, we were unable to find any significant increase in plasma TNF-\textalpha{}, IL-6, BDNF, and NGF. Blood gas analyses indicated that this rat model was able to maintain its blood pH, with only moderate decrease in base excess. TTC stained brain slices indicated that as the amount of blood loss increased, the area of brain tissue injury increased. FGA/PET imaging detected both mTBI-induced tissue necrosis and its increasing severity by HS. Radioactive counts in cerebral tissue injured by CCI were significantly increased as compared to those in normal contralateral tissue (p < 0.001). We conclude that this non-invasive technique to image and quantify tissue damage in TBI by PET imaging with FGA has a potential to impact diagnostic assessment of TBI ± HS injury in a clinical setting, including the evaluation of sports-related concussion and accidental head injury.
Prognostic Value of CRS-R for Long-Term Outcome in VS and MCS Patients

Francesco De Bellis¹², Orsola Masotta¹, Vincenzo Loreto¹, Pasquale Moretta¹, Salvatore Fiorenza¹, Daniela Lo Sapio¹, Luigi Trojano², Anna Estraneo¹
¹Maugeri Clinical Scientific Institutes, Telese Terme, Italy, ²University of Campania “Luigi Vanvitelli”, Caserta, Italy

Introduction: Patients with Disorders of Consciousness (DoC) following a severe brain injury can survive for a long time and show clinical improvements in level of disability and consciousness even beyond 12 months after injury [1]. Better outcome is more frequent in minimal conscious state (MCS) than in vegetative state (VS) [2], and in traumatic than in non-traumatic aetiology [3]. Nowadays, specific markers for long-term prognosis in VS and MCS are still unavailable. Recently, it has been observed that the Coma Recovery Scale Revised (CRS-R, [4]) predicts 1-year outcome in patients with DoC [5]. Here, we assessed the prognostic value of CRS-R, along with other clinical and demographic variables, on long-term outcome (from 12 to 36 months post-injury) in VS and MCS patients separately.

Materials and Methods: Patients. 159 patients in VS (61 females, mean age 59.8±17 years, traumatic=31, vascular=67 and anoxic=61) and 57 patients in MCS (23 females; mean age: 56.7±18.7 years; traumatic=18, vascular=29 and anoxic=10).

Procedure: Demographic (i.e., sex, age at time of injury), anamnestic (i.e., time since onset and aetiology) and clinical data (i.e., level of consciousness and of functional disability, assessed by CRS-R and Disability Rating Scale – DRS respectively) were collected at study entry as possible predictors. Outcome measures, including incident mortality and improvement in clinical diagnosis (i.e., transition from VS to MCS and from MCS to full consciousness), were collected at 12, 24, and 36 months post-onset. Multivariate logistic regression analyses were used to assess relationships of candidate predictors with outcome measures.

Results: In VS, CRS-R total scores at enrolment predicted higher chance of survival and clinical improvement at 12 months. At the same time point, younger age and shorter time since injury were associated to higher survival and clinical improvements respectively. Moreover, female sex predicted clinical improvements at 24 months. In MCS group, younger age and female sex were predictive of improvements in clinical diagnosis at 12 months.

Conclusions: We found that CRS-R was a valuable prognostic indicator for relatively long-term (12 months) prognosis in VS but not in MCS. Moreover, we identified some other clinical factors (age, sex and time from injury) related to the clinical evolution up to 24 months in VS. We also observed that sex and age predict 1-year prognosis in MCS group, but the clinical heterogeneity of MCS (that might be subcategorized in MCS minus and plus) likely prevented identification of other relevant prognostic markers.

References
Predictors of Outcome and Health-Related Quality of Life After Mild TBI in Elderly

Joukje van der Naalt¹, Amaal Eman Abdulle¹, Jacoba Spikman², Gerard Hageman³, Gerwin Roks⁴

¹Department of Neurology, University Medical Center Groningen, Groningen, Netherlands, ²Department of Psychology, University Medical Center Groningen, Groningen, Netherlands, ³Medisch Spectrum Twente, Enschede, Netherlands, ⁴Elisabeth Hospital, Tilburg, Netherlands

Scope of the Problem: The risk of sustaining a traumatic brain injury (TBI) increases with age. Currently one in 4 patients admitted to the Emergency department with TBI is aged 60 years or older and this percentage is increasing. Most outcome studies focus on patients of the working age and specific information on elderly patients is lacking in current outcome studies. Elderly patients have additional age-related factors that influence outcome like increased comorbidities, physical and cognitive impairments. Most patients sustain a mild TBI after low-energy accidents such as a fall and are at risk for secondary deterioration because of the use of oral anti-coagulation therapy. In view of the increasing number of elderly patients it is important to identify specific factors that are related to outcome after mild TBI in elderly in order to develop targeted treatment.

Study Design and Results: Between 2013-2015 a long-term follow-up study of patients with mild TBI was started at 3 level-1 trauma centers in the Netherlands (UPFRONT-study). Data were collected on posttraumatic complaints, physical impairments, coping and emotional distress during several intervals (2 weeks, 3 and 6 months) up to one-year post-injury. Pre-injury mental and physical complaints together with frailty were determined. Outcome was determined with the Glasgow Outcome Scale Extended (GOSE) and health-related quality of life (HRQoL) six months after injury.

In total 1151 patients were included of whom 292 (25%) were aged 60 years or older. Overall outcome showed incomplete recovery (GOSE ≤7) in 44% of patients. HRQoL was high with 75% rating of level 4-5 (good to very good). Pre-injury complaints, coping style and emotional distress with GOSE at 6 months post-injury were predictive factors for overall HRQoL. Elderly patients showing a higher HRQoL than their younger counterparts. Moreover, outcome was found not to be related to age, but merely to frailty in elderly patients, in addition to early posttraumatic complaints (Nagelkerke R2 of 46%). In elderly, the living situation nor the severity of injury (determined by CT-abnormalities and GCS on admission was associated with outcome.

Conclusion: Data will be presented on the outcome of elderly patients after mild TBI. Focus will be on the differences between elderly patients and other age categories regarding the predicting factors that determine outcome of patients. Finally, advices for post-injury identification of patients at risk for incomplete recovery and treatment of this particular category of patients will be formulated.
Treatment of Recractory Myoclonus with Perampanel in Lance Adams Syndrome- A Report of Two Cases

Kudret Yelden¹, Luke Rendell¹, Linda Vardy¹, Alex Rose¹, Sarah Crilly¹, Kathryn Merrison¹
¹Royal Hospital for Neuro-disability, London, United Kingdom

Lance-Adams syndrome (LAS) is a rare complication of anoxic brain injury (ABI) and characterized by uncontrolled myoclonic jerks/action myoclonus. Patients usually have good cognition but physically disabled due to severe myoclonic jerks.

Here we report two cases of LAS who were resistant to treatment with high-doses of triple antiepileptics (levetiracetam, clonazepam and valproate) but responded well to Perampanel with improvement of myoclonic jerks and their functional abilities.

Case-1 was a 69-year-old man who suffered from ABI following severe pneumonia. His past medical history included paranoid schizophrenia, leg length discrepancy of 10cm and vertigo. He was admitted to our unit 3 months post-ABI. He had severe daytime somnolence which prevented him participating in his rehabilitation program. He also had severe cognitive and communication difficulties.

His Unified Myoclonus Rating Scale (UMRS) on admission showed severe functional disability score of 27/28 and global disability score of 3/4. Following the start of Perampanel we stopped the daytime doses of clonazepam which resolved daytime somnolence. With Perampanel his UMRS scores improved greatly (Functional score 19/28 and global disability score 2/4). On discharge he was able to self-propel in his wheelchair, and feed and drink himself more efficiently. Therapeutic techniques included a combination of isolated and paced movements with repeated reach and grasp tasks. This was extended by using distraction to divide attention from the intentional movement and give opportunity for more automatic movements.

Case-2 was a 37-year-old female who suffered from ABI due to accidental decannulation of tracheostomy tube. She was admitted to our rehabilitation unit 6 months post ABI. Her past medical history included obstructive sleep apnoea, obesity and anxiety disorder. Her myoclonic jerks were severe putting her at risk of falls and even effecting her speech. She was able to mobilize two lengths of parallel bars with assistance of two. Her motor functions showed great variability and at her best she was able to mobilize 5 meters with assistance of one. Her BERG balance score was 18/56. We managed to wean the clonazepam off without increase of myoclonic jerks. She was commenced on Perampanel which led to increased fluidity of stepping, ability to mobilize 30 meters with supervision of one person, climbing up and down 20 steps and a much clearer speech. Her BERG balance score increased to 32/56. Moreover, were able to wean off Valproate. She was also supported with mindfulness approach, cognitive-behavioural therapy and music & singing as a distraction during mobilization.

Conclusion: Lance Adams Syndrome is a very disabling condition and may be difficult to treat. Perampanel should be considered for refractory cases. In our two cases Perampanel led to increased function and aided to wean off other anti-epileptic medications without any worsening of myoclonus.
Age-Related Long-Term Health-Related Quality of Life After Mild TBI

Amaal Eman Abdulle¹, Jacoba Spikman², Gerard Hageman³, Gerwin Roks⁴, Joukie van der Naalt¹
¹Department of Neurology, University Medical Center Groningen, Groningen, Netherlands, ²Department of Psychology, University Medical Center Groningen, Groningen, Netherlands, ³Medisch Spectrum Twente, Enschede, Netherlands, ⁴Elisabeth Hospital, Tilburg, Netherlands

Introduction: Although majority of patients who sustain mild traumatic brain injury (MTBI) show full recovery within 3-6 months, 15-25% still experiences persistent post-traumatic complaints 6 months after injury interfering with return to work. Epidemiological patterns for TBI have changed with more injuries occurring among elderly patients and large studies investigating the age-related HRQL in MTBI patients are currently lacking. Therefore, the aim of this study is to investigate the age-related HRQL in MTBI patients and to identify the predictors of a reduced HRQL.

Methods: Data on 453 participants admitted with MTBI to the Emergency Department (January 2013 - January 2015) of three Dutch Level-1 hospitals were collected. Long-term health related quality of life was assessed at 1-year post-injury. In addition, information on anxiety and depression, post-traumatic complaints, functional outcome, post-traumatic stress and coping style was assessed at 6 months post-injury. Patients were divided in three age-groups, namely: young adults (16-40), adults (41-60) and elderly (≥ 61 years).

Results: Mean age was 49.8 (± 18.2) range 16-91 years, with a male/female ratio of 1:1.5. At six months post-injury, the majority (57%) of all patients showed complete recovery (young adults 35%, adults 49%, elderly 43%, p=0.06). Post-traumatic complaints differed significantly between groups (young adults 85%; adults 73%; elderly 79.6%, p<0.01). No significant differences between groups were found regarding post-traumatic stress (p=0.64), anxiety (p=0.42) and depression (p=0.83). In relation to the overall HRQL, a distinctive pattern was observed with decreasing scores up to age-group 51-60 and increasing scores beyond this age-group. Pre-injury complaints, coping style, the presence of anxiety or depression and GOSE scores were found to be the main predictors of long-term HRQL.

Conclusions: The current study demonstrated that one-year post-injury, the majority show high levels HRQL but with clear age-related differences. It was demonstrated that pre-injury complaints, coping style, the presence of anxiety or depression and GOSE scores are the main predictors of long-term HRQL. The fact that age was not found to be a significant predictor of HRQL, might indicate that other group-dependent variables have a greater impact on HRQL. We postulate that the identification of long-term HRQL could help to identify the long-term care needs for MTBI patients.
Great Toe Hyperextension as a Result of Maladaptive Compensation for Spastic Foot Drop in Post-Stroke Hemiplegic Gait

Jason Edwards¹, Elaine Magat¹,², Sheng Li¹,²
¹University of Texas Health Science Center at Houston / McGovern Medical School, Houston, United States, ²TIRR Memorial Hermann, Houston, United States

A 64-year-old female with history of right MCA stroke 15 months ago with residual left-sided weakness presents with a one-year complaint of hyperextension of her left great toe with associated pain. She regained the ability to walk several weeks following her stroke with subsequent development of great toe hyperextension. She had two previous injections of her left extensor hallucis longus (EHL) (50, and 100 units of Onabotulinum toxin A, respectively) at an outside facility without improvement. The patient was referred to our clinic for possible phenol neurolysis for EHL overactivity.

On exam, patient had hyperextension of her left great toe of 60 degrees in a resting supine position. Walking with a cane, she had full foot contact on the left during stance phase, but the left ankle then became plantarflexed (~30 degrees) with great toe hyperextension. Needle electromyography showed spontaneous firing greatest in the left gastrocnemius and EHL muscles with moderate activity of soleus and faint activity of tibialis anterior. A diagnostic lidocaine block of her tibial nerve was performed, resulting in full foot contact with the floor and greatly reduced great toe hyperextension during stance phase.

Given the gradual development of great toe hyperextension, needle EMG findings, and the patient’s responses to the nerve block, EHL overactivity and great toe hyperextension are likely a maladaptive reaction to spastic foot drop and compensatory to provide ankle and foot stability for weight bearing on the metatarsophalangeal joint.

This case emphasizes the importance of carefully selecting muscles based on the mechanical effects of spastic muscles on ankle and foot positioning during walking when treating post-stroke spasticity with botulinum toxin.
Experiences of Intimate Relationships in Young Women with Brain Injury

Valérie Poulin¹², Catherine Wiseman-Hakes³, Mélissa Laflamme¹, Madiha Saleem³, Peraveena Balachandran³, Emily Nalder³⁶, Caron Gan⁴, Angela Colantonio³⁵, Alexandra Jean¹
¹Université Du Québec À Trois-rivières, Trois-Rivières, Canada, ²Centre interdisciplinaire de recherche en réadaptation et en intégration sociale (CIRRIS), Québec, Canada, ³University of Toronto, Toronto, Canada, ⁴Bloorview Research Institute, Toronto, Canada, ⁵Toronto Rehabilitation Institute, Toronto, Canada, ⁶March of Dimes, Toronto, Canada

Rationale: Youth and adults with traumatic brain injury (TBI) often experience difficulties initiating and maintaining intimate relationships, and social isolation is well recognized as one of the prevalent long-term consequences. Given that intimate relationships are a critical component of mental health and an important part of human development, research which explores the experiences of intimacy in those with TBI is necessary to understand the needs as well as barriers and facilitators to the development of appropriate interventions. As males have a higher incidence of TBI, most studies have focused primarily on male survivors, however, there is increased awareness of sex and gender differences in recovery following TBI and increasing evidence that women have unique needs for rehabilitation. Also, the challenges faced by younger woman with TBI in developing and maintaining intimate relationships are often overlooked in both research and traditional rehabilitation programs, leaving them vulnerable to loneliness, lack of meaningful friendships, and potentially, exploitation and abuse. Furthermore, parents of girls and young women have identified significant concerns regarding their daughter’s emotional and physical well-being and safety.

Objectives: This study aimed to explore the lived experiences of young women with moderate to severe TBI in relation to how they engage in intimate relationships and, to explore the experiences of their parents as their daughters navigated intimate relationships.

Methods: A qualitative study using interpretative phenomenological analysis was conducted with four women (18-25 years old) with moderate to severe TBI and two parents. Data were collected through individual semi-structured interviews and analysed by two coauthors. The interview guide was revised through consultation of interdisciplinary experts (clinicians and researchers) and a young woman with TBI.

Results: The young women described a loss of friends and social networks after their TBI and a lack of opportunities to build intimate relationships. Positive support from their close social environment, particularly their family members, was perceived as a facilitator. They also discussed the benefits of engaging in valued and meaningful occupations to promote their sense of self-worth and self-confidence, as a prerequisite to engagement in satisfying intimate relationships. Parents reported being concerned with various issues regarding their daughter’s ability to navigate intimate relationships; both sexual and non-sexual. They also cited concerns regarding lack of balance between their caregiving responsibilities and their other life roles since their child’s TBI, as well as the limited access to educational and support services for both themselves and their daughter.

Conclusion: This study represents a first step towards a better understanding of the development of intimate relationships in young women with TBI. Findings may contribute to inform the development of future gender-specific multi-disciplinary interventions to promote the development and maintenance of sustainable, healthy, intimate relationships, which may facilitate positive social outcomes.
Dynamic Resting State Functional Connectivity in Moderate-Severe Traumatic Brain Injury

Arianna Rigon¹, Melissa Duff¹, Michelle Voss²
¹Vanderbilt University Medical Center, Nashville, United States, ²The University of Iowa, Iowa City, United States

Disruption in the functional integrity of large-scale neural networks following traumatic brain injury (TBI) has been well documented, in particular using static resting state functional magnetic resonance imaging (fMRI), which examines the temporal correlations between spatially remote brain regions. However, to date no work has investigated whether moderate-to-severe TBI disrupts the way functional connectivity changes over short periods of time (i.e., dynamic functional connectivity, dFC), and how different large-scale systems interact with each other.

The aim of the current study was to use resting state fMRI to examine dFC in a moderate-to-severe TBI population, in order to add to our knowledge of how TBI disrupts brain functionality, and to uncover new possible biomarkers of cognitive dysfunction caused by TBI. We used a sliding window approach to examine resting state dFC in a sample of 32 individuals with moderate-severe TBI and 21 healthy comparison (HC) participants. In particular, we focused on seven brain networks: Visual, Somatomotor, Dorsal Attention, Ventral Attention, Limbic, Frontoparietal, and Default, and found that individuals with TBI displayed significantly lower dFC (i.e., fewer oscillations of functional connectivity between these brain networks and the rest of the brain) than HCs. Further inspection of the topographical data revealed that it was predominantly network hubs (i.e., regions that are habitually rich in connections, such as the precuneus, anterior insula, and dorsal anterior cingulate cortex) that were less dynamically connected to large-scale brain networks in TBI.

This work reveals that moderate-severe TBI disrupts the dynamic functional integrity of large-scale neural systems and provides evidence that TBI is associated with abnormal patterns of fluctuating communication between brain networks that underlie different cognitive, affective, and behavioral functioning.
Spatial Relational Memory in Individuals with Traumatic Brain Injury

Arianna Rigon¹, Hillary Schwarb², Nathaniel Klooster³, Neal Cohen², Melissa Duff¹
¹Vanderbilt University Medical Center, Nashville, United States, ²Beckman Institute, University of Illinois at Urbana-Champaign, Urbana, United States, ³University of Pennsylvania, Philadelphia, United States

Relational memory is the ability to bind arbitrary relations between elements of experience into durable representations and the flexible express of these representations. While the fact that declarative memory is impaired in individuals with moderate to severe traumatic brain injury (TBI) is well known, to date no study has examined the effect of TBI on relational memory. Here, we used a spatial reconstruction task (SRT) to 29 individuals with TBI and 23 normal comparisons (NCs) to investigate four different types of spatial relations: (A) identity-location relations, i.e. the relationship between a specific item and its known location; (B) item-item relations, or the relationship between one item and another; (C) item-display relations, or the relationship between an item and its position in the display; and (D) compound-item relations, i.e. relations that involve combinations of A, B, and C. Our data revealed that individuals with TBI showed impairments in learning identity-location relations and increased compound errors compared to NCs. We also found evidence that when item identity is disregarded, individuals with TBI do not perform differently from NCs. In addition, an exploratory analysis revealed that while performance on relational memory was significantly correlated with scores on the California Verbal Learning Test (CVLT), more participants with TBI exhibited impairment on the SRT than of the CVLT. Our findings show for the first time that relational memory is impaired following TBI and provide preliminary evidence for an easy-to-administer task that might be sensitive to detect memory impairment.
The Modulatory Impact of Cognitive Reserve on the Clinical Outcome of Patients with Severe Traumatic Brain Injury: A Voxel- Based Morphometry Study

Chiara Falletta Caravasso¹, Laura Serra¹, Giovanni Giulietti¹, Francesco de Pasquale², Paola Ciurli¹, Umberto Sabatini³, Marco Bozzali¹,³, Rita Formisano¹

¹Irccs Fondazione Santa Lucia, Rome, Italy, ²University of Teramo, Faculty of Veterinary Medicine, Teramo, Italia, ³Brighton & Sussex Medical School, University of Sussex, Brighton, United Kingdom, ⁴Department of Medical and Surgical Sciences, Magna Graecia University, Catanzaro, Italy

Objective: The study aimed at investigating the neurobiological correlates of cognitive reserve (CR) when modulating the clinical outcome of patients with traumatic brain injury (TBI). As previously shown in neurodegenerative disease, we hypothesized that changes in regional grey matter (GM) volumetrics might, at least partially, reflect an effect of CR.

Methods: 26 TBI patients naïve for any rehabilitation treatment at the time of recruitment, underwent a 3T MRI brain scan. In all patients the functional clinical outcome was assessed using the Level of Cognitive Functioning Scale and Glasgow Outcome Scale. Patients were divided in two groups on the basis of their level of CR estimated by years of formal education: high CR (HCR) and low CR (LCR). After outlining and removing macroscopic lesions, T1-weighted scans were used to perform voxel-based morphometry (VBM) analysis. We confined VBM analysis to the GM tissue that was spared by macroscopic damage in all patients.

Results: Cross-sectional VBM comparison showed GM volume loss in the Thalamus, Posterior Cingulate Cortex, Frontal Cortex, Cerebellum, and Precuneus in the TBI group compared to HS.

TBI-HCR patients respect to HS group showed GM volume loss in the right Thalamus, Hippocampus, Cerebellum, Parietal and Frontal Lobe bilaterally. TBI-LCR patients compared to HS group, showed GM volume loss in the left Caudate and Thalamus, Cerebellum and in the Insula, Hippocampus and Frontal cortex bilaterally. HCR respect to LCR showed reduction in GM volume in the Temporo-Parietal Junction, the Precuneus and Parieto-Occipital areas, the Cerebellum, and Supplementary Motor area.

Despite similar levels of disease severity, significant direct correlation was found in the TBI-HCR group but not in the TBI-LCR patients’ group, between scores obtained at the GOS scale and GM volume in the Occipital Inferior cortex and in the Cuneus, Lingual gyrus, Calcarine and middle Temporal cortex bilaterally.

Conclusions: In presence of similar macroscopic lesions and clinical outcomes between groups, HCR patients showed an association between GM volumes in critical areas for cognition and the clinical outcome. The findings of this study suggest the influence of CR in modifying the relationship between GM tissue damage and clinical outcome. In particular, patients with TBI and HCR withstanding brain damage better than those with low CR (CR hypothesis).
Bilateral M1 Anodal Transcranial Direct Current Stimulation in Post-Traumatic Chronic Minimally Conscious State: A Pilot EEG-tDCS Study

Nino Basaglia¹, Laila Craighero², Felipe Fregni³, Susanna Lavezzi¹, Sonia Mele², Andrea Montis³, Valentina Bonsangue¹, Sofia Straudi
¹Neuroscience and Rehabilitation Department, Ferrara University Hospital, Ferrara, Italy, ²Biomedical and Specialty Surgical Sciences Department, Ferrara University, Ferrara, Italy, ³Sardinian Health Trust, Neurorehabilitation Unit, San Martino Hospital, Oristano, Italy, ⁴Department of Physical Medicine and Rehabilitation, Harvard Medical School, Neuromodulation Center, Spaulding Rehabilitation Hospital, Boston, United States

Objective: Disorders of consciousness (DOC) after severe brain injury are associated with multiple impairments and have a significant impact on public health related costs. We tested the preliminary effects of bilateral anodal transcranial direct current stimulation (tDCS) in patients with disorders of consciousness.

Design: Open label pilot study.

Subjects: we enrolled 10 patients who were admitted to the Severe Brain Injury Unit (Neuroscience and Rehabilitation Department, Ferrara University Hospital, Italy) between November 2014 and October 2016 for a multidisciplinary rehabilitation program. Ten chronic (greater than 12 months) patients in a minimally conscious state (MCS) following severe traumatic brain injury, iv) > 12 months after the injury.

Methods: The patients received 10 sessions of bilateral M1 anodal tDCS, (five sessions/ week for two weeks). tDCS was applied for 40 minutes at a current intensity of 2 mA. Behavioural changes were assessed with the Coma Recovery Scale-Revised (CRS-R) before stimulation (T₁, T₀), after five sessions (T₁), at the end of the stimulation (T₂), after two weeks (T₃) and after three months (T₄). Moreover, an EEG assessment was conducted.

Results: All patients tolerated tDCS without any significant adverse effects related to the stimulation. Eight out of 10 patients showed new clinical signs of consciousness; specifically, a 2-point CRS-R improvement was detected in the last follow-up (p=0.004). EEG upper α bandwidth was greater in the parietal site at T₁ (p < 0.034). In addition, we found a significant correlation between behavioral and EEG indices at T₁ (r=0.89; p=0.001).

Conclusion: This longitudinal pilot study shows that the bilateral application of anodal tDCS over M1 is feasible and preliminarily safe in severely compromised patients with MCS and that it may improve CRS-R total scores and transiently alpha frequency. Our study is the first that stimulated bilateral M1 with anodal tDCS with the aim of accessing subcortical structures, especially the thalamus. This preliminary study presents several limitations (small sample size and no control group). However, it provides important initial data that can be used to design randomized clinical trials testing this novel approach in MCS and to further explore EEG as a neural marker for the effects of tDCS.
Abnormal Brain Enlargement Revealed in Patients with Chronic Mild and Moderate Traumatic Brain Injury

David Ross¹
¹Virginia Institute of Neuropsychiatry, Midlothian, United States

There have been few reported cross-sectional studies of MRI brain volume in patients with chronic mild or moderate traumatic brain injury (TBI). NeuroQuant 2.0 has been used extensively clinically and provides a richly detailed evaluation of brain volume.

Methods: 41 patients with chronic mild or moderate TBI were compared to 80 normal control participants. The patients were consecutive admissions to the outpatient clinic at the Virginia Institute of Neuropsychiatry who met the selection criteria. The normal controls were participants in the Alzheimer’s Disease Neuroimaging Initiative (ADNI) study. Patients and normal controls did not differ significantly with respect to age, sex or education. All participants underwent brain MRI scanning. Cross-sectional brain volume of 78 brain regions was measured with NeuroQuant 2.0. The NeuroGage 2.0 brain volume estimation method was used to estimate volume for each patient just before injury (time 0 = t1), and then brain volume change from before to after injury (t0-t1) was compared to normal control brain volume change over a 1-year period. For additional details regarding methods, please refer to the multiple previous publications by our group.

Results: For the t0-t1 analyses, the TBI patients had abnormally fast atrophy of cerebral white matter and abnormally fast enlargement of subcortical nuclei + infratentorial regions, essentially replicating our previous findings. At time 1 (t1), the patients had abnormally large cerebellar white matter, ventral diencephalon, primary motor cortex, inferior parietal cortex, medial occipital cortex, fusiform gyrus, amygdala and hippocampus.

Discussion: To our knowledge, this is the first report of widespread brain volume enlargement in patients with (mild or moderate) TBI. This finding stands in contrast to decades of previous research done mostly in patients with moderate or severe TBI, and which found extensive brain atrophy. We hypothesize that the abnormal brain enlargement is caused by hyperactivity and hypertrophy of less-injured brain regions attempting to compensate for injury to other brain regions. We present a case report of a TBI patient providing preliminary evidence for this hypothesis: on the day of injury, CT scanning showed extensive left cerebral injury with bleeding; about a year later, MRI scanning showed some left-sided cerebral atrophy but more extensive right-sided cerebral abnormal enlargement.
The Predictive Value of Persisting Post Concussion Symptoms on Recovery Trajectories

John Olver¹,², Bianca Fedele¹,², Dean McKenzie¹,², Rose Acher¹
¹Epworth Healthcare, Richmond, Australia, ²Monash University, Melbourne, Australia

Objectives: Post-concussion, approximately 15% of cases will experience ongoing symptoms for months after the injury. This prolongs recovery and return to pre-injury activity. This group can benefit from individualised treatment of symptoms within a concussion clinic. The study evaluates the predictive value of post-concussion symptom clusters on patients' activity levels on discharge from the Epworth Rehabilitation Concussion Clinic.

Method: The Clinic administers the Oregon Post Concussion Symptom Checklist on admission and discharge. It consists of 23 symptoms, which the patient rates between 0 – 6 in severity. The list is grouped by symptom clusters (physical, cognitive, emotional and sleeping deficits).

Results: These preliminary results reflect patients currently discharged from the clinic (n=63). Patients were admitted on average, 88.8 days post injury (SD = 149.4), the average age was 33.2 years (SD=14.8) and the majority were male (68%). The primary causes of concussion were sport-related (41.3%), falls (23.8%) or motor vehicle accidents (12.7%). A prior history of concussion was present in (57.1%).

Cronbach’s alpha, a measure of internal consistency, was calculated for each of the above symptom clusters. Alpha was high for Physical (0.85), Thinking (0.92) and Emotional (0.92), with all items exhibiting item-total correlations) =>0.40.

The scale was evaluated at a symptom level, to determine whether specific predictors exist for worsening performance on discharge. Linear regression (controlling for age, gender, time elapsed since injury and past history of concussion), and entering all 23 items simultaneously identified sensitivity to light (p = 0.008) and noise (p = 0.021), dizziness (0.062), difficulty concentrating (0.097), emotional irritability (0.086) and sleeping more than usual (p = 0.082) as achieving or approaching statistical significance. For each one-point increase in symptom severity, final adjusted activity levels were reduced by: 14.4% for sensitivity to light, 10.1% for dizziness, 6.4% for emotional irritability and 1.7% for difficulty concentrating.

Conclusions: In this preliminary study, specific symptom severity on admission was found to have predictive value related to outcome on discharge. This information can be used for rehabilitation program development to achieve better functional outcomes and symptom resolution after concussion. The study is continuing and more formal scale development, including Rasch modelling is planned.
The Impact of the Cognitive Level on Recovery in Traumatic Brain Injury Patients During A Robot-Assisted Gait Training (RAGT)

Marina Macca¹, Valentina Bonsangue¹, Luc Oscar Lissom¹, Sofia Straudi¹, Susanna Lavezzi¹, Giacomo Severini², Nino Basaglia¹
¹Neuroscience and Rehabilitation Department, Ferrara University Hospital, Ferrara, Italy, ²School of Electrical and Electronic Engineering, University College Dublin, Dublin, Ireland

Background: Traumatic brain injury (TBI) leads to cognitive and functional sequelae in 25-95%. Recently, robot-assisted gait training (RAGT) has been introduced in the rehabilitation settings to increase functional recovery; however, no clear evidence is available on the role of the cognitive status on the applicability and effects of this intervention. The aim of this study was to investigate the role of the cognitive level at admission on recovery, in terms of walking function, independence of daily living and cognition, in a cohort of TBI patients who received RAGT.

Methods: We retrospectively analyzed a database that includes patients with TBI who undergone an inpatient multidisciplinary rehabilitation at Ferrara University Hospital and received a robot-assisted gait rehabilitation (Lokomat, Hocoma, Switzerland) between January 2007 and December 2017. In this retrospective observational study, we have collected demographic (sex, age) and clinical data. Moreover, a set of outcome measures at admission and discharge has been registered to measure their walking function (Functional Ambulatory Classification), independence of daily living (Functional Independence Measure) and cognition (Levels of Cognitive Functioning). In addition, the rehabilitation length of stay (LOS) and the number of RAGT sessions were collected.

Results: We collected 86 patients with TBI (20 females and 66 males, 34.96 ± 16.11 years, 15-8979 days since TBI) who underwent RAGT during their rehabilitation. They were grouped into three classes according to their level of cognitive functioning (LCF); group 1 LCF 2-3 (n = 26); group 2 LCF 4-5 (n=27); group 3 LCF 6-7 (n = 33). The analysis showed that patients with a low cognitive level at admission had the greater recovery during rehabilitation, characterized by an improvement not only of their cognition (p = 0.001), but also of their walking function (p = 0.037) and independence of daily living (p = 0.0001). In addition, evidence of greater gains were demonstrated in patients in the sub-acute rather than chronic rehabilitation phase (p = 0.0001). All groups received the same number of RAGT sessions during rehabilitation.

Conclusion: A classification based on the level of cognition at admission highlighted the proportional recovery reached by TBI patients during a multidisciplinary rehabilitation that encompass robot-assisted gait training.
Left Hemisphere White-Matter Integrity is Associated with Short-Term Verbal Memory Impairment Following TBI

Arianna Rigon¹, Michelle Voss², Lyn Turkstra³, Bilge Multu⁴, Melissa Duff⁵
¹Vanderbilt University Medical Center, Nashville, United States, ²The University of Iowa, Iowa City, United States, ³McMaster University, Hamilton, Canada, ⁴The University of Wisconsin, Madison, United States

Deficits in both long and short-term memory are among the most common and frequently treated consequence of moderate-severe traumatic brain injury (TBI). These deficits interfere with daily life and post-injury rehabilitation, including the learning of new compensatory strategies. Short-term verbal memory is the ability to store verbal information for brief periods of time. However, little is known about the neural correlates of short-term deficits following TBI and in particular about whether specific patterns of white-matter damage lead to worse verbal short-term memory outcomes. In the current study, we used diffusion tensor imaging (DTI), particularly fractional anisotropy (FA), to examine the association between white-matter damage and short-term verbal memory performance on a sample of thirty-two individuals with chronic moderate-to-severe TBI and twenty healthy-comparison participants. To measure short-term verbal memory, we used the Immediate Recall subtest of the California Verbal Learning Test (CVLT-Immediate). Our analyses revealed that the performance of individuals with TBI was significantly lower on the CVLT-Immediate (p<.05) and that individuals with TBI displayed lower FA in widespread white-matter tracts than healthy comparison participants (p<.01). An exploratory whole-brain analysis showed that, within the TBI group, performance on the CVLT-Immediate was significantly correlated with white-matter integrity in the following tracts: the bilateral anterior thalamic radiation; inferior front-occipital fasciculus; inferior longitudinal fasciculus, forceps minor, and uncinate fasciculus; and the left superior longitudinal fasciculus, cingulum, forceps major, and corticospinal tract. Further analysis revealed that 76% of the voxels whose white-matter integrity correlated with CVLT-Immediate performance within the TBI group were located in the left hemisphere, while only 23% were located in the right hemisphere. These preliminary findings suggest that white-matter damage predominantly located in the left hemisphere might be associated with verbal short-term memory deficits in the chronic phase of a TBI.
Persistent Fatigue Following Moderate and Severe TBI - A Prospective Longitudinal Study

Daniel Løke1,2, Nada Andelic2,3, Anne-Kristine Schanke1,2, Olav Vassend2, Stein Andersson2, Eirik Helseth2,3, Marianne Løvstad1,2

1Sunnaas Rehabilitation Hospital, Nesodden, Norway, 2University of Oslo, Oslo, Norway, 3Oslo University Hospital, Oslo, Norway

Objectives: Various biological, psychological and social mechanisms have been shown to be associated with the development of subjective fatigue in different patient groups. There is currently a scarcity of longitudinal studies examining the mechanisms associated with fatigue following traumatic brain injury (TBI). The overall aim of the study is to examine trajectories and mechanisms associated with subjectively reported persistent fatigue within the first year following moderate to severe TBI. More precisely the study will: a) establish frequency and severity of persistent fatigue following moderate to severe TBI, b) investigate clinical subgroups based on symptom clusters, included trajectories of fatigue and related symptoms during the first year post-injury, and c) study the contribution of intraindividual pre- and co-morbid psychological mechanisms, such as premorbid fatigue, personality, somatic complaints, resilience, emotional distress, reward sensitivity and injury-related cognitive deficit, to the development of persistent fatigue. The latter aim includes an attempt to replicate and elaborate a model of fatigue following TBI proposed by Ponsford et al. (2015).

Methods: A representative sample of patients will be recruited in a prospective study design. The study inclusion started in January 2018 and will continue until the sample has reached a sufficient size to align with a priori power analyses, estimated to 125. Patients with moderate to severe TBI (Glasgow Coma Scale score 3-13 and/or radiologically confirmed intracranial injury), between the ages 18 and 65 living in Eastern Norway are included. Patients must have sufficient communicative and sensorimotor function to complete the study protocol. Exclusion criteria are premorbid neurological disorders ongoing substance abuse and psychiatric disorders. Follow-up assessments will be performed at six- and twelve-months post-injury. The self-report questionnaires Fatigue Severity Scale and Chalder Fatigue Scale are employed as primary outcome measures. The study further incorporates neuropsychological measures (IQ, sustained attention and executive functions), self-report measures (personality, resilience, behavioral inhibition/activation, optimism, loneliness, pain, mental and somatic health distress), blood parameters and injury characteristics, in order to achieve a broad approach to potentially contributing mechanisms. The study will employ growth mixture modeling and multilevel modeling in order to establish trajectories and clinical subgroups.

Preliminary Results: Currently 29 patients have been included and consented to participate, 16 of which have already completed the first assessment. In the recruited sample, there are 24 males and 5 females, with a mean age of 42 (range 18 to 64), 8 of which have suffered severe TBI. Preliminary data analyses will be conducted, and the results and the descriptive data will be presented at the Congress.

Conclusion: The study aims to provide clinicians with knowledge about pre-dispositional and maintaining mechanisms involved in persistent fatigue, which may be addressed in rehabilitation of patients with traumatic brain injury.
Effect of Insurance Status on Treatment and Outcomes in Adult Patients with Severe Traumatic Brain Injury

Austin Porter¹, Kevin Thomas¹, Jeffrey Henson¹, Kori Gray¹, Mason Sifford¹, Kevin Sexton¹, Analiz Rodriguez¹
¹University of Arkansas for medical sciences, Little Rock, United States

Introduction: Adult severe traumatic brain injury (TBI) is a leading cause of morbidity and mortality after injury, with up to 60% of patients not surviving or requiring 24-hour assistance. Sociodemographic factors, such as insurance status, have been demonstrated to impact outcomes in various trauma populations. In this study, we determine the impact of insurance status on management and outcome of adult severe TBI patients in a national cohort from the United states.

Methods: The National Trauma Data Bank (NTDB) was analyzed from January 1, 2007 to December 31, 2014 and 48,786 patients (18-64 years of age) with an isolated severe TBI were identified. Patients with a head Abbreviated Injury Scale (AIS) score of 3+ and no other regional AIS of 3+ defined the study population. ICD-9 procedure codes were used to identify primary treatment approaches: craniotomy/craniectomy and external ventricular draining (EVD)/intracranial pressure monitoring (ICP). Multivariate logistic regression was used to determine the impact of insurance status on procedures and patient outcomes. Patient and injury characteristics were included in the analysis.

Results: Median age of the cohort was 40 years and 36,656 (75.1%) were insured. The most common mechanism of injury was motor vehicle collision (36.1%). 66% of insured patients and 68% of uninsured patients had a presentation Glasgow coma score (GCS) of 3. Insured patients had significantly more ICP monitors placed (12.5% vs 9.1%; p<0.0001), craniotomies performed (17.5% vs 13.3%; p<0.0001), intensive care unit admissions (88.7% vs 82.5%; p<0.0001), and discharges to rehabilitation centers (53.9% vs 32.6%; p<0.0001) in comparison to uninsured patients. Uninsured patients were more likely to expire (32.0% vs 25.9%; p<0.0001) or be discharged home (61.4% vs 38.8%; p<0.0001). In a regression model, insured patients had a 37% (p<0.0001) and 29% (p<0.0001) increased odds ratio of receiving an intracranial pressure monitor and cranial surgery, respectively. Furthermore, insured patients were associated with a 33% decrease in odds of dying (p<0.0001). Lastly, insured patients with a GCS of 3 at presentation had a 40% higher odds ratio of receiving neurosurgical intervention in comparison to uninsured patients with a GCS 3.

Conclusions: Uninsured adult severe TBI patients received less interventional procedures and had an increased odd of dying in comparison to the insured population. Further studies are needed to determine the reasons behind these treatment and outcomes disparities in order to decrease morbidity and mortality in this patient population following severe TBI.
Physicist Lee Smolin has proposed the distinction between a ‘Timeless’ and a ‘Temporal’ Naturalism based on fundamental considerations. (1) In Timeless Naturalism there is a sundering of the temporal continuum into sequential distinct frames rendering the flow of time effectively digitized and discontinuous, introducing binarism and unresolvable dynamical paradox. Free will is deemed ‘illusory’ in this causally deterministic context. In this dominant modern worldview—recognized as the ‘Way of Ideas’ (2)—nominalistic ‘necessitarianism’ (3) reigns supreme in the form of the ‘Cartesian Myth’ as the focally attended ‘object’ is torn from its surround and severed from the subjective being of the observing organism. Perception occurs in ‘cinematic mode’ via sequential discrete momentary ‘snapshots,’ and the process of semiosis is effectively ‘digitized,’ rendering the spectating organism fully distinct and estranged from its surround. In contrast, Temporal Naturalism recognizes time as a true continuum, where potentialities and ‘generals’ are real, and action unfolds and flows continuously in time in concordance with ‘Synechism’ (4) -- the evolutionary metaphysics of Charles Sanders Peirce.

The Triadic Analogue-Digital-Integrative Cerebration (TriADIC) hypothesis will be presented in which the cerebral hemispheres are each linked to one of these two ways of temporally contextualizing the world. In the conceptual understanding developed by Iain McGilchrist,(5) the cerebral hemispheres allow the organism to do two things that cannot be done synchronically within the same system: (A) identify individual objects of interest nominally distinguishing their presence from their background, while (B) continuously monitoring ongoing activity globally so that focal attention can be interrupted, shifted and broadened as needed for survival and reproductive purposes, with emergence of attending emotive qualia—for example, when a hungry predator sneaking up is detected or an alluring potential partner appears on the horizon. Critical to the ongoing survival of the organism is the diachronic coordination between these distinct but highly interdependent systems that occurs via transcallosal signaling between the two hemispheres drawing them together into a singular integrated agential system. The broader implications of this hypothesis with respect to understanding brain injury and its holistic treatment will be examined.

Baseline Virtual Reality Scores in a Large Cohort of Division I Athletes: Differences Based on Gender, Sport, and Previous Concussion History

Alexa Walter1, John Gaspich2, Semyon Slobounov1

1Penn State University, University Park, United States

Baseline performance differences in athletes can exist among many different demographic variables and can be a useful tool in understanding an athlete’s individual differences post-injury. High-competing athletes have been shown to function at a different level than the general population for both physical ability and cognitive and vestibular functioning. Using a novel and previously validated virtual reality device (HeadRehab), Division I athletes were tested from 2013 – 2018. The data was collected using a 3D immersive environment that provides stereofeedback and egomotion. Three main modalities were used: balance (modified tandem Romberg stance in both stationary and moving rooms), reaction time (full body measures of reaction time), and spatial memory (navigating a pathway to and from a starting point after visual presentation). Scores are generated from 0 (fail) to 10 (perfect) based on previously created algorithms. A total of 257 athletes’ data was used for analysis and analyzed to create a normative score for an elite athletic population and to examine different demographic factor’s influence on performance.

Subjects were college-aged, male (n=149, 58%), right handed (n=220, 85.6%), participating in contact sports (n=225, 87.5%), from a variety of sports (football, soccer, ice hockey, lacrosse, basketball, swimming and diving, field hockey, volleyball, rugby), and with a history of concussion (n=95, 37%). Results revealed that the mean score ± standard deviation for each module was: balance (8.12±2.29), reaction time (5.04±2.69), and spatial memory (7.62±2.78). Independent t-tests revealed significant differences (p<0.05) based on gender, with males having a higher spatial memory score than females (7.16±2.96). Additionally, there was a significant difference (p<0.05) based on previous concussion history with those who had a previous concussion (8.51±1.99) having higher balance than those who did not have a history of concussion (7.93±2.38). Sport differences also existed with males participating in rugby (5.86±1.91) having significantly higher (p<0.05) reaction time than males in football (4.67±2.77). ANCOVAs, with either spatial memory, balance, or reaction time scores as the dependent variable, gender and sport played as fixed factors, and previous concussion history (yes or no) as a covariate were run. Gender was significantly related to spatial memory score, F (1, 234)=5.122, p=0.025, but not sport played. Sport played was significantly related to balance score, F (8, 234)=3.358, p=0.001, but not gender. These results highlight the importance of understanding an athlete’s baseline ability, especially in regard to concussive injury. Individual differences, highlighted by gender or sport played, can influence outcomes after injury and having individualized measures of functional ability could lead to future clinical value.
Injury Rates in Football and Football Alternatives

Joseph Toninato¹
¹Hennepin Healthcare, Minneapolis, United States

Introduction: Football has been at the forefront of discussions of sports-related injuries for decades. A high priority has been made by football leagues of all levels to make the game safer for its athletes, specifically in regard to head injury and concussions. One suggestion is to encourage participation in non-tackling alternatives, especially in younger athletes. A potential alternative is flag football, which utilizes many of the same rules as traditional football, but incorporates a belt carrying flags which must be removed for a ball carrier to be considered “down”. Another alternative is TackleBar™ football. This alternative maintains the same rules as traditional football, including use of protective equipment along with a harness holding foam bars. A ball carrier is “down” when a player “wraps up” the carrier with normal tackle form and removes the foam bar rather than tackling the carrier to the ground. In order to assess the relative safety of these, a literature review was performed to analyze overall injury rates and compare to open source data for TackleBar™.

Methods: Articles were searched for on ebscohost using the terms “injury”, “football” and “rates”. Matches were analyzed and used for comparison if they recorded athletic exposures (AE), defined as one player participating in one game or practice, and defined an injury as occurring during sport participation, needing attention from coach, athletic trainer, or physician, and requiring loss of playing time. Independent analysis of open source data from TackleBar™ football injury reporting was done and compared to articles meeting the criteria.

Results: Five articles met all criteria. Two reported the concussion rates of 100 high school tackle football teams over 5 years, 0.82 per 1000 AE (N= 3,528,790 AE’s) and 1.0 per 1000 AE’s (N= 2,517,207). Others followed youth, high school, and collegiate tackle football leagues over the course of a single season. These found youth injury rates to be 2.25 and 2.6 per 1000 AE’s (N= 142,536, and 44,164), high school rates to be 4.74 and 4.36 per 1000 (N= 860,202 and 431,242), and college to be 3.21 and 8.61 1000 AE’s (N=315,723 and 401,932). One article reported on youth flag football, ad found the rate of injury to be 5.77 per 1000 AE’s (N= 2252). Youth TackleBar™ football was found to have an overall injury rate of 0.31 per 1000 AE’s (N= 15,910).

Discussion: Flag football had the highest injury rate among youth leagues at 5.77 per 1000 AE’s compared to ~2.5 for tackle and 0.31 for TackleBar™, which produced the lowest injury rate of any competition level and form of football assessed. Limitations of this study include ascertainment bias in data collection methodology and relatively smaller numbers for TackleBar™.
Effect of Insurance Status on Treatment and Outcomes in Pediatric Patients with Severe Traumatic Brain Injury

Austin Porter, Kevin Thomas, J.M. Tilford, Kevin Sexton, Saleema Karim, Namvar Zohoori, Clare Brown, Minhajul Islam, Analiz Rodriguez

1University of Arkansas for Medical Sciences, Little Rock, United States

Introduction: Pediatric severe traumatic brain injury (TBI) remains a leading cause of mortality. Treatment of severe TBI is variable, and not all patients receive interventions such as intracranial pressure monitoring (ICP) or craniotomy. Furthermore, the impact of insurance status on management and outcomes in this patient population has yet to be studied.

Methods: Pediatric patients (<18 years) with a severe isolated TBI were identified in the National Trauma Database, years 2007-2014. For isolated TBI, we used patients with a head Abbreviated Injury Scale (AIS) score of 3+ and excluded those with another regional AIS of 3+. ICD-9 procedure codes were used to identify four primary treatment approaches: craniotomy/craniectomy and external ventricular draining (EVD)/intracranial pressure monitoring (ICP). Multivariate logistic regression was used to determine the impact of insurance status on procedures and patient outcomes. Patient and injury characteristics were included in the analysis.

Results: We identified a total of 10,490 pediatric patients with severe TBI. Among those, 89.8% (n = 9,423) had insurance, while the remaining 10.2% (n = 1,067) were self-pay patients. Compared to uninsured, insured patients had significantly more EVD/ICP monitors placed (13.4% vs.7.6%; p < .0001), craniotomies or craniectomies performed (16.9% vs. 13.2%; p = .002), intensive care unit admissions (83.8% vs 68.6%; p < .0001), and discharges to rehabilitation centers (36.9% vs. 24.5%; p < .0001). Insurance status was associated with 52% lower odds of mortality when adjusted for confounders (p < .0001).

Conclusion: Uninsured pediatric TBI patients received less interventional procedures and had increased odds of dying compared to the insured patients. Further studies are needed to determine the reasons behind these treatment and outcome disparities in order to decrease morbidity and mortality in this patient population following severe TBI.
The trajectories of occupational therapy and speech therapy use across 10 years after moderate-to-severe traumatic brain injury

Marit Forslund1, Paul Perrin2, Unni Sveen3, Solrun Sigurdardottir3, Emilie Howe1,4, Svein Berntsen5, Cecilie Røe1,4, Nada Andelic1,4

1Department of Physical Medicine and Rehabilitation, Oslo University Hospital, Oslo, Norway, 2Department of Psychology, Virginia Commonwealth University, Richmond, United States, 3Department of Research, Sunnaas Rehabilitation Hospital Trust, Nesoddtangen, Norway, 4Faculty of Medicine, University of Oslo, Oslo, Norway, 5Department of Physical Medicine and Rehabilitation, Sørlandet Hospital, Kristiansand, Norway

Background: Individuals with traumatic brain injury (TBI) may encounter long term difficulties in participation and engagement in activities of daily living. Among multidisciplinary health services, occupational therapy (OT) and speech therapy (ST) is essential to regain independent living and improve disturbances in communication, eating or swallowing. Yet, we lack knowledge on long-term use of OT and ST after TBI.

Aims: To examine OT and ST use probability trajectories and baseline predictors of their use across the first 10 years after injury.

Methods: Longitudinal observational study of 97 individuals with moderate-to-severe TBI enrolled at the Trauma Referral hospital, Oslo, Norway, in 2005-2007. Socio-demographics and injury characteristics were recorded at baseline. The use of OT and ST was assessed at 1-, 2-, 5- and 10-year follow-ups. Hierarchical linear modelling (HLM) was applied to examine OT and ST use, and whether their trajectories could be predicted by time, gender, age, relationship, education, employment pre-injury, occupation, cause of injury, GCS, length of posttraumatic amnesia (PTA), CT findings, and Injury Severity Score, as well as the interaction terms between time and significant predictors.

Results: Overall, the use of OT decreased from 19% to 1% and ST from 13% to 3% from 1 to 10 years. In the main model of OT use trajectories; age, relationship status, employment at injury, and PTA yielded statistically significant effects. Individuals employed pre-injury (p=0.049), and those with a longer PTA duration (p=0.004) had higher probability trajectories of OT use. For age and relationship status effects (ps<0.05), no discernible visual trends emerged when graphed, suggesting that these effects were likely due to multicollinearity among predictors and therefore devoid of substantive interpretation. A final HLM revealed that only the PTA*time interaction term was statistically significant (p=0.001). Those with longer PTA had a greater downward slope of OT use; the visual inspection showed especially higher OT use among those with longer PTA at the 1-year follow-up.

In the main model of ST use trajectories; gender and PTA yielded statistically significant effects. Women had a higher ST use probability trajectory, although the graph suggested that this effect was primarily due to much higher ST probability use among women at 1-year follow-up (p=0.023). Also, individuals with longer PTA duration had a higher probability trajectory of ST use over time (p=0.007). A final HLM found that the PTA*time interaction term approached significance (p=0.051).

Conclusion: The trajectories of OT and ST use showed linear decrease in the first 10 years post-injury. As expected, individuals with a longer PTA (more severe TBI) had a more frequent use of OT and ST across the follow-up period. Yet, the 1-3% use of services at 10-year post-injury is much lower than the corresponding problem profile of severe TBIs in this phase.
Physical and Mental Health Trajectories Across 10 Years After Moderate-to-Severe Traumatic Brain Injury

Marit Forslund1, Paul Perrin2, Solrun Sigurdardottir3, Cecilie Røe1,4, Emilie Howe1,4, Helene Søberg1,5, Unni Sveen1,5, Mari Rasmussen1,4, Nada Andelic1,4

1Department of Physical Medicine and Rehabilitation, Oslo University Hospital, Oslo, Norway, 2Department of Psychology, Virginia Commonwealth University, Richmond, United States, 3Department of Research, Sunnaas Rehabilitation Hospital Trust, Nesoddtangen, Norway, 4Faculty of Medicine, University of Oslo, Oslo, Norway, 5Oslo Metropolitan University, Oslo, Norway

Background: Traumatic brain injury (TBI) often leads to changes in cognitive, emotional and physical functioning with a long-lasting impact on health, participation and health-related quality of life (HRQL). As chronic TBI may affect lives for decades, increased knowledge of what factors influence HRQL is needed to increase health professionals’ awareness of vulnerable individuals as well as contribute to development of beneficial interventions.

Aims: To assess physical and mental health trajectories along with baseline predictors of these trajectories across the first 10 years post-injury.

Methods: A longitudinal cohort of 97 survivors who sustained a moderate-to-severe TBI in 2005-2007 in southeastern Norway was followed over 10 years. Socio-demographics and injury characteristics were recorded at baseline. The SF-36 questionnaire measured HRQL at 1-, 2-, 5- and 10-year follow-ups. The Physical Component Summary (PCS), consisting of Physical Functioning, Role Physical, Bodily Pain and General Health scores, and the Mental Component Summary (MCS), consisting of Vitality, Social Functioning, Role Emotional and Mental Health scores, were outcome measures of physical and mental health. Hierarchical linear modelling (HLM) was applied to examine whether the trajectories across the four time points could be predicted by fixed effects of: time, gender, age, relationship status, education, employment pre-injury, occupation, cause of injury, GCS, duration of posttraumatic amnesia (PTA), CT findings, and Injury Severity Score, as well as the interaction terms between time and significant predictors.

Results: In the main effect model of PCS trajectories; time, gender, employment pre-injury, and PTA yielded statistically significant effects. The PCS scores significantly increased over time (p<0.001), and a linear trend best fit the data. Women had lower overall PCS trajectories (p<0.001). Individuals employed pre-injury (p=0.016), and those with a shorter duration of PTA (p=0.031) had higher PCS trajectories over time. A final HLM found no significant interaction terms between time and the previously significant predictors.

In the main effect model of MCS trajectories; time, gender and employment pre-injury yielded statistically significant effects. The MCS scores significantly increased across the four time points (p=0.006), and a linear trend over time best fit the data. Women had lower overall MCS trajectories (p=0.001). Individuals employed pre-injury (p<0.001) had higher MCS trajectories over time. A final HLM on MCS trajectories found no significant interaction terms between time and the previously significant predictors.

Conclusion: Physical (PCS) and mental (MCS) health trajectories increased in a linear fashion across the first 10 years after injury. Female gender, pre-injury unemployment and more severe injuries predicted less favorable HRQL trajectories. At risk individuals may be targeted to receive extra follow-up to improve their quality of life outcomes, and the findings highlight the importance of long-term care.
Injury Severity and Extracranial Injuries Are Associated with Delayed Return to Work in Mild Traumatic Brain Injury Patients

Antti Huovinen¹, Harri Isokuortti¹, Ivan Marinkovic¹, Simo Vanni¹, Susanna Melkas¹
¹Neurology, University of Helsinki and Helsinki University Hospital, Helsinki, Finland

Objectives: The main objective of this study was to evaluate extracranial injuries and their effect on return to work (RTW) and symptoms in mild traumatic brain injury (MTBI) patients using Injury Severity Score (ISS) and Abbreviated Injury Score (AIS).

Methods: This study included 130 MTBI patients from the Traumatic Brain Injury Outpatient Clinic of Helsinki University Hospital. 114 of them were currently employed or students and their partial and full RTW were assessed. The symptoms of MTBI were assessed by Rivermead Post-Concussion Symptom Questionnaire (RPQ) and their recovery measured by Glasgow Outcome Scale Extended Questionnaire (GOS-E) at one month after injury. Extracranial injuries were classified by ISS and AIS scores (at least one moderate AIS>1 level injury in any extracranial region). The differences between patient groups were tested with Mann-Whitney U and Spearman correlation tests.

Results: Full RTW rate at one year was 98.2% and median RTW was 9 days (SD 69.9). Median ISS was 6 (IQR 4-10). Mean RPQ was 10.90 (SD 9.80) and mean GOS-E 7.42 (SD 0.74). ISS was moderately correlated (0.455, p<0.001) with full RTW. AIS head (0.403, p<0.001), AIS external (0.261, p=0.005) and ISS total (excluding head injuries) (0.313, p=0.001) were also associated with slower RTW. RPQ and ISS did not correlate statistically significantly, whereas AIS head and RPQ had a significant correlation (0.235, p=0.014). When comparing groups with extracranial injuries (n=28) with patients of isolated MTBI, their full RTW was slower (median 20 vs. 7 days, p=0.003) and they reported extracranial pain more often (75.0% vs. 42.1%, p=0.002) and with higher severity (39.3% vs. 21.1% of patients with at least moderate pain, p=0.005). However, they did not report significantly more symptoms in RPQ (11.3 vs. 10.8, p=0.834) or worse recovery in GOS-E (7.26 vs. 7.46, p=0.159) at one month.

Conclusions: Extracranial injuries are correlated with delayed RTW in MTBI patients. ISS and RTW were correlated but ISS did not seem to correlate with post-concussion symptoms. However, the strength of correlation was from weak to moderate. In our study, even bruises and wounds (AIS external) seemed to correlate with delayed RTW, which could be explained by longer recovery time, symptom burden or primary physician’s tendency to give longer leave of absence based on visual evidence of injury.
The Impact of Bone Fractures on Functional and Psychosocial Outcomes after Traumatic Brain Injury

Natasha Mehta1, Anthony Lequerica2,3, Peter Yonclas2

1Rutgers-New Jersey Medical School, Newark, United States, 2Rochester Regional Health, Rochester, United States, 3Kessler Foundation, West Orange, United States

Objective: To determine if associated peripheral injuries in patients who have had a traumatic brain injury chronically worsen function, mood, and participation in the post-acute period.

Introduction: Traumatic brain injury (TBI) disease complexity lends to high cost of care and caregiver burden. In our healthcare system if a patient does not have a physical disability they are often overlooked. Understanding the cognitive and psychosocial implications of brain injury can help guide therapies, navigate resources, and provide prognostic information. It is clear that cognitive and psychiatric problems tend to persist years after a brain injury. Clinically, some brain injury patients may experience worse cognitive and psychiatric function over time despite the same severity and mechanism of injury. Although there is a component of non-modifiable factors that likely contributes to these variable outcomes, some recent evidence suggests that associated extra-cranial injury (ECI) may impact long-term outcomes.

Methods: The Northern New Jersey Traumatic Brain Injury System database was queried from 2008-2016, with complete follow-up data available at 1-year for 78 patients. Functional status was measured using the FIM™ instrument and psychosocial outcomes were measured using the Participation Assessment with Recombined Tools-Objective (PART-O) and the Patient Health Questionnaire (PHQ-9). Fracture codes using the International Statistical Classification of Diseases (ICD) were inspected to determine extent of extra-cranial injury. The sample was divided into a multiple fracture group and a group with no more than 1 fracture.

Results: Individuals with more than one fracture were 3.4 times more likely to have been in a MVA than those with no more than one fracture, OR=3.4, 95%CI 1.3, 8.8, p=0.010. There were no significant differences between the fracture groups in functional status as measured by FIM™ or community participation as measured by PART-O at one-year post-injury. Patients with TBI and more than one fracture were three times more likely to endorse psychomotor disturbance on the PHQ-9 at one-year post-injury, and males with TBI and more than one fracture were six times more likely to report sleep disturbance on PHQ-9 at one year regardless of TBI severity, age, or FIM™ at one-year follow-up.

Conclusion: This study adds to the existing literature suggesting that an added ECI can lead to poorer outcomes. In this sample, traumatic brain injury patients with more than one fracture were more likely to endorse psychomotor disturbance on PHQ-9 after one year than those without associated fracture. Male brain injury patients with more than one fracture were more likely to endorse sleep disturbance on PHQ-9 after one year that those without associated fracture. Further evaluation should include longer term follow-up aiding in the ability to perform a repeated measure analysis, a control for pain, and pre-injury determinants.
Characterizing the Prevalence and Effects of Lifetime Traumatic Brain Injury on Neuropsychiatric Symptoms and Corpus Callosum White Matter Integrity in a Marginally Housed Sample

Jacob Stubbs1,2, Allen Thornton2,3, Tiffany O’Connor2,3, Kristina Gicas1,2, Amiti Mehta1,2, Henri Lu2, Emily Livingston1,3, Donna Lang2,4, Talia Vertinsky4, Manraj Heran4, Alasdair Barr1,2,5, Tari Buchanan1,2, Alex Cheng1,2, Jessica Sevick1,2, Tasha Chan1,2, Jamie Wong1,2, William Honer1,2, William Panenka1,2,6

1Department of Psychiatry, University Of British Columbia, Vancouver, Canada, 2BC Mental Health and Addictions Research Institute, University of British Columbia, Vancouver, Canada, 3Department of Psychology, Simon Fraser University, Burnaby, Canada, 4Department of Radiology, University of British Columbia, Vancouver, Canada, 5Department of Anesthesiology, Pharmacology, and Therapeutics, University of British Columbia, Vancouver, Canada, 6BC Neuropsychiatry Program, University of British Columbia, Vancouver, Canada

Background: Tens of millions of individuals sustain traumatic brain injuries (TBI) worldwide every year, and the lifetime prevalence of TBI in homeless and marginally housed populations is significantly higher than the general population. Despite this, little is known about the mechanisms by which marginally housed individuals sustain TBI, and the contribution of lifetime TBI to neuropsychiatric symptoms or neuroimaging metrics in these individuals.

Objectives: First, we aimed to characterize the prevalence, mechanisms, and sex differences of lifetime TBI in a marginally housed sample. Second, we evaluated the contribution of lifetime TBI to depressive and psychosis symptoms. Finally, we investigated the relationship between lifetime TBI and corpus callosum diffusion, a marker of white matter integrity.

Methods: Data was collected during the course of a longitudinal study of marginally housed individuals who live in the Downtown Eastside neighborhood of Vancouver, Canada. Lifetime history of TBI was ascertained with the Brain Injury Screening Questionnaire. Depressive symptoms were assessed with the Beck Depression Inventory, and psychosis symptoms were assessed with the Positive and Negative Syndrome Scale. Participants received structural magnetic resonance imaging (MRI) and diffusion tensor imaging (DTI) scans. Structural MRI scans were reviewed by a neuroradiologist and a neuropsychiatrist for evidence of trauma-induced brain injury. Multiple linear regression was used to evaluate the contribution of lifetime TBI to neuropsychiatric symptoms and corpus callosum fractional anisotropy (FA).

Results: The sample consisted of 360 participants (median age = 45; 75% male). The lifetime prevalence of TBI was 79.7%, with 22.5% reporting at least one moderate or severe TBI (loss of consciousness greater than 30 minutes). The most frequently reported mechanism of injury was assault, and females reported significantly more TBIs through physical abuse than males (χ² (1, N = 360) = 19.6, p < 0.0001). Structural MRI evidence of previous TBI was present in 11.1% of the sample. Adjusting for age and sex, a higher self-reported number of lifetimes TBI was associated an increased severity of depressive symptoms (β = 0.226, p < 0.0001), though the number and severity of lifetime TBI were not associated with the severity of psychosis symptoms. Reporting one or more moderate or severe TBI was associated with lower corpus callosum FA (β = -0.11, p = 0.04), as was having structural MRI evidence of TBI (β = -0.18, p < 0.001).

Conclusions: We observed a high lifetime prevalence of TBI in this marginally housed sample. The frequency and severity of lifetime TBI were differentially associated with neuropsychiatric symptoms and corpus callosum diffusion. Sustaining more TBIs over the lifetime was associated with an increased severity of
depressive symptoms, and sustaining at least one moderate or severe TBI, or having MRI evidence of TBI, was associated with lower corpus callosum FA.
Intracranial Traumatic Lesions Delay Return to Work in Mild Traumatic Injury Patients

Antti Huovinen$^1$, Ivan Marinkovic$^1$, Harri Isokuortti$^1$, Antti Korvenoja$^2$, Simo Vanni$^1$, Susanna Melkas$^1$

$^1$Neurology, University of Helsinki and Helsinki University Hospital, Helsinki, Finland; $^2$HUS Medical Imaging Center, Radiology, University of Helsinki and Helsinki University Hospital, Helsinki, Finland

Objectives: The main objective of this study was to evaluate whether intracranial lesion is a significant prognostic factor of return to work (RTW) and post-traumatic symptoms in mild traumatic brain injury (TBI) patients.

Methods: This study included 114 mild TBI patients, currently employed or students, from the Traumatic Brain Injury Outpatient Clinic of Helsinki University Hospital. Their partial and full RTW were assessed. All patients had either mild (n=76) or mild complicated (n=38) TBI based on World Health Organization classification. MRI imaging was performed in 3-17 days and all MRI scans were evaluated by a board certified neuroradiologist. The symptoms of mild TBI were assessed by Rivermead Post-Concussion Symptom Questionnaire (RPQ). The differences between patient groups were tested with Mann-Whitney U and Kruskal-Wallis H tests. A Kaplan-Meier log rank analysis was performed to investigate the time differences in RTW between groups.

Results: Full RTW rate after one year was 98.2%. Mild complicated group returned to work slower (median 16 days) than mild group (5.5 days, p<0.001) and the Kaplan-Meier curve showed the greatest difference in full RTW percentages at two weeks (36.8% vs. 76.3%, p<0.001). At three months, there were no significant differences. Mild complicated group had significantly more likely a partial labour period compared to mild TBI patients (23.7% vs. 2.6%, p<0.001). Among patients with traumatic intracranial lesion positive primary CT (n=24), RTW was significantly slower (median 33 days) than among patients without lesion (n=83, 7 days) or who did not undergo primary CT scan at all (n=7, 4 days, p<0.001). Patients with contusion (n=11) had a median of 50 days to RTW and patients with SDH (n=16) 37.5 days (p<0.001). Patients with any extraparenchymal lesion (SDH, SAH or EDH) had a median of 31 days to RTW (p<0.001). Patients with intracranial lesions visible exclusively in MRI scans were not associated with delayed RTW (p=0.863), though 57% of the patients returned to work before primary MRI imaging. Mild group reported significantly more disorientation (87.8% vs. 68.4%, p=0.013) in the acute phase after trauma. One month after trauma, mild complicated group reported significantly more symptoms in RPQ (11.5 vs. 8.75, p=0.027) and so did patients (n=28) with any intraparenchymal (contusion, microhemorrhages referential to DAI, other ICH) lesion (12.3 vs. 8.78, p=0.013).

Conclusions: Patients with mild complicated TBI tend to return to work slower than mild TBI patients. Delayed RTW may be the result of prolonged symptoms and slower recovery or due to primary physician’s tendency to give longer leave of absence based on intracranial lesion in the primary CT scan. Nevertheless, RTW percentage of mild TBI patients is excellent and intracranial lesion is not a long-term predictor of disability to work.
Diagnostic Assessment of Chronic Insomnia Following Mild Traumatic Brain Injury

Dora Zalai¹, Colin Shapiro³, Michael Cusimano²,₅, Todd Girard⁴
¹Oakville Centre For Cognitive Therapy & Evidence-based Treatment, Training & Testing, Oakville, Canada, ²St. Michael’s Hospital, Toronto, Canada, ³Youthdale Child and Adolescent Sleep Centre, Toronto, Canada, ⁴Ryerson University, Toronto, Canada, ⁵University of Toronto, Toronto, Canada

Background and Rationale: Insomnia symptoms following mild traumatic brain injury (mTBI) -including concussion- are major predictors poor mTBI outcomes. Insomnia symptoms may be caused by specific sleep disorders that can be effectively treated, which in turn, may improve mTBI outcomes. Previous studies have focused on insomnia symptom assessment in mTBI or evaluated samples with all TBI severities. To effectively manage insomnia following mTBI, it is important to move beyond symptom assessment and conduct a diagnostic sleep evaluation in individuals with mTBI order to understand which sleep disorders contribute to insomnia symptoms in this clinical group.

Objective: Determine the prevalence of sleep disorders that contribute to chronic insomnia symptoms in a homogeneous and representative sample of patients with mTBI.

Methods: Individuals with chronic insomnia symptoms following mTBI (N = 50; age 17-65; 64% females; 3 - 24 months post mTBI) participated in a multi-method sleep and circadian assessment, including a standard sleep and psychiatric interview, questionnaires, standard sleep diary, actigraphy, polysomnography and dim light melatonin onset test. Sleep and circadian disorders were diagnosed according to International Classification of Sleep Disorders criteria.

Results: Insomnia disorder was the most common diagnosis (62%), followed by obstructive sleep apnea (OSA) - 44%; circadian rhythm sleep-wake disorders (CRSWD) - 26% and periodic limb movement disorder (PLMD) - 8%. The most common comorbid sleep disorder conditions were insomnia disorder and OSA (34%).

Conclusions: OSA and CRSWD frequently occur among patients whose main presenting sleep symptom is chronic insomnia following a mTBI. Given that 72% of patients with insomnia symptoms had a specific sleep or circadian disorder (OSA, PLMD, or CRSWD) that require objective assessment methods, asking about insomnia symptoms is insufficient for diagnostic purposes after a mTBI. Instead, strategically selected objective sleep and circadian assessment should be part of the diagnostic chronic insomnia evaluation following a mTBI. With regards to treatment implications, patients who report chronic post-concussion insomnia symptoms need individually-tailed sleep and circadian disorder treatment that target each of the specific sleep and circadian disorders that contribute to their insomnia symptoms. This involves a combined insomnia disorder and OSA treatment at least in one-third of this clinical group, while an additional quarter requires specific circadian sleep treatment. Treatment studies testing the effects of these interventions on long-term TBI outcomes are needed.
Development of a Concussion Digital Health Tool: HeadCheck

Simone Darling1, Cathriona Clarke1, Franz Babl1,2,3, Gavin Davis1,4,5, Peter Barnett1,2,3, Patrick Clifton6, Peter Harcourt2,6, Alison Crichton1, Michael Takagi1, Gabi Ceregra7, Sanji Kanagalingam7, Vicki Anderson1,2,3

1Murdoch Children’s Research Institute, Parkville, Australia, 2University of Melbourne, Melbourne, Australia, 3The Royal Children’s Hospital, Melbourne, Australia, 4Austin Health, Melbourne, Australia, 5Cabrini Hospital, Melbourne, Australia, 6Australian Football League, Melbourne, Australia, 7Curve Tomorrow, Melbourne, Australia

Background and Objectives: Digital technology is being used to bridge the gap between healthcare and the community. There are over 300,000 health smartphone applications, yet most are not evidence-based or medically regulated. In line with digital health development best-practice, we aimed to develop a mobile application to increase access to evidence-based, developmentally appropriate guidance around the recognition and management of childhood concussion to increase the standard of concussion information in the community.

Method: A multidisciplinary team of concussion experts, design-thinking and ICT development specialists and key industry partners translated current gold-standard concussion recognition tools and clinical management strategies into a community-facing user-friendly mobile application. The app also incorporates a symptom-driven psycho-education component to help parents manage their child’s recovery following concussion. HeadCheck was released in May 2018 and has undergone usability and feasibility testing in both community and clinical populations.

Results: The HeadCheck app is freely available on the Australian iTunes and Google Play stores, has been downloaded over 22,000 times and assisted with the assessment of 4500 head knocks. HeadCheck is not considered a medical device. Usability data and uptake rates suggests that HeadCheck is a useful tool for the community.

Conclusions: HeadCheck helps parents and coaches recognise concussion, assess whether medical attention is required and manage the child’s safe return to school, play and organised sport. Input from a multidisciplinary team of clinicians, researchers, software developers and industry partners is key to ensuring the development of evidence-based, user-friendly digital technologies that addresses a need in the community.
The Experience of Challenging Behaviours Following Severe TBI: A Family Perspective

Adam McKay1,2,3, Sammi Tam, Sue Sloan, Jennie Ponsford1,3
1Monash University, Melbourne, Australia, 2Epworth Healthcare, Melbourne, Australia, 3Monash Epworth Rehabilitation Research Centre, Melbourne, Australia

Primary Objective: Family caregivers play an important role in managing challenging behaviours after TBI. The aims of this study were to understand how family caregivers of individuals with TBI perceive challenging behaviours and their impact on the TBI individual’s community integration and family functioning.

Research Design: A qualitative research design was employed to capture the lived experience of family caregivers of individuals with TBI.

Methods and Procedures: Face-to-face interviews were conducted on six female family caregivers of individuals with severe TBI (sustained an average of 17 years earlier) and longstanding challenging behaviours.

Main Outcomes and Results: The results revealed that family caregivers adopted a broader definition of challenging behaviour than that used by professionals and these behaviours impacted on the community integration of the individual with TBI, most notably leading to poor social relationships. Challenging behaviours were viewed as a key source of distress and burden for family caregivers and they used many different strategies to manage the behaviours.

Conclusion: Greater understanding of challenging behaviours from the perspectives of family caregivers may help provide more effective support and interventions to improve quality-of-life for individuals with challenging behaviours after TBI and their families.
From Judgement to Acceptance: A Brain Injury Survivors Journey

Katie Miles

Camp Dawn, London, Canada

Before November 27th, 2005, I was popular, athletic, and had big plans for the future. I was in grade 12 and was applying to universities the following September. I received many awards and achieved high marks. On November 27, 2005, I was in a single vehicle accident. I lost control of my car while driving over a bridge and drove into a tree. My injuries included a lacerated spleen, a fractured pelvis, multiple rib fractures, collapsed lungs and a severe, traumatic acquired brain injury with a Glasgow coma Score of 3. As someone without any prior medical knowledge, and an intellectual delay due to the accident, this was described to me as being “almost dead” with a heartbeat. My eye sight, speech and fine motor functions were tested, and because I was in a coma, none were responsive.

After I awoke, I was forced to relearn how to walk, talk, and eat which are skills that people take for granted every day. I was successful with this part of my recovery because of the incredible support offered by my family which I’m told is not always evident for the injured.

Less than 2 years after acquiring my brain injury, I enrolled in King’s College at the University of Western Ontario. Four years later, in 2011, I graduated achieving an honors BA in social science with a double major in criminology and sociology.

Between November 27, 2005 and September 2012, I felt lost. I did not seem to fit in anywhere. I looked “normal”, so parts of society judged me as a lazy person without any challenges or disabilities. I was criticized and insulted when occupying a “disabled” seat on the bus. However, other parts of society openly discriminated against me. Working as a cashier at Wal-Mart, many customers called me a “retard”, and treated me like absolute garbage because of my speech impediment.

I reluctantly attended Camp Dawn for the first time in September of 2012. I had preconceived notions that I would not fit in, because I’m not really “disabled”. I don’t drool, much, and can feed myself... I went to camp and my sister came to camp as a leader for a different cabin to provide support from a distance. At camp I realized 3 things. I was wrong! I had done what I felt everyone else in society had done to me, by stereotyping brain injuries as being all the same. Secondly, that camp was the most rewarding experience in my life. We all have deficiencies or struggles, and it is quite common to not recognize our own imperfections, which brings me to my third realization. Camp Dawn is the only place I’ve found, where I belong!
Cognitive Impairments in Community-Level Rugby Players in Nuevo Leon, Mexico

Ricardo Caraza¹, Roberto Cortés¹, Beatriz Freymann¹, Roberta Rosas¹, Ana Chapa-Montemayor¹
¹Tecnologico de Monterrey, Monterrey, Mexico

Background: Rugby is a sport involving numerous collisions and tackles. It has a high reported incidence of concussion and other traumatic brain injuries which are believed to cause serious consequences in short and long term, damaging their neurocognitive abilities and altering their ability to regulate their emotions (1).

Aim: Identify the cognitive profile of community-level rugby players in Nuevo León, Mexico, and its association with demographic and clinical history.

Methodology: We selected information from the baseline assessment of 5 teams of community-level rugby in Nuevo León, Mexico. Two primary domains were assessed: 1) clinical history including history of sport-related concussion, and 2) pre-season neuropsychological assessment. The later consist in the follow paper-pencil test: naming visuo-verbal test (NV), complex verbal material test (CVM), and similarities test (S) from the Barcelona battery; Brief visuospatial memory test-revised (BVMT-R), Hopkins verbal learning test-revised (HVLT-R), fluency test (F), digit span (D), letter-number sequencing (LN), trail making test (TMT), symbol digit modalities test (SDMT), Stroop test, and Tower of London (TOL).

Results: From the 150 players registered within the 5 teams, we analyzed 75 who had the complete information. The majority are men (81%), with an average of 22.6 years old; 52% are forwards and 48% backwards. The average experience is of 2.8 years while 43% have less than 1 year playing. In relation to clinical history: 45% have suffered a sport-related concussion, 21% present chronic headache, 20% reports anxiety, and 69% have academic difficulties. The most frequent percentage of impairment was TOL total time (45%), Stroop word (44%), naming (39%), TOL time violation (33%), similarities (33%), TOL rule violation (23%), TOL move score (22%), and BVMT-R total recall (21%). The TOL time violation impairment was significative more frequent in backwards (p=0.007), and the frequency of concussion was significative in forwards (p=0.02).

Conclusions: Speed processing in lecture and complex tasks, and naming were the most frequent impairments, followed by verbal abstraction, immediate visuospatial memory, and planning. Although no significant relationship between cognitive performance and history of concussion was found, forwards had more concussions and backwards had less speed processing in planning tasks. However, significant differences have been found, both in pre- and postseason assessments, for attentional tasks involving a visuomotor component (2). This could imply that alterations could be found upon subsequent analysis.

References:
Depression After a Traumatic Brain Injury: Associations with Quality of Life, Social Participation and Coping Strategies

Kristina Gravel1,2, Marie-Josée Sirois1,3, Natalie Le Sage1,3, Josée Savard1,3, Bonnie Swaine4, Lynne Moore1,3, Elaine de Guise5, Simon Beaulieu-Bonneau1,2,3, Marie-Christine Ouellet1,2,3

1Université Laval, Québec, Canada, 2Centre Interdisciplinaire de Recherche en Réadaptation et Intégration Sociale (CIRRIS), Québec, Canada, 3Centre de Recherche du Centre Hospitalier Universitaire (CHU) de Québec - Université Laval, Québec, Canada, 4Département de Réadaptation - Université de Montréal, Montréal, Canada, 5Département de Psychologie - Université de Montréal, Montréal, Canada

Objectives: The objective of this study was to examine how major depression following traumatic brain injury (TBI) is linked to health-related quality of life, social participation, and coping strategies.

Methods: Participants were 219 adults who were hospitalized after TBI in a Level I trauma centre in Canada assessed two years post-injury (mean age = 42.1±14.5 years; 74% men; 55% mild, 45% moderate/severe TBI). They completed the Structured Clinical Interview for DSM-IV (SCID), the Quality of Life after Brain Injury (QOLIBRI), the Participation Assessment with Recombined Tool–Objective (PART-O) and the Brief-COPE. Participants who fulfilled the criteria for a major depressive episode (MDE) on the SCID between 12- and 24-months post-injury (n = 15) were compared to those with at least one other psychiatric disorder but no depressive episode (n = 34), those with a major depressive episode and at least one comorbid disorder (n = 14) and those without any diagnosis (n = 159). A 2X2 (presence/absence of MDE, presence/absence of any other disorder) multivariate analysis of variance (MANOVA) was performed on five dependent variables measured at 24 months post-TBI: quality of life (QOLIBRI), social participation (PART-O), and use of three types of coping strategies (extracted from the Brief-COPE): emotion-focused, problem-focused, and dysfunctional.

Results: Results from the MANOVA indicated significant effects of depression, F(5, 211)= 11.12, p< .001, and of other disorders, F(5, 211)= 3.52, p< .01, and a significant interaction, F(5, 211)= 2.74, p< .05. The association between presence of depression and the five combined dependent variables was modest (partial η²= .21), while the association between other mental disorder scores and the combined dependent variables was lower (partial η²= .08). Univariate tests were significant for the association of depression with the QOLIBRI, F(5, 211)= .52.16, p< .01, PART-O F(5, 211)= 10.04 p< .01, and dysfunctional strategies on the Brief-COPE, F(5, 211)= 17.46, p< .01. Compared to participants without depression, depressed participants showed lower quality of life (M= 46.6 ±19.7 vs 70.5 ±16.6), lower social participation (mean ±SE = 1.57 ± 0.53 vs 1.92 ± 0.56), and higher use of dysfunctional coping strategies (mean ±SE = 3.99 ±1.03 vs 3.32 ±0.81).

Conclusions: Results from this study suggest that participants who experience major depression between 12 to 24 months post-TBI have significantly lower scores in health-related quality of life and social participation two years post-injury. These results highlight the important social cost of post-TBI depression. Furthermore, higher use of dysfunctional coping strategies (e.g., substance use) in persons with major depression could become a specific focus for intervention. The higher proportion of variance explained by depression compared to other disorders also suggests that this disorder might constitute a priority of intervention when working with patients presenting multiple psychiatric issues after a TBI.
Implication of Uric Acid in Blood-Brain Barrier Permeability and Brain Inflammation after Hemorrhagic Shock in a Murine Model

Sydnée L’Ecuyer1, Benjamin Brochu1,2, Kim Gilbert1, François Khazoom1,2, Guy Rousseau1,2, Emmanuel Charbonney1,2

1Centre de Recherche de l’Hôpital du Sacré-Coeur de Montréal, Montréal, Canada, 2Université de Montréal, Montréal, Canada

Background: Following haemorrhagic shock (HS), mediators can be released systemically, due to cell death and inflammation. In our murine model, we have demonstrated that uric acid (UA) is released after resuscitated HS and is persistently increased in plasma and organs (lung and kidney); in addition, we could reverse organ inflammation and apoptosis using a recombinant uricase to degrade UA. UA is known for its implication in endothelial dysfunction, but data report a possible protecting effect of UA on blood-brain barrier (BBB) permeability, in other disease context. Our hypothesis was that UA released after HS could alter the permeability of the BBB and contribute to increasing the inflammatory response in the central nervous system (CNS).

Methods: Male Wistar rats were randomly (n=6 per group) assigned to resuscitation after controlled HS: (1) SHAM with instrumentation only, (2) HS with fluid resuscitation (HS) and (3) HS with fluid resuscitation and IP injection of uricase [1.5 mg/kg] (HS+U) at the beginning of reperfusion; the rats were then observed for 72h. In order to measure BBB permeability, rats were injected IP with 0.5 mL fluorescein sodium salt (NaF) 10% in normal saline, one hour before sacrifice. Brains were then collected and scanned to measure fluorescence. Neutrophil infiltration was measured using myeloperoxidase (MPO) assay. Cell death and inflammatory response, in the amygdala, were measured using: caspase-3 (C3) activity (enzymatic assay) and markers of CNS microglia (Iba-1) and astrocytes (GFAP) activation with immunofluorescence or Western Blot.

Results: Following HS, an increase of NaF staining was observed in the amygdala, which was prevented with the use of uricase treatment leading to the decrease of circulating UA. MPO was almost doubled in the amygdala following HS with a return to SHAM levels following uricase treatment. The activity of C3 in the amygdala was increased almost two-fold in the HS group with a level back to SHAM in the HS+U group. Finally, for local CNS inflammation Iba-1 (1.5 fold) and GFAP (1.5 fold) were both increased in the amygdala in the HS group with a prevention of this increase if treated with the uricase.

Conclusion: After resuscitated HS, UA seems to be involved in the alteration of BBB permeability; it is accompanied by signs of increased cell death and CNS inflammatory response. Ongoing investigation into the mechanism underlying these observations could link the alteration of the BBB permeability and subsequent CNS inflammation with the circulating UA following systemic ischemia.
Transcranial, Near-infrared Photobiomodulation to Improve Cognition in Two, Retired Professional Football Players Possibly Developing CTE

Margaret Naeser¹², Paula Martin¹², Michael Ho¹, Maxine Krengel¹², Yelena Bogdanova¹³, Jeffrey Knight¹³⁴, Andrea Fedoruk¹, Michael Hamblin⁵⁶⁷, Bang-Bon Koo⁸

¹Department of Psychiatry, Boston University School of Medicine, Boston, United States, ²VA Boston Healthcare System, Boston, United States, ³Department of Neurology, Boston University School of Medicine, Boston, United States, ⁴National Center for PTSD - Behavioral Sciences Division, VA Boston Healthcare System, Boston, United States, ⁵Wellman Center for Photomedicine, Massachusetts General Hospital, Boston, United States, ⁶Department of Dermatology, Harvard Medical School, Boston, United States, ⁷Harvard-MIT Division of Health Sciences and Technology, Cambridge, United States, ⁸Department of Anatomy & Neurobiology, Bio-imaging Informatics Lab, Boston University School of Medicine, Boston, United States

Background: Photobiomodulation (PBM) therapy is a safe, painless, noninvasive, nonthermal modality that uses red, and/or near-infrared (NIR) wavelengths (600–1100nm) to stimulate, heal, and repair damaged cells. PBM with red/NIR photons promotes increased ATP production by activating the mitochondria in hypoxic/compromised cells. Increased vasodilation occurs locally. Two, retired professional football players, possibly developing chronic traumatic encephalopathy (CTE), received red/NIR transcranial, light-emitting diode (t-LED) treatments. CTE, associated with repeated head impacts, is only diagnosed postmortem where perivascular tau deposits are concentrated in sulcal depths.

Methods/Results: Player 1: 65 Yr, CFL player, middle linebacker. PhD, Exercise Physiology. 1st LED Series: In-Office t-LED treatments (18, 30-minute sessions, 3x/Wk, 6 Wks). Treated with 500mW, red/NIR LED cluster heads (MedXHealth Corp.), fluence 26 J/cm² per LED placement. Post-testing at 1 Wk showed +2SD on 5 neuropsychological (NP) tests (+1SD, 9); 1 Mo later, +2SD, 3 tests (+1SD, 12); but at 2 Mo, +2SD, only 1 test (+1SD, 5). Same pattern, PTSD (PCL-C) scores, Pre- 58, improved to 25 and 32 at 1 Wk and 1 Mo; but 47 at 2 Mo; and Beck Depression scores, Pre- 24, improved to 1 and 0 at 1 Wk and 1 Mo; but 9, at 2 Mo. After a 3-month No Treatment Period, he started treating at home with NIR LED device (Vielight Neuro Gamma), 810nm, 40 Hz (Iaccarino et al., 2016). NIR diodes were 25–100mW, fluence 15–60 J/cm² ONLY over cortical nodes of Default Mode Network: mesial prefrontal, precuneus, angular gyrus, and hippocampal areas; also used a red, 633nm, intranasal. After 3 months of At-Home LED treatments, there were again significant improvements vs. Baseline, +2SD on 6 tests (+1SD, 10); reduced PTSD, PCL-C, 23; no depression. Resting-state functional-connectivity MRIs showed parallel changes - increased functional connectivity after In-Office and At-Home series, but decreased, after 3-month No Treatment Period.

Player 2: 57 Yr, NFL player, cornerback. History of depression; 15 surgeries, 3 pain meds (2 narcotics). In-Office t-LED treatments applied with a helmet lined with 15 red/NIR LED cluster heads (Thor, Inc.), 26 J/cm² per LED placement. Post-testing at 1 Wk showed +1SD on 5 NP tests; at 1 Mo, +2SD, 3 tests (+1SD, 8). PTSD improved, Pre- 65, down to 27 and 30, at 1 Wk and 1 Mo; and Beck Depression, Pre- 28, down to 15 and 12, at 1 Wk and 1 Mo. VAS pain score was reduced, Pre- 7/10, only 3/10 at 1 Wk, and 5.5/10, 1 Mo, at which time he had discontinued narcotics. Currently doing t-LED home treatments.

Conclusions: Decline after the No Treatment Period in Player 1, is similar to observations with progressive neurodegenerative disease/dementia cases (Saltmarche, Naeser et al., 2017). Continued t-LED, PBM treatments may improve behavioral symptoms. Controlled studies are warranted.

Avinash Chandran1,2, Zachary Kerr1,2, Aliza Nedimyer2,3, Patricia Combs2,3, Alan Arakkal4, Scott Zuckerman5,6, Lauren Pierpoint4, R. Dawn Comstock5,7

1Department of Exercise and Sport Science, University of North Carolina at Chapel Hill, Chapel Hill, United States, 2Matthew Gfeller Sport-Related Traumatic Brain Injury Research Center, University of North Carolina at Chapel Hill, Chapel Hill, United States, 3Human Movement Science Curriculum, University of North Carolina at Chapel Hill, Chapel Hill, United States, 4Department of Epidemiology, University of Colorado Anschutz, Aurora, United States, 5Vanderbilt Sports Concussion Center, Vanderbilt University School of Medicine, Nashville, United States, 6Department of Neurological Surgery, Vanderbilt University School of Medicine, Nashville, United States, 7Department of Pediatrics, University of Colorado School of Medicine, Aurora, United States

Objective: High school (HS) sports participation continues to increase in the United States, and youth sport-related concussions (SRCs) remain a public health concern. To better understand SRC etiology in HS athletes, it is important to examine the profile of observed concussions. This study examined concussion symptomology, in 20 HS sports during the 2013/14-2017/18 academic years using data from the High School Reporting Information Online (HS RIO™) surveillance system.

Methods: A convenience sample of athletic trainers (ATs) reported concussion and athlete-exposure (AE) data to HS RIO™. The number of participating programs varied each year. Diagnostic rationale for concussions was not standardized and relied upon the expertise of the ATs or other medical staff seen by athletes. For each concussion, ATs provided information on symptom presentation (yes/no for 14 symptoms), event type (competition/practice), and injury mechanism (analyzed as non-player-contact/player-contact). Sports were classified into categories based on contact-level (Collision: Boys-Football, Wrestling, Ice Hockey, and Lacrosse; High contact: Boys/Girls-Soccer, and Basketball, Girls-Field Hockey, and Lacrosse; Low contact: Boys/Girls- Swim & Dive, Track & Field, and Cross Country, Boys-Baseball, Girls- Volleyball, and Softball). We estimated symptom prevalence, and computed average symptoms reported for each concussion. Χ² (Fisher’s exact when χ² assumptions violated) tests were used to compare differential symptom prevalence between groups, and Wilcoxon rank sum tests were used to identify group-differences in the number of symptoms per concussion. Statistical significance was evaluated at the 0.001 level, accounting for the multiple comparisons involved.

Results: Among all concussions (n=9542), headache was the most prevalent symptom reported (94.5%), followed by dizziness (73.8%), difficulty concentrating (56.0%), and light sensitivity (52.6%). On average, 4.7±2.4 symptoms were reported per concussion. We observed differences between practice (n=3463) and game-related (n=6079) concussions in reported amnesia (n=304(8.8%) vs. n=789(13.0%);p<0.001), and loss of consciousness (LOC) (n=45(1.3%) vs. n=193(3.2%);p<0.001). We also observed differences between non-player-contact (n=3177) and player-contact-related (n=5941) concussions in reported amnesia (n=295(9.3%) vs. n=756(12.7%);p<0.001), and confusion (n=1092(34.4%) vs. n=2301(38.7%);p<0.001). There were significant differences between female (n=2009) and male (n=904) high contact sport concussions in reported irritability (n=307(15.3%) vs. n=88(9.7%);p<0.001), and LOC (n=24(1.2%) vs. n=36(4.0%);p<0.001); and between female (n=727) and male (n=183) low-contact sport concussions in reported amnesia (n=42(5.8%) vs. n=32(17.5%);p<0.001). Between collision (n=5279) and all other SRCs (n=1087) among boys, there were no differences in symptom proportions. We also observed no group-differences in number of symptoms reported.
Conclusion: There were no group-differences in the most prevalent symptoms, though observed group-differences in other symptoms must be reconciled. As such, attention may be diverted towards the relatively high prevalence of amnesia observed in game-related concussions, following player-contact concussions, and from SRCs in boys playing low contact sports. Similarly, greater attention may be paid to explain sex-differences in LOC within high contact sports.
Dissociating PTSD and Depression Structural Neuroimaging Profiles

**Benjamin Wade**, David Tate, Carmen Velez, Randall Scheibel, Heather Belanger, Carlos Jaramillo, Blessen Eapen, Mary Newsome, Brian Taylor, Sidney Hinds II, Gerald York, Tracy Abildskov, Erin Bigler, Elisabeth Wilde

1. Missouri Institute of Mental Health, St. Louis, United States,
2. University of California, Los Angeles, Los Angeles, United States,
3. University of Utah, Salt Lake City, United States,
4. Michael E. DeBakey Veterans Affairs Medical Center, Houston, United States,
5. H. Ben Taub Department of Physical Medicine and Rehabilitation, Houston, United States,
6. James A. Haley Veterans Hospital, Tampa, United States,
7. University of South Florida, Tampa, United States,
8. C. Kenneth and Dianne Wright Center for Clinical and Translational Research, Richmond, United States,
9. VA Greater Los Angeles Health Care System, Los Angeles, United States,
10. Virginia Commonwealth University, Richmond, United States,
11. Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury, Silver Springs, United States,
12. Alaska Radiology Associates, Anchorage, United States,
13. Brigham Young University, Provo, United States

**Background:** Post-traumatic stress disorder (PTSD), major depression (MD), and mild traumatic brain injury (mTBI) are common in Veteran populations and exhibit marked overlap in structural neuroimaging profiles. The duality of symptomatic and neurological disturbances between these disorders’ obscures potentially unique association of each with aberrant neural circuitry. Dissociating contributions of PTSD and MD to patterns of neural circuitry might improve diagnosis and inform more targeted interventions. We investigated whether associations between PTSD symptoms and structural neuroimaging measures are mediated by MD symptoms in a large, multi-site cohort of Veterans from the Chronic Effects of Neurotrauma Consortium (CENC).

**Methods:** Two hundred and five Veterans (age=39.53 years ± 10.67; 31 Female) with a history of mTBI from four sites were included. The Patient Health Questionnaire-9 (PHQ-9) and PTSD Checklist for DSM-5 (PCL-5) assessed MD and PTSD symptoms. We conducted exploratory factor analyses (EFA) of the PHQ-9 and PCL-5 items, separately, to identify latent symptom dimensions that might be less correlated than their total scores. Volumes of the accumbens, amygdala, caudate, hippocampus, pallidum, putamen, and thalamus were estimated with FreeSurfer v6.0; the ENIGMA shape pipeline defined the local thickness of each structure. The ENIGMA-DTI pipeline was used to estimate fractional anisotropy (FA) in 48 white matter tracts. Mediation analyses adjusting for age and sex were used to determine whether significant associations between PTSD symptoms and imaging measures were mediated by MD symptoms.

**Results:** The PHQ-9 only partially mediated the negative association between the PCL-5 and volumes of the right amygdala and hippocampus volume and shape. PCL-5 and PHQ-9 total scores were correlated at r=0.74. The PHQ-5 factored into two dimensions: core depression (PHQ-F1) and somatic/anhedonia symptoms (PHQ-F2). The PCL-5 also factored into two dimensions: ruminative symptoms (PCL-F1) and negativty bias (PCL-F2). Factors of the two scales were less correlated than the total scores, on average. PHQ-F1 only partially mediated the positive association between PCL-F1 and the corona radiata (CR). Negative associations between PCL-F1 and the right amygdala volume and shape were only partially mediated by PHQ-F2. Both PHQ symptom dimensions only partially mediated positive associations between symptom dimensions of the PCL and the inferior fronto-occipital fasciculus (IFO) FA.

**Discussion:** We used EFA and mediation analyses to determine whether associations between PTSD and structural neuroimaging profiles were dissociable from overlapping MD symptoms in Veterans with a history of mTBI. Our results suggest that PTSD symptom influences on structural imaging markers are discernable from MD symptoms and exert effects on amygdala and hippocampal morphometry and fiber integrity of the
IFO and CR in excess of those exerted by MD. Treatment of comorbid disorders remains challenging. These findings may help identify targeted treatment strategies to serve patients suffering from comorbid PTSD and MD.
Lance-Adams Syndrome: Functional Rehabilitation Via Multidisciplinary Intervention

Derek Thong¹, Bonnie Buchko², Rouaa Mandurah¹, Flor Muniz-Rodriguez¹,², Seyed-Hossein Hosseini², Gihan Perera², Zhihui Deng¹,²
¹McMaster University Department of Medicine Division of PMR, Hamilton, Canada, ²Hamilton Health Sciences, Hamilton, Canada

Lance-Adams syndrome (LAS), a chronic form of post-hypoxic myoclonus, is a rare complication developed days or weeks after a successful cardiopulmonary resuscitation. The characteristic features of this condition are action and reflex myoclonus that subside at rest. The myoclonus can produce marked functional disability and it especially interferes with gait, which can be bouncy and unsteady, resulting in falls and close-calls. The pathophysiology of LAS is not clear. The imaging studies of LAS patients indicated a heterogeneous mechanism with the involvement of cortical-subcortical structures, brainstem, and/or cerebellum. The current literature suggests that the most effective agents - levetiracetam, piracetam, clonazepam, and valproic acid - produce the best outcomes when used in any combination, except for levetiracetam and piracetam when used together. Despite there being approximately 150 case reports, there appears to be a paucity regarding functional outcomes after multidisciplinary treatment. In addition to myoclonus, most patients with LAS present with neurocognitive and communication impairments, which also impact the patients’ functional ability.

Our group at Hamilton Health Sciences represents a multidisciplinary team who specialize in the inpatient rehabilitation of acquired brain injury (ABI) and includes: physiatrists, neurologists, physiotherapists, pharmacists, psychiatrists, neuropsychologists, nurses, occupational therapists, speech language pathologists, therapeutic recreationists, social workers, and registered dieticians. We present four cases of LAS admitted between 2015 and 2018 that received multidisciplinary assessment and therapy at our ABI rehabilitation program. These patients were treated with a variety of pharmacologic and non-pharmacologic interventions. These interventions have shown to increase their functional ability as demonstrated by the change in their Functional Independence Measures scores (FIM) between admission and discharge. The FIM is a validated and widely used assessment tool to quantify a patient’s functional ability in the following domains: self-care, sphincter control, transfers, locomotion, communication and social cognition. Additionally, we discuss the patients’ progress towards specific myoclonus treatment goals with the utilization of the Goal Attainment Scale (GAS).
Incidence of Traumatic Brain Injury among Ontarian Adults with and without Intellectual and Developmental Disabilities

Katherine Seto, Meghann Lloyd, Vincy Chan, Hannah Chung, Kinwah Fung, Robert Balogh

1University of Ontario Institute of Technology, Oshawa, Canada, 2Institute for Clinical Evaluative Sciences, Toronto, Canada, 3University Health Network, Toronto, Canada

Background: In Ontario, there are approximately 66,000 adults living with a diagnosis of intellectual and developmental disability (IDD). These individuals have poorer health and health outcomes compared to the general population. For instance, it is known that persons with IDD experience falls and injuries more frequently than the general population. However, little is known about traumatic brain injury (TBI) in this population. Traumatic brain injuries (TBIs) are a leading cause of death and disability in Canada and cost the healthcare system nearly $300 million annually in direct costs from Ontario emergency departments alone. TBI captured by Ontario emergency departments also account for more than $650 million in lost productivity. Falls are a known risk factor for TBI, indicating a potential increased TBI burden among persons with IDD compared to the general population and resulting in even higher healthcare costs.

Despite this, there is no research examining the risk of TBI among persons with IDD. The objective of this study was to compare TBI among Ontarian adults with and without IDD over time and by demographic information.

Methods: Using administrative data, annual incidence of TBI for fiscal years 2002/03 - 2016/17 were compared across three cohorts: 1) all adults with IDD (ALL IDD), 2) persons with IDD diagnosed prior to experiencing any TBI (IDD prior to TBI), and 3) random 10% sample of Ontarians without IDD (No-IDD). Records of persons with IDD and/or TBI were identified using International Classification of Diseases (ICD) codes in three administrative health databases: the Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD), Same Day Surgery (SDS), and the National Ambulatory Care Reporting System (NACRS). Annual incidence was calculated using the first new instance of TBI in a unique individual in a given fiscal year. Incidence of TBI in the three study groups was adjusted for age and sex.

Results & Discussion: Data analysis will begin in December 2018 and results will be ready in time for the conference. Based on existing literature indicating falls as a leading cause of TBI in combination with literature indicating a greater risk of falls and injury-related loss of consciousness among persons with IDD, it is anticipated that the yearly incidence of TBI will be greater among persons with IDD than the general population. This will be the first known study to quantify TBI in persons with IDD using population level data. Our findings could be used to guide TBI prevention strategies specific to the needs of people with IDD.
Delivering Intensive Rehabilitation Intervention in Partnership with Parents - Can It Be Done, Does It Make A Difference?

Anne Gordon¹,², Dereena Minehane³, Jill Massey¹, Ben Siegle³, Tomoki Arichi¹,²
¹Evelina London Children’s Hospital; ²Guy’s & St Thomas’ Hospital NHS Foundation Trust, London, United Kingdom; ³King’s College London, London, United Kingdom

Despite compelling evidence for specific modalities of individualised, protocolised, goal-directed intensive interventions to make lasting improvements in motor function for children with hemiparesis translation into clinical practice is rare. We developed an intensive intervention programme, in conjunction with parents and therapists across a wide geographical region. The aims of the programme are to place coaching of parents and young people at the centre, and through partnership working deliver both clinically and cost-effective intervention.

The intervention programme delivers prescribed intensity of intervention with clearly defined protocols. The children attending are predominantly infants and preschoolers, who present clinically with hemiparesis and may have a congenital or acquired brain injury. The assessment protocol includes standardised measures of adaptive behaviour, bimanual function, child-centred GAS goals, and parental/young person rating of performance and satisfaction with functional tasks requiring 2 hands. The children/young people are assessed 6 weeks and immediately prior to the intervention, immediately after, and 6 weeks and 6 months after the intervention to evaluate retention of benefit.

We present the findings of the first 25 children who were preschool age at the time of enrolment in the programme. Clinical presentation and brain lesion characteristics will be presented along with findings of standardised assessments, individualised goals and parent ratings of outcome and for their child and themselves. We make the case for coaching as a fundamental element of partnership delivery of neurorehabilitation for children, to support long-term self-management and participation outcomes.
Three-Dimensional Multiple Object Tracking as A Marker of Normal Cerebral Functioning after Paediatric Mild Traumatic Brain Injury: A Pilot Study

Laurie-Ann Corbin-Berrigan1, Kristina Kowalski5, Jocelyn Faubert2,3, Brian Christie5, Isabelle Gagnon1,4

1Mcgill University, Montreal, Canada, 2Université de Montréal, Montreal, Canada, 3Faubert Lab, Montreal, Canada, 4Trauma Programs, Montreal Children’s Hospital, Montreal, Canada, 5University of Victoria, Victoria, Canada

Background: Paediatric mild traumatic brain injury (mTBI) care seeking has drastically increased over the past years. While mTBI management is symptom dependent; it has been highlighted in recent literature that subtle physical and cognitive deficits may outlast symptom presentation. It is also suggested that these deficits may be responsible for the increased risk of head re-injury noted in children following the initial injury. MTBI management clinics have started to emerge exponentially with hopes of ascertaining adequate cerebral functioning before allowing children to engage back in their activities (sport, school, leisure). Clinicians could benefit from validated markers of normal cerebral functioning after mTBI before allowing children to return to activities. Research from our group has suggested that 3-dimensional multiple object tracking (3D-MOT) may be sensitive to mTBI recovery through differences in improvements on speed of processing over the course of repetitive trainings. Previous work suggests that it may be used as a measure of cognitive readiness to go back to activities after sustaining a mTBI.

Objective: The aim of this study was to explore if children who were followed in a mTBI-specialized clinic and underwent a multimodal assessment including a physical exertion test before going back to physical activities performed similarly to healthy controls on a 3D-MOT training paradigm and on clinical measures of recovery.

Design: Longitudinal design.

Setting: Concussion Clinic/Mild Traumatic Brain Injury (MTBI) Program. Participants: 10 children who were considered clinically recovered from their mTBI and cleared for full return to sports within the last week (14.60 ± 1.50 years) and 10 children with no history of mTBI in the last 12 months (13.12 ± 2.34 years) were recruited as healthy control participants.

Intervention: Participants underwent 6 training sessions of 3D-MOT separated by 3-7 days.

Outcome Measures: D-MOT performance, over the course of 6 training sessions was collected at each visit. In addition, clinical measures of balance, coordination, post-concussion symptoms, cognitive performance, self-efficacy, fatigue and quality of life were collected at the initial and final training sessions.

Results: A repeated measure ANOVA (2 x 6) showed no significant between group effects (F (1,10) = 0.005, p= 0.946, η2p< 0.001), and significant time effect (F (5,50)= 21.737, p<0.001, η2p=0.685 ) when looking at 3D-MOT performance. Independent t-test revealed no significant differences in clinical measures within and between groups for initial and final visits.

Conclusions: Results suggest that clinically recovered children exhibit similar 3D-MOT performance as healthy controls. No significant differences were noted on clinical measures. Based on previously published work by our group, these results enforce the possibility that 3D-MOT may act as a marker of cognitive
readiness after mTBI. In addition, the results support the use of multimodal management in specialized clinics to ensure a safe return to activities after mTBI.
Ecological Validity in the Rehabilitation of a Service Member with Penetrating TBI

Carolyn Perez¹, Tracy Floyd², Rocio Norman¹
¹University of Texas Health Science Center at San Antonio, San Antonio, United States, ²Brooke Army Medical Center, San Antonio, United States

Background: In recent years, the goal of therapeutic intervention has shifted towards placing a greater emphasis on ecological validity. This shift can be attributed to a need to enable patients to generalize intervention to meaningful everyday pursuits. The importance of considering ecological validity is apparent in the traumatic brain injury (TBI) rehabilitation literature, as it is a theoretical concept subserving successful intervention and recovery. We report the treatment of a twenty-two-year-old male service member (SM) with a severe, penetrating TBI secondary to a high-velocity projectile and resulting in severe facial and skull fractures and epidural and subdural hematoma. Post-injury, symptoms included depression, anxiety and mild cognitive disorder characterized by deficits in visual motor construction, executive function, sustained attention, verbal learning, memory and cognitive flexibility. Concomitant physical conditions included monocular vision with complete loss of visual field in the left eye and hearing loss in the left ear. Three months post-injury, the SM participated in outpatient occupational, recreational and speech-language pathology intervention at a U.S. Army Medical Center. Treatment outcomes were assessed via self-report measures including the Quality of Life After Brain Injury (QOLIBRI) and the Patient Global Impression of Change (PGIC)Measure. Functional gains were assessed using a standardized driving assessment and probes of cognitive insight and awareness.

Methods/Design: Single-subject case study combining functional interventions within an interdisciplinary rehabilitation approach. The SM’s goals were based on tasks with high ecological validity and considered the SM’s self-selected vocational and personal goals (e.g. regaining driver’s license). Fifty-two weeks of group and individual intervention focused on the cognitive domains of cognitive flexibility and visuospatial skills. Therapy approaches included the following: 1) Metacognitive training; 2) Driving simulation; 3) Robotics; and 4.) Role-playing and coaching.

Results: Results of the QOLIBRI indicated improvement in health-related quality of life in the Daily Life and Autonomy (4.18% increase) and Social Relationships (10.08% increase) subscales from pre- to post-intervention. On the PGIC, the SM reported a considerable improvement (score of 7) in his status since the start of care. Functional results included reinstatement of driver’s license with no restrictions and increased insight to better inform vocational goals.

Discussion: The case study demonstrates the importance of including ecologically valid and contextual therapy tasks in outpatient rehabilitation. The interplay between self-selected goals and therapy approaches aligned with those goals positively influenced both health-related quality of life as well as functional outcomes for the SM depicted in this case study. Future research should consider ecologically valid tasks and routines as the cornerstone of effective rehabilitation practice.

Keywords: Traumatic Brain Injury (TBI), Ecological Validity, Cognitive flexibility training, Computer-based training, Driving Simulation, Rehabilitation outcome, Executive functions, Cognitive control, Robotics.
College after Concussion: Student Self-Advocacy and Knowledge Challenges

Katy O'Brien¹, Anna Fink¹
¹University of Georgia, Athens, United States

Objectives: Millions of concussions are sustained annually in the United States and estimates of prevalence rates of concussions on college campuses range from 16 to 28% (respectively, Krause & Richards, 2014; Brown, Hux, & Shepherd, 2015). An emerging literature is considering how recovery from a concussion effects student returning to the classroom, finding academic problems are common immediately after an injury, and can linger for months (Moreau & Langdon, 2014; Wasserman, Bazarian, Mapstone, Block, & Wijngaarden, 2016). The current study examined the return to learn experiences of college students with concussion, with a focus on student recommendations for improvements to care.

Methods: Using a phenomenological approach, we conducted semi-structured interviews with 12 students with a history of concussion. All participants were non-athlete students that returned or attempted to return to learn at a large university in the southeastern United States. The interviews included broad, open-ended questions beginning with academic and overall injury experience, then moving toward questions about symptoms and returning to studies after concussion. Using an open coding system, “significant statements” that contributed in some way to interpretation of the student’s return to learn and overall concussion experience were identified and grouped in to common themes.

Results: Students identified avenues to improvement of care for student with concussion on campus through two subthemes: recommendations for others returning to learn post-concussion to approach professors and self-advocate for their recovery and academic needs, and recommendations to improve concussion and/or campus resource knowledge. Barriers to self-advocacy included class size, unfamiliarly with professors, and perceived limited concussion knowledge of professors. Limited knowledge of symptom management, safety measures, strategy use, and resource use following concussion affected the students’ overall healing processes.

Conclusions: Findings are in line with other research suggesting that students face a multitude of challenges upon the return to the classroom following concussion (McGrath, 2010; Chrisman et al., 2013; Moreau et al., 2014; Iadevaia et al., 2015; Childers & Hux, 2016; Wasserman et al., 2016; André-Morin et al., 2017), but also describe particular approaches for targeted education to support these students and improve care systems on campus. Limited knowledge of concussion effects and resources resulted in many students not seeking resources until falling behind or experiencing negative academic consequences. Future research should address education models for both students and faculty that address prevention of academic effects post-concussion, such as training about concussion signs and symptoms, campus resources, management approaches, and use of short-term academic adjustments. Outcome measures may consider student grades or dropped courses, but also factors such as persistence of symptoms, number of interactions with professors, or type and variety of academic adjustments provided.
Evaluating the Test-retest Reliability of Strength Measures for the Assessment of Concussion in Youth Athletes

Tiffany Toong1, Katherine Wilson1, Nick Reed1,2,3

1Concussion Centre, Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, 2Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada, 3Department of Occupational Science and Occupational Therapy, University of Toronto, Toronto, Canada

Background: Previous research has found strength deficits following a brain injury in youth. Thus, strength may have the potential to add value to the assessment of concussion in youth athletes. However, strong test-retest reliability of any assessment must be first established. Current concussion measures in youth have demonstrated less than adequate reliability in part because of the cognitive and physical maturation that youth undergo during this time period. No studies to date have examined the test-retest reliability of strength measures for the assessment of concussion in youth athletes. In addition, the influence of clinically relevant test-retest time intervals used in concussion, sex, and development on test-retest reliability has yet to be explored.

Objectives: This study aims to explore the test-retest reliability of upper and lower body strength measures in youth athletes (10-18 years) and to further investigate the influence of time between reassessments, sex and development on test-retest reliability.

Methods: A total of 79 healthy youth athletes completed baseline measures of grip strength (dominant and non-dominant hand) and standing long jump on two separate occasions (0.5 –21.5 months apart). Reliability was assessed using Intraclass Correlation Coefficients (ICCs) and Reliable Change Indices (RCIs) with correction for practice effects. Change in height between assessments was used as a proxy for development/growth.

Results: ICCs for all grip strength and standing long jump measures ranged from 0.83 - 0.97 (CI= 0.75-0.98), exceeding clinical reliability standards (ICC >0.7). RCIs revealed only a small percentage of cases (0-1.8%) falling outside the 90% and 95% confidence intervals, demonstrating overall strong reliability for all measures. There was a trend towards decreased reliability with increased time between test-retest assessments. Stronger reliability on standing long jump was found in males compared to females and in those that had minimal changes in height.

Conclusions: This study contributes to the literature by presenting, for the first time, the test-retest reliability of strength measures for concussion assessment. Results indicate that grip strength and standing long jump measures are reliable in youth athletes ages 10-18 across clinically relevant concussion test-retest time intervals under a year, both sexes, and with ongoing development. Our findings offer preliminary psychometric support for the inclusion of strength measures as a useful tool in the assessment of concussion for youth athletes.
Caregivers of people with Traumatic Brain Injury (TBI) are vital ‘secret agents’ in helping to develop person-centred therapeutic goals. Family caregivers are the ‘invisible’ link in interdisciplinary collaboration: The role of a spousal caregiver is not usually one expects or trains for, but rather a role that one unwittingly steps into right after an accident happens – a journey with an open-ended ticket to an undetermined destination. The outcome becomes more positive thus creating a successful continuum of care for clients living with TBI and their families. The presenter will share her unique perspective as a recreation professional coupled with her lived experience as a caregiver and apply it to practice. The front-line, caregiving spouse is an integral resource for assisting with a self-management program for one’s spouse, helping to create a safe and secure environment for continued improvement, keeping the home running on all cylinders and keeping the legal team (where involved) abreast of the home situation.

Creating this presentation is two-fold:
1) Encouraging the professional, either in the health care or legal field, to become more passionate in one’s work to make a difference: active listening, creating an atmosphere of connecting and sincerely caring and helping. Ultimately being responsive to your client’s needs and those of their family - giving necessary attention to your client to be clearly understood and to ignite positive responses for the benefit of your client.
2) Giving other caregivers hope, resources and help to empower them to hold their heads high and get involved in their family member’s recovery. They are a pivotal part of the whole recovery process and the glue that holds everything together

According to “Word IQ”, knowledge is the awareness and understanding of facts, truths or information gained in the form of experience or learning. Knowledge is an appreciation of the possession of interconnected details, which in isolation, are of lesser value.

When the caregiver and professionals come together “on the ledge” intending to check and share with each other the “interconnected” details, this serves to add to a greater sense of acceptance for the injured person and his/her family. Creating and brainstorming more solutions and resources is ultimately a way to strengthen the family unit during this time of uncertainty.

Upon completion of this session, participants will be able to:
1. Define two symptoms that affect the traumatic brain injury client’s well-being and overall family dynamics.
2. Develop client-centred goals based on a family member viewpoint for participation in community leisure activities
3. Identify tools to use when working with family members to enhance working with their clients and as part of an interdisciplinary team.
The Deception of Bilateral Frontal Contusions: Deterioration in Minutes

Laurie Dabaghian1,2, Ondrea McKay1, Peter Yonclas1

1Rutgers New Jersey Medical School, Newark, United States; 2Kessler Institute for Rehabilitation, West Orange, United States

Introduction: Contusion on imaging leads to decreased vigilance because risk of deterioration is less, yet 2% of fatal head injuries on autopsy show only cortical contusions. This case demonstrates the delayed rapid deterioration of a patient with bilateral frontal contusions.

Case Description: A 28-year old male presented to our hospital with persistent headache. He was in a motorcycle accident 5 days ago and admitted to an outside hospital, where imaging showed suboccipital fracture, subarachnoid hemorrhages, subdural hematoma (SDH) and edema. He was discharged home a day prior to this admission.

On admission, CT Head (CTH) showed bilateral frontal lobe contusions, right >left, SDH, diffuse sulcal effacement and parietal bone fracture. He was admitted to the medical intensive care unit (ICU) and placed on frequent neuro-checks. Repeat CTH showed stable bifrontal contusions with slight increase in right temporal lobe contusion and midline shift.

On Hospital Day 1, patient had Glasgow Coma Scale (GCS) score of 15. On exam, he was awake, alert and oriented, conversational and able to participate in a cognitive exam which demonstrated higher level executive dysfunction. He had no other neurologic deficits and ambulated 100ft with physical therapy.

On Hospital Day 2 (7 days post injury), he became acutely unresponsive with dilated and unequal pupils. CTH showed increased edema, mass effect and herniation. He was taken to the OR emergently for right hemi-cranietomy with evacuation and intracranial pressure (ICP) monitor placement. EVD was placed the following day. Patient had refractory high ICPs (high as 55) and hypernatremia despite CSF diversion, hyperosmolarity treatment and pentobarbital coma. On Hospital Day 9, he was pronounced brain dead.

Discussion: Although early in their care isolated bifrontal contusion patients may have high GCS scores and benign clinical courses, these patients are at risk for deterioration until Day 9 post injury with 28.3% suffering from herniation. Deterioration is delayed because the frontal region of the brain tolerates progressing lesions longer. Patients don’t present with lateralizing warning signs of midline shift and pupils don’t change size early on. Deterioration is due to increased ICP from worsening edema or new hemorrhage in contused area.

With mild to moderate head injury, ICP monitoring isn’t routinely recommended and patients with bifrontal contusions don’t fit Brain Trauma Guidelines. Due to potential deterioration, recommendations are to monitor patients with bifrontal contusions in the ICU for 7 days and consider ICP monitoring in those with severe headache, mass effect and extensive contusion. Since ICP monitoring has potential systemic complications, less invasive monitoring recommendations include using blood flow measurements in patients with GCS>8 or scoring patients based on clinical findings.

Knowledge of this potential outcome in bifrontal contusions should promote vigilance and prevent sudden acute deterioration and death.
Emerging Promising Practices in Disaster Preparedness for People with Traumatic Brain Injury: A Systematic Review and Meta-Analysis

James Akkidas¹, Teresa McCourt¹, Sara Miller¹
¹West Virginia University Center for Excellence in Disabilities, Big Chimney, United States

Through a systematic review and meta-analysis, identify promising practices in emergency and disaster preparedness for individuals with traumatic brain injury (TBI) and emergency response systems in local communities.

Historically, people with disabilities, including individuals with TBI, are at an increased risk during emergency situations because responding localities are underprepared to effectively serve this group. Since 2006, regulations have been in place requiring the inclusion of people with disabilities in all aspects of preparedness plans within the United States. However, in emergency situations since 2006, including Hurricane Irma in 2017, the 1000-year flood in South Carolina in 2015, and the 1000-year flood in West Virginia in 2016, implementation of these inclusive protocols still fell short. In order to prevent reoccurring inefficiencies in emergency response, a review of the literature to determine promising practices is necessary.

A systematic search was conducted in databases like SCOPUS, PubMed and Google Scholar using key words and phrases like “disability” and “disaster preparedness,” which resulted in over 250 articles. They were then screened using a predefined inclusion criterion. An in-depth review was conducted on literature to outline research into emergency preparedness for individuals with disabilities. The research was overlaid with known potential characteristics of people with TBI to identify potential needs in emergency situations. SAS 9.4 will be used for conducting a meta-analysis with the data collected from a few articles from the systematic review. Heterogeneity of the effect sizes will be tested to assess whether a fixed effect or a random effect meta-analysis should be used to examine the association between disaster preparedness among people with TBI during emergency situations.

As a result of the systematic review certain themes emerged leading the researchers to specific promising practices, including the importance of including individuals with TBI in the disaster planning process; identifying and educating individuals with TBI in the community on disaster preparation; and identifying specific methods of communication, mobilization and shelter accessibility to cover the array of potential disabilities that could be results of TBI. A meta-analysis in underway which could produce statistically significant results supporting the systematic review. People with disabilities are at a higher risk of being unprepared in emergencies. First responders have historically been underprepared to respond effectively to the needs of people with disabilities in emergencies. Federal guidelines now require the inclusion of people with disabilities in all aspects of emergency planning, preparation and training scenarios. Despite these more recent federal regulations, emergency preparedness for this special population is still lacking. There is limited research into best practices to ensure the safety of individuals with disabilities in emergencies. However, promising practices are beginning to emerge in the field. A study on comprehensive approaches is needed.
The Use of Neuroimaging by Community Physicians in Children with Mild Traumatic Brain Injuries

**Lesley Abraham**, Elizabet Davenport, Donald Kasitinon, Stephen Bunt, Tonia Sabo, Munro Cullum, Kathleen Bell

*University of Texas Southwestern Medical Center, Dallas, United States*

Purpose: The acute clinical symptoms after mild traumatic brain injury (mTBI) are often due to functional disturbances, and structural abnormalities are typically not seen on brain imaging. The Pediatric Emergency Care Applied Research Network published guidelines to predict the need for neuroimaging after a traumatic head injury. We examined the utilization of computerized tomography (CT) brain imaging after acute concussion in a community-based registry for youth concussion in the Dallas area to determine adherence to guidelines.

Methods: This prospective study included 633 subjects enrolled in the North Texas Concussion Registry (ConTex) between the ages of 5-18 years who presented to an emergency department or primary care physician’s office acutely after mTBI. Information collected included demographic data, mechanism of injury, initial symptoms after injury, neuroimaging ordered (CT), and where the neuroimaging was ordered (emergency department or primary care physician’s office).

Results: There were a total of 633 subjects who were initially seen in an emergency department or primary care provider’s office, of which 273 (43.1%) had a CT scan and 360 (56.9%) did not. Emergency room providers ordered head CT scans more frequently than primary care physicians (52.6% versus 7.5%, \(\chi^2=87.05, df=1, p<0.001\)), and a higher percentage of males underwent CT than females (49.1% versus 36.7%, \(\chi^2=9.85, df=1, p=0.002\)). The percentage of CT scans ordered varied significantly by mechanism of injury: sports related concussion (34%), motor vehicle accident (41%), fall (60.6%), hit by an object (39.5%) and assault (61.5%). A higher percentage of CT scans were ordered when certain symptoms were reported post-injury: vomiting versus no vomiting (62.2% versus 39.0%), loss of consciousness versus no loss of consciousness (65.3% versus 33.6%), motor and balance difficulties versus no motor and balance difficulties (49.7% versus 29.6%), confusion versus no confusion (49.2% versus 30.4%), and amnesia versus no amnesia (57.1% versus 33.1%). Reported headache post-injury did not show a significant difference in whether a CT scan was ordered.

Conclusions: In this study, symptoms that were related to increased ordering of CT scans include vomiting, loss of consciousness, motor and balance difficulties, confusion, and amnesia, which is consistent with current imaging guidelines. However, a significant number of youth without designated symptoms were imaged as well. The findings also suggest that there is a significant difference in the practices of providers in the emergency room compared to primary care. Lastly, findings suggest that males are more likely to undergo CT than females following concussion. Further analysis is needed to better characterize variables affecting CT ordering patterns and practices in the community. It is likely that additional community education is needed for implementation of imaging evaluation guidelines after acute concussion.
Determinants of Psychological Flexibility in Individuals with a Traumatic Brain Injury

Diane Whiting, Grahame Simpson, Kasey Metcalf

Brain Injury Rehabilitation Research Group, Ingham Institute of Applied Medical Research, Liverpool, Australia, John Walsh Centre for Rehabilitation Research, University of Sydney, Sydney, Australia, Brain Injury Rehabilitation Unit, Liverpool Hospital, Australia

Objectives: Poor psychological flexibility has been associated with a wide range of mental health problems and is considered to be the mechanism for change in Acceptance and Commitment Therapy (ACT). A component of psychological flexibility is proposed to be cognitive flexibility, but this has not been empirically established. Individuals with a TBI tend to demonstrate impairments in their cognitive flexibility and therefore this study investigated the factors contributing to psychological flexibility, and how this may impact on the delivery of psychological treatment.

Method: Participants with a moderate to severe TBI (n=73) were recruited from Liverpool Brain Injury Rehabilitation Unit, Australia on average 16.4 months after their injury (range 1-192 months) They were administered self-report measures of distress (Depression Anxiety Stress Scale - 21), experiential avoidance (Appraisals of Threat and Avoidance Questionnaire - ATAQ) and psychological flexibility (using a measure of acceptance and action, the AAQ-ABI). These were administered in conjunction with a full neuropsychological assessment which included several measures of cognitive flexibility (Trail Making Test B, Wisconsin Card Sort Test, Alternate Uses Test, Controlled Oral Word Association Test, Stroop and Stroop Neuropsychological Screening Test). Relationships were explored between the variables and a model of psychological flexibility was developed using structural equation modelling.

Results: Avoidance measures and measures of psychological distress indicated strong relationships with psychological flexibility as has been indicated by research in non TBI populations. Functional measures of cognitive flexibility that assess the ‘ability to shift’ were not related to psychological flexibility but broader measures of cognitive flexibility that capture additional cognitive processes, were correlated. Overall, measures of cognitive flexibility indicated limited relationships with psychological flexibility and in the model was cognitive flexibility mediated by full scale IQ score.

Conclusions: Psychological flexibility is better explained by psychological distress and avoidance behaviour than by cognitive flexibility in individuals with a TBI. Clinically, this indicates the need to address psychological distress in the first instance but cognitive rehabilitation to address cognitive inflexibility may increase the effectiveness of psychological interventions.
Procedural Memory Following Traumatic Brain Injury: The Role of Individual Differences

Arianna Rigon, Nathaniel Klooster, Samantha Crooks, Melissa Duff

1Vanderbilt University Medical Center, Nashville, United States, 2The University of Pennsylvania, Philadelphia, United States, 3The Kennedy Krieger Institute, Baltimore, United States

Memory impairments are among the most common consequences following moderate to severe Traumatic Brain Injury (TBI), and are particularly debilitating, because not only do they influence an individual’s capacity for independence and their quality of life, but they can also interfere with an individual’s ability to adhere to a rehabilitation protocol. Procedural memory deficits following TBI have received relatively little attention, and the few studies that have investigated it show mixed results, possibly due to the large individual variability within TBI populations.

The aim of the current work was to examine procedural memory in a sample of individuals with moderate to severe TBI (n=36) and demographically matched healthy comparisons (HC, n=30) with the Rotary Pursuit task, to investigate 1) whether as a group, individuals with TBI underperform HC on a procedural memory task, and 2) whether within TBI populations there are individual differences in procedural memory and learning performance. Linear mixed-effects modeling revealed that during the Rotary Pursuit, the TBI group spent significantly less time on target than HCs, but, their rate of learning was not significantly different. Analyses of individual differences revealed that 13 participants with TBI (14%) displayed significant impairment in their rate of procedural learning.

These results provide evidence that while as a group TBI patients may not show impairment on tasks of procedural memory and learning, this might not be true for all individuals. We discuss the implications of our findings within the context of post-injury rehabilitation strategies and treatment plans.
Short- and Long-Term Approaches to Address Traumatic Brain Injuries: Results from Imaging and Epidemiological Studies

Guido Guberman¹, Sheilagh Hodgins², Alain Ptito¹, Maxime Descoteaux³
¹McGill University, Montreal, Canada, ²University of Montreal, Montreal, Canada, ³University of Sherbrooke, Sherbrooke, Canada

Due to their massive prevalence and often insidious nature, traumatic brain injuries (TBIs) are a challenging public health concern. As a result of subtle injuries or in cases of incomplete recovery, victims of TBI may be cleared to return to the activities that caused their injuries, exposing them to repeat injuries. Given the recently-discovered link between repetitive brain trauma and chronic traumatic encephalopathy, strategies are needed to address the issue of TBIs both in a short-term setting, by improving detection and informing treatment, and a long-term setting, by improving prevention. In this presentation, I will outline the results of two studies. In the first, we scanned 20 youth with mild TBIs (mTBI) in the sub-acute stage of recovery (3 to 90 days) and 40 healthy controls. We used recent advances in magnetic resonance imaging (MRI) to better understand the neuropathology involved in mTBIs. We found concurrent neuropathologies in the patient group, which, based on linear regression analyses, were predictive of symptoms. In the second study, we analyzed a longitudinal sample of males followed from age 6 to 30 to assess whether childhood behavioural problems can predict TBIs sustained in adolescence and adulthood. When participants were children, teachers rated them on a variety of externalizing behaviours, including inattention and hyperactivity, and hurtful and uncaring behaviours. Using logistic regressions, we found that such behaviours could predict TBIs in adolescence and adulthood, after controlling for previous TBIs and familial social-status. Results from the first study suggest that advanced MRI techniques can be used to better understand the neuropathology of TBIs, which could inform on potential treatments. Results from the second study show that childhood behaviours can provide an inexpensive and easily-accessible way to predict future risk of TBIs and suggest that behavioural therapies aimed at reducing these behaviours may also reduce the risk of future TBIs.
The Utility of Clinical and Biomechanical Metrics of Gait and Balance in Distinguishing Pediatric Concussion from Healthy Controls

Daniel Corwin1,2,4, Catherine McDonald1,5, Kristy Arbogast1,2,4, Declan Patton1, Fairuz Mohammed1, Melissa Pfeiffer1, Kristina Metzger1, Colin Huber1, Christina Master1,3,4

1Center for Injury Research and Prevention, The Children's Hospital of Philadelphia, Philadelphia, United States, 2Division of Emergency Medicine, The Children's Hospital of Philadelphia, Philadelphia, United States, 3Sports Medicine and Performance Center, The Children's Hospital of Philadelphia, Philadelphia, United States, 4Perelman School of Medicine, University of Pennsylvania, Philadelphia, United States, 5School of Nursing, University of Pennsylvania, Philadelphia, United States

Background: Gait and balance are frequently altered in concussed youth. These dysfunctions can be assessed clinically as well as with biomechanical force-plate devices. While studies comparing these approaches have been conducted in collegiate athletes, this comparison has yet to be performed in the pediatric population. Our objective was to compare the ability of the modified balance error scoring system (mBESS), tandem gait, and a modified clinical test of sensory interaction and balance (mCTSIB) to discriminate concussed from non-concussed youth.

Methods: We enrolled 81 cases and 90 controls age 14-18 years old from August 2017-June 2018. Controls were recruited from a suburban high school, and cases were recruited from the sports medicine clinics of a tertiary care academic pediatric center and a suburban high school. Balance tests included: (1) mBESS, scored as total number of errors on three standing tasks (feet together, feet in tandem, on one foot); (2) Tandem gait, with errors defined as either sway or steps off line during 4 conditions of walking (five steps forward and backward, with eyes open [EO] and closed [EC]); and (3) mCTSIB, performed on the Biosway Portable Balance System (Biodex Medical Systems) and scored as a sway index, the standard deviation of the average center of gravity for four conditions (EO and EC on a firm or dynamic surface). P-values were obtained for tests between proportions, medians (Wilcoxon rank test), and means (T-test). Area under the receiver operating curve (AUC) was used to describe the discriminatory ability of each approach.

Results: Age, sex, race/ethnicity, and insurance were similar among cases and controls. Cases were seen a median of 11 (IQR: 5,17) days after injury. The median number of total mBESS errors was 4 (IQR: 1,7) for cases and 2 (IQR: 1,4) for controls (p = 0.003), AUC=0.65. On tandem gait, 25% of cases versus 5% of controls had sway/error walking forward EO (p=0.001); 40% of cases versus 17% of controls had sway/error walking backward EO (p=0.003); 64% of cases versus 48% of controls had sway/error walking forward EC (p=0.04); and 82% of cases versus 59% of controls had sway/error walking backward EC (p=0.003). AUC for total number of conditions provoking sway was 0.65. The mean (SD) sway index on the mCTSIB was 1.3 (0.5) for cases versus 1.1 (0.3) for controls (p=0.003), AUC=0.61.

Conclusions: Significant differences between cases and controls were present on three different gait and balance assessments. Objective measures of balance produced similar discriminatory ability as the two clinical assessments. While more concussed adolescents demonstrated balance difficulties than non-concussed controls, no balance test showed more than mild discriminatory ability (all AUC<0.65). Balance deficits should be taken in context of a patient’s history and additional physical examination findings when diagnosing concussion.
Inpatient Rehabilitation Occurrence Between Minorities and Non-Minorities Following Traumatic Brain Injury

Aiwane Iboaya¹, Nneka Ifejika¹
¹University of Texas Southwestern Medical Center, Dallas, United States

Traumatic Brain Injury (TBI) is a major contributor of death and long-term disability in industrialized and developing countries across the world. Of those affected, studies have consistently shown that minority patients are at an increased risk for TBI and have higher rates of severe morbidity and mortality following TBI compared to non-Hispanic whites (NHWs). Regardless of these facts, disproportionate number of minorities are less likely to be discharged to an acute inpatient rehabilitation (IPR) facility following their hospitalization compared to NHWs. This disparity in post-acute management is important given that at four years post injury, regardless of race and gender, most survivors with moderate to severe disabilities neither returned to work or school though they had no physical disabilities and had a normal life expectancy. Since the World Health Organization poses that TBI will be the leading cause of death and disability by 2020, the estimated economic burden this patient population poses onto their family, society, and the healthcare system in large is profound given these statistical findings coupled with the racial outcomes. To date, no evidence-based guidelines have been established for the optimal management of the post-acute care of people with TBI. Currently, the most sought practice of hospitalized TBI patients is IPR which has shown: a decrease in overall healthcare costs, greater functional improvements with a reduced length of stay, and patients discharge with less complications and impairments compared to those treated in other post-acute facilities, such as skilled nursing facilities. A strong negative correlation between race/ethnicity and TBI outcome has been noted in several medical publications, however a clear or definitive reason(s) for this disparity continues to be unclear. The authors of this research investigate racial disparities of discharge destination to an IPR following TBI by analyzing data collected from January 2007 to July 2018 from University of Texas Southwestern (UTSW) Zale Lipshy University Hospital in Dallas, Texas. The data composed of patients with a TBI diagnosis of varies ages and genders and their post-hospital healthcare service outcomes are compared based on race/ethnicity and insurance status in hopes of finding possible compounding variables that determine a cause(s) of the racial disparity in post-acute destination.
Executive Functioning Deficits Following Right Hemisphere Brain Damage

Ghalia Albakri¹, Laura Murray²
¹Health and Rehabilitation Sciences, Western University, London, Canada, ²School of Communication Sciences and Disorders, Western University, London, Canada

Background: A growing body of literature has indicated that various executive functioning (EF) abilities are compromised subsequent to right hemisphere brain damage (RHD). EF supports communication and other complex daily activities via planning, monitoring, and controlling other cognitive processes to accomplish goal-oriented behaviors. Individuals with intact EF can achieve desirable tasks through fine cognitive control that includes skills such as planning, problem-solving, cognitive flexibility, and self-monitoring. The ability to use and understand pragmatics and discourse is dependent on one or more of these EF abilities. Consequently, if one of these cognitive abilities is impaired, communication challenges are expected. For example, problems with inhibition subsequent to RHD can affect the ability to select and process only relevant contextual cues, which can, in turn, lead to inappropriate conversational content, style, or both, as well as misinterpreting the conversation output of others.

Objectives: To date, no previous systematic review has focused on EF abilities and RHD. The goals of this systematic review are: (a) to examine the RHD literature to identify EF deficits and the standardized EF assessments used to detect these deficits and (b) to evaluate the psychometric properties of EF assessments being used in this literature.

Methods: A comprehensive list of established search terms is developed and divided into four subcategories: right hemisphere, brain injury, EF abilities, and assessments. The search strategy will include searching the Cumulative Index to Nursing and Allied Health (CINAHL), Scopus, PsychInfo, and PubMed electronic databases between 1980 and November 2018. Titles and abstracts of peer-reviewed articles of any study types will be screened to meet the inclusion criteria, followed by a second screening of full-text articles. For the studies that meet the inclusion criteria, various data regarding EF abilities and demographic information will be extracted. Moreover, two assessment tools will be adapted and used to rate the quality of the included articles, as well as the quality of the assessments.

Future directions/implications: This systematic review will allow researchers and clinicians alike to identify gaps within the RHD literature pertaining to EF abilities, the type of assessments available and currently used in RHD investigations, as well as the type of clinical and demographic data being collected to characterize individuals with RHD. This study will drive research forward by shedding light on whether more accurate information collected regarding RHD is needed, and the type of assessments used when researchers and clinicians diagnose RHD participants with EF deficits.
Sleep and Psychiatric Disorders Preceding Occupational Head Trauma: Gender Differences

Bristol Baldwin1,2, Cori Snow1,2, Tatyana Mollayeva1,2, Angela Colantonio1,2

1Toronto Rehabilitation Institute - University Centre, Toronto, Canada, 2University of Toronto, Toronto, Canada

Introduction: Although research reports sleep and psychiatric disorders are common after head trauma, little is known regarding whether they are consequences of head trauma or exacerbations of pre-existing disorders, and how these disorders differ between men and women.

Objectives: In a consecutive sample of Ontarian workers presenting with delayed recovery from occupational head trauma, we aimed to describe and compare sex-specific prevalence and type of sleep and psychiatric disorders, preceding injury. Methods: A medical records review of 344 workers (79% men, aged 39.93±12.08 for men, and 42.43±11.07 for women) was performed. Two-sided t-tests and chi-square tests were conducted to identify differences between men and women in demographics and health status data.

Results: Pre-injury depression, anxiety, substance abuse, and sleep disorders were common, affecting 19%, 11%, 17%, and 8% of our sample, respectively. For 16% of injured workers, this was not their first head trauma. Pre-injury, women were more likely to have depression and anxiety disorder diagnoses compared to men (2=7.99, p=0.05 and 2=6.48, p=0.011, respectively). Previous head trauma and substance use disorders were more frequently observed in men compared to women (2=4.47, p=0.035 and 2=11.57, p<0.001, respectively). Of 26 workers diagnosed with a sleep disorder pre-injury, 92% were men and 8% were women.

Conclusion: Observed differences between men and women in frequency and type of sleep and psychiatric disorders warrants further investigation. Of particular interest is to investigate whether these disorders are linked to certain mechanism of injury, for targeted preventative intervention.
Intimate Partner Violence-Induced TBI Alters Autonomic Function Metrics

Jonathan Smirl¹, Liz Jones¹, Paige Copeland¹, Omeet Khatra¹, Paul van Donkelaar¹
1UBC Okanagan - Concussion Lab, Kelowna, Canada

Problem: An extremely prevalent, yet under-reported problem in North America is intimate partner violence (IPV). Reports have estimated >10 000 000 people in North America experience domestic abuse each year, and 29% of women (51 900 000) and 10% of men (1 800 000) are likely to experience physical violence, stalking or rape from an intimate partner at some point in the lives. Traumatic brain injuries (TBI) are thought to range between 30% and 74% in IPV survivors, as the face, head and neck are among the most commonly reported targets of the physical assault. Additionally, this is often a recurrent issue as ~25% of survivors are report being hit in the head more than 20 times in the past 5 years. Given these injury mechanisms, it is understandable some of the mental health challenges faced by IPV survivors may be rooted in alterations in brain/autonomic function.

Objectives: The objective of this investigation is to understand the physiological changes underlying TBI symptoms and neurocognitive deficits in women who have experienced IPV. Hypothesis: TBI as a result of IPV will lead to quantifiable impairments in autonomic regulation (i.e. heart rate variability and cardiac baroreceptor sensitivity).

Methods: Eighteen female IPV survivors (35.4 ± 8.7 years; BMI 25.5 ± 7.4 kg/cm²) with 13.4 ± 1.7 years of education participated in this investigation. The survivors were tested on 2 separate days. The first day consisted of the psychopathological self-reported and semi-structured interviews performed by a trained clinician. The second day consisted of the SCAT5 and a series of laboratory-based examinations including an assessment of autonomic function.

Results: All of the IPV survivors demonstrated impairments (as compared to normative control population data) in at least one of the autonomic function metrics assessed in the current protocol. In particular, 89% showed elevated resting sympathetic tone (indexed via low frequency heart rate variability spectrum); 89% displayed blunted cardiac baroreceptor sensitivity (indexed via low frequency cardiac BRS gain); and 72% demonstrated suppressed vagal tone (indexed via RMSSD heart rate variability).

Conclusion: The augmented sympathetic tone, blunted parasympathetic tone, and reduced blood pressure regulation in IPV survivors provides objective evidence of autonomic dysregulation in this population. This, in turn, may contribute to the challenges women who have experienced IPV face in trying to break free from the cycle of abuse.
Physiological Alterations within the Cerebrovasculature in Survivors of Intimate Partner Violence

Jonathan Smirl1, Liz Jones1, Paige Copeland1, Omeet Khatra1, Paul van Donkelaar1
1UBC Okanagan - Concussion Lab, Kelowna, Canada

Problem: Intimate partner violence (IPV) is an under-reported but extremely prevalent problem in North America. It is estimated 51.9 million (29%) women and 1.8 million (10%) men living in Canada (or USA) will experience rape, stalking, or physical violence from an intimate partner at some point in the lives. Recently it has been reported there are >10 million people in North America each year who are victims of domestic abuse, with 25% of survivors report being hit in the head more than 20 times in the past 5 years. The prevalence of traumatic brain injuries (TBI) within this population is thought to range between 30% and 74%, as the face, head and neck are among the most commonly reported targets of the physical assault by IPV survivors. Given these injury mechanisms, it is understandable some of the mental health challenges faced by victims of IPV may be rooted in alterations in brain physiology/function.

Objectives: The overall objective of this investigation is to understand the physiological changes underlying the symptoms and deficits in neurocognitive function observed in the women who have experienced IPV.

Primary Hypothesis: TBI as a result of IPV will lead to quantifiable impairments in cerebral blood flow regulation (i.e. cerebral autoregulation and neurovascular coupling metrics). Secondary Hypothesis: The degree of impairment in cerebrovascular and cardiovascular functions will correlate with higher degrees of brain injury severity in survivors of IPV.

Methods: Eighteen female IPV survivors (35.4 ± 8.7 years; BMI 25.5 ± 7.4 kg/cm2) with 13.4 ± 1.7 years of education participated in this investigation. The survivors were tested on 2 separate days. The first day consisted of the psychopathological self-reported and semi-structured interviews performed by a trained clinician. The second day consisted of the SCAT5 and a series of laboratory-based examinations including an assessment of cerebral autoregulation and neurovascular coupling tasks.

Results: IPV survivors with greater brain injury severity assessment scores (indicative of more frequent, recent and severe TBIs) displayed greater alterations in certain cerebrovascular markers (increase buffering in cerebral autoregulation, reductions in cerebral blood velocity) with minimal changes to others (area under the curve for neurovascular coupling).

Conclusions: These findings of reductions in cerebral blood velocity and increased buffering in cerebral autoregulation are indicative of stiffening of the cerebrovasculature in this population. Of additional concern is these impairments appear to be related to the severity of self-reported brain injury and may contribute to the augmented symptoms reported in this population. Taken together, the current study provides objective evidence of TBI-related cerebrovascular impairments in women who have experienced IPV and suggests this should be taken into account in providing support services to this population as they negotiate the myriad changes required to break the abuse cycle.
Stress, Coping and the Bipartite Serotonin Neurotransmission Hypothesis. Implications for Neuropsychopharmacology in Brain Injury Medicine and Beyond.

Gary Goldberg¹²
¹Hunter Holmes McGuire Veterans Administration Medical Center, Richmond, United States, ²Medical College of Virginia / Virginia Commonwealth University Healthcare System, Richmond, United States

A novel bipartite functional model of serotonin neurotransmission has recently been proposed in which two major serotonin receptor subtypes--5-HT1AR and 5-HT2AR, respectively--are involved in a complementary manner in the processes involved in ‘flexible coping’ with allostatic load.(1) While the 5-HT1AR receptor subsystem is proposed to be involved in ‘passive coping’ understood as habituation to adverse circumstances, the 5-HT2AR subsystem is proposed to be involved in ‘active coping’ understood as the active process of addressing a source of stress. This active process involves ‘enhanced plasticity’ associated with a ‘capacity for change’ in relation to the projected impact of the source of stress. While the typically dominant ‘default’ response to stress may be the habituation/accommodation mediated through the 5-HT1AR receptor subsystem, 5-HT2AR mediated plasticity supporting ‘creative re-structuring’ may become an increasingly dire imperative as the level of adversity and perceived existential threat rises to a critical point at which a decompensating ‘catastrophic reaction’ due to overwhelming existential uncertainty may be precipitated resulting in incapacitating severe anxiety and/or depression.(2) This hypothesis will be reviewed and presented along with various implications for clinical strategies for neuropsychopharmacological facilitation of serotonin-mediated adaptive response to the allostatic load produced by acquired brain injury (ABI). This approach will be developed recognizing that the central nervous system (CNS) normally plays a primary role in coordinating the strategic dynamic management of existential uncertainty through allostasis (3,4) and the reduction of free energy in the system comprised of the injured person striving to function effectively in the context of various affordances offered through perceived environmental conditions.(5) The basic challenges in effective holistic ABI rehabilitation relate to the fact that it is injury to the CNS that itself produces complex allostatic load while simultaneously precipitating increased personal vulnerability to adversity through diminishment of the capacity of the primary organ system involved in conferring resilience through the intentional effective strategic coordination of allostasis.(6) The broader implications of this overall conceptual approach for Brain Injury Medicine will be examined in this paper.

Acceptance and Commitment Therapy to Facilitate Psychological Adjustment after a Severe Traumatic Brain Injury: A Pilot Randomised Controlled Trial

Diane Whiting1, Frank Deane2, Graham Simpson1-3, Hamish McLeod4, Joseph Ciarrochi5

1Brain Injury Rehabilitation Research Group, Ingham Institute of Applied Medical Research, Liverpool, Australia, 2School of Psychology, University of Wollongong, Wollongong, Australia, 3John Walsh Centre for Rehabilitation Research, University of Sydney, Sydney, Australia, 4Institute of Health and Wellbeing, University of Glasgow, Glasgow, Scotland, 5Institute of Positive Psychology & Education, Australian Catholic University, Strathfield, Australia

Objectives: The adjustment process after a traumatic brain injury (TBI) is complex, and often results in high levels of psychological distress as the individual comes to accept their post-injury self. This study compared Acceptance and Commitment Therapy (ACT) to an active control, for people with a severe TBI, in order to facilitate post injury adjustment.

Method: A single centre, two-armed, Phase II pilot Randomised Control Trial (RCT) was undertaken with 19 participants with a very severe TBI (PTA=>7 days) who met a clinical threshold for psychological distress (DASS>9) in conjunction with a holistic brain injury rehabilitation program. Participants were randomly allocated to either ACT-Adjust or an active control (Befriending Therapy). Primary (psychological flexibility and participation) and secondary (depression and stress) outcomes were measured at three time points (pre, post and follow up).

Results: Significant decreases were found for DASS-depression (group by time interaction, F1,14 = 6.97, p = .02) and DASS-stress (group by time interaction, F1,14 = 6.66, p = .02) in comparison to the Befriending group. Primary outcome measures of psychological flexibility and participation did not demonstrate significant reductions. The changes in both depression and stress were also clinically significant as reductions in severity category demonstrated.

Conclusions: The results indicate ACT can decrease psychological distress and facilitate psychological adjustment for individuals with a severe TBI. Though no significant change was evident in the psychological flexibility, the proposed mechanism for change in ACT, these pilot results suggest a larger clinical trial is warranted.
Family Illness Trajectory During Seven Years After A Severe Traumatic Brain Injury-Family Interviews

Maud Stenberg1, Britt-Marie Stålnecke3, Britt-Inger Saveman2
1Department of Community Medicine And Rehabilitation, Rehabilitation Medicine, Umeå University, Umeå, Sweden., Umeå, Sweden, 2Department of Nursing, Umeå University., Umeå, Sweden

Background: Traumatic brain injury (TBI) is a major public health problem and is a leading cause of death and long-term disability in people of working age, causes great personal suffering of patients and their families. The annual incidence of TBI in Sweden is estimated to 250–350/100 000/year. Severe traumatic brain injury (STBI) is much rarer, with incidence estimated to 3–12/100 000/year. STBI comprise a heterogeneous group with varying complexity of deficits and impairments and that may affect physical, mental status, activity capacity, social and family life. It is difficult for others to understand what kind of problems a person with STBI and their families have to manage. In several published work related to family situation and their experiences as related to a person with STBI, there are overriding results that show great demands on the family and distress on the family. Living with a close relative with STBI affects the whole family and often means that relatives take a big responsibility for the injured person and changes needed in their everyday life. Relatives may make sacrifices and may experience anxiety, fear loneliness and frustration. The aim of this study was to investigate family illness trajectory who had lived with STBI for 7 years.

Design: A qualitative design was used to explore experiences in a seven-year follow-up study after STBI.

Methods: In this study data were collected through interviews with 21 persons who was in working age and suffering from STBI 2010 and 2011 in northern Sweden and their family members totally 47 participants. A phenomenological hermeneutic method was used for interpretation of family illness.

Results: This study described trajectory from being between life and death and the transition to acceptance, survival and go to stability for persons with STBI and their family members. Outcome varied but during these seven years the lack of treatment that support the injured person to well-being and support to close relatives was described. The family was gathering and close to the injured person and in some cases a guardian. Some families went apart. To struggle, think positive or humor in the family are ways to handle a situation like this. A mom extends far and striving to keep the family together. Family compounding, coordination and striving for cohesiveness is important. Larger network gives greater opportunity to survive and move on.

Conclusions: This study showed experiences from family during a seven years journey after STBI. The feeling of loneliness, lack of treatment and support is a challenge for professionals.

Keywords: Severe traumatic brain injury, long-term perspective, family interviews
Lisinopril Triggers a Neuroregenerative Progress Via Activating Intracellular ERK, JNK/c-JUN and PI3K/AKT Pathways

Chung-An Fang¹, Su-Wei Ou¹, Chia-Feng Kung¹, Yu-Chia Kuo¹, Yin-Cheng Chao¹, Chin-Wei Chen¹, Tsai-Wei Lin¹, Shyh-jong Wu¹, Yuan-Han Yang¹
¹Kaohsiung Medical University, Kaohsiung City, Taiwan

Background: Treatment options for neuronal degeneration, including Alzheimer's disease, remain limited. Evidence from animal studies and clinical trials indicates a positive role of ACE-inhibition in ameliorating signs of progressive neurodegeneration, independent of their blood pressure lowering properties. Beyond the contradicting argument of ACE in degradation of Aβ peptides, however, precise mechanism by which ACE inhibitors improve cognitive function is largely unclear.

Aim: Thus, we aimed to investigate the role of lisinopril, a centrally acting ACE inhibitor, in protecting neurons against degenerative stress and to demonstrate the possible intracellular signaling mechanism applied by this drug to promote neuronal survival.

Methods: Human neuroblastoma SH-SY5Y cell line was cultured to detect the intracellular signal response of lisinopril treatment. After differentiation with retinoic acid (RA), the influence of adding lisinopril on cell morphology was visualized using a phase contrast microscope. The expression of hyper-phosphorylated tau protein, tyrosine hydroxylase, neurofilament-L and Bcl-XL were also measured under Okadaic acid (OA) stress to study the protective mechanism exerted by lisinopril.

Results: We found that ERK and then JNK/c-JUN pathway was activated and the anti-apoptotic protein─ Bcl-XL was also increased in response to lisinopril treatment. Two regenerative markers, tyrosine hydroxylase and neurofilament-L, were significantly up-regulated by lisinopril in undifferentiated SH-SYSY cells. Moreover, the apparent neuronal morphology with long extending neurites of RA-differentiated cells was first lost and then restored in the lisinopril-treating group, compared to the control group. A similar morphologic changing pattern could be observed using undifferentiated SH-SYSY cells, which could be offset by U0126 (an ERK inhibitor) or PD98059 (an AKT inhibitor) pretreatment.

Conclusions: In conclusion, our results indicate that, at least in our cultured neurons, a centrally acting ACE inhibitor could trigger ERK, JNK/c-JUN and PI3K/AKT signaling pathways to activate a regenerative progress, which might provide a protection against the neurodegenerative fate.
Bridging the Gap: Facilitating Transition of Adolescents with Acquired Brain Injury to Adult Services

Jasmine Xavier1, Jacqueline Cousins1

1Illawarra Brain Injury Service Port Kembla Hospital, Wollongong, Australia

Introduction: The transition between paediatric and adult care for adolescents with disability is challenging, and often poorly managed. People who have sustained an acquired brain injury in childhood have similar aspirations as those without disabilities, but they have more difficulty accessing services that “limits opportunities for full participation in adult life”. In 2014, only three clients transitioned to the adult team from the paediatric service. Poor success with transition of clients discharged from the paediatric service was evident. Transition clinics had been developed, but no formal process was in place. Consultations with carers and clinicians found that that clients who did not engage in a transition process succumbed to poorer outcomes such as unemployment or limited employment choices and access to vocational training, poor self-esteem and self-confidence, lacking in self-care abilities, financial issues, drug, alcohol and gambling addictions, crime involvement, and mental health issues. Anecdotal experience was supported by general transition literature, but very little was found specific to brain injury. Attempts to obtain local data was difficult with no significant findings revealed.

Objective: For all paediatric clients with moderate-to-severe brain injury requiring transition to adult services to have a transition plan in place within 9 months.

Method: To achieve this aim previous transition clinics were evaluated using telephone surveys with clients and carers. Consultations were undertaken with past families. A project team was established to examine this data and current practice to identify the barriers to achieving successful transition for the young person. From the information gathered, the project team developed strategies to overcome these barriers and the transition process was amended to better facilitate this transition. The meeting format was more flexible to accommodate individual needs, a resource pack was developed, and the HEEADSSS assessment tool was used to assist with identifying rehabilitation goals and implement strategies. These changes were incorporated into formalised guidelines. Staff were provided with training to work effectively with adolescents.

Results: Following the development of the formalised guidelines in the form of a flow chart, all eligible clients commenced the transition process. Clients attended at least one meeting which included receiving explanation of the transition process and an information pack, and HEEADSSS assessment was undertaken. Goals were identified and an Individual Transition Plan was developed. Clients were observed to exhibit greater confidence and develop increased responsibility for their rehabilitation. Adult team members developed more awareness of issues associated with adolescence that differ from working with adults and increased collaboration between paediatric and adult teams has occurred.

Conclusion: The development of a formalised transition process that incorporates the unique needs of adolescents with brain injury has increased retention of paediatric clients as they transition to adult services, and successful transitions have occurred.
TOPiCS rTMS trial: Treatment of a Persistent Headache Attributed to Mild Traumatic Injury to the Head (PHATIH) in Patients with Persistent Post Concussion Symptoms (PPCS) using Repetitive Transcranial Magnetic Stimulation (rTMS)

Joan Stilling¹,²,³, Eric Paxman¹, Leah Mercier¹,², Liu Shi Gan¹,², Meng Wang¹,², Farnaz Amoozegar¹,²,³, Sean Dukelow¹,²,³, Oury Monchi¹,²,³, Chantel Debert¹,²,³
¹University Of Calgary, Calgary, Canada, ²Hotchkiss Brain Institute, Calgary, Canada, ³Department of Clinical Neurosciences, Cumming School of Medicine, Calgary, Canada

Context: Annually, approximately 280,000 people in Canada experience a traumatic brain injury (TBI). Eighty percent of those are classified as mild (mTBI). Symptoms experienced following injury usually resolve within 3 months. However, approximately 5-30% of patients will experience persistent post-concussive symptoms (PPCS) beyond the 3-month period, characterized by headaches, fatigue, insomnia, anxiety, depression, and cognitive deficits, which contribute to significant functional impairment and disease burden. The most common symptom experienced is headache, which has up to a 90% cumulative incidence over one year.

Objective: To improve headache frequency and severity at one month following rTMS treatment in patients with persistent post-traumatic headache and post-concussion symptoms.

Methods: Design: Double-blind, sham-controlled, concealed allocation, randomized pilot clinical trial. Twenty patients aged 18-65 yrs with a diagnosis of persistent headache attributed to traumatic injury to the head (ICHD-3 criteria) and persistent post-concussion symptoms (ICD-10) were recruited from Calgary, Alberta, Canada from May 2017 – February 2018. Intervention: Ten sessions of rTMS therapy to the left dorsolateral prefrontal cortex (DLPFC), over 2 weeks, at 10Hz (600 pulses) and 70% of resting motor threshold amplitude. Assessments: Clinical questionnaires included headache impact test – 6 (HIT-6), Rivermead PPCS questionnaire, British Columbia post-concussion symptom inventory (BC-PSI), Montreal cognitive assessment (MoCA), quality of life after brain injury questionnaire (QOLIBRI), patient health questionnaire-9 (PHQ-9), generalized anxiety disorder scale-7 (GAD-7) and the post-traumatic stress disorder checklist for DSM-5 (PCL-5). Questionnaires and a 2 week long daily headache diary were completed at baseline, immediately following treatment (day 14), and at 1, 3, and 6 months post-rTMS.

Results: A two-factor (treatment x time) RM-ANOVA indicated an overall significant interaction for the average headache severity [F (3,54) = 3.684, p=0.017] at one month. There was a significant decrease in severity between baseline and the post-treatment (day 14) assessment for the rTMS group (p=0.013; simple effect comparison, Bonferroni correction). Between baseline and 1-month assessment, the average severity of REAL group decreased from 5.09 (SD=0.65) to 4.21 (SD=1.64); while the SHAM group increased from 4.43 (SD=1.26) to 4.68 (SD=1.17). There were no statistical differences between REAL and SHAM for headache frequency. Secondary outcomes demonstrated a significant overall time interaction for the HIT-6 score [F(3,54)=3.543, p=0.020]. In the REAL group, 60% returned to work while only 10% returned in the SHAM (p=0.027).

Conclusion: This pilot study demonstrates a decrease in headache severity and functional impairment following rTMS treatment in patients with PPCS and PHATIH. There were no serious adverse effects. A larger phase III study is warranted.
Clinical Perspectives on Training and Delivering a Positive Behaviour Support Intervention for People with Acquired Brain Injury: A Qualitative Study

Penelope Analytis1,2, Amelia Hicks1,2, Kate Gould1,2, Jennie Ponsford1,2
1Monash-Epworth Rehabilitation Research Centre, Monash University, Melbourne, Australia, 2Monash Institute of Cognitive and Clinical Neurosciences, School of Psychological Sciences, Monash University, Melbourne, Australia

Background and Objectives: Challenging behaviours (CB) are distressing sequelae for individuals with acquired brain injury (ABI) and their families. Positive Behaviour Support (PBS) is a collaborative approach to reducing CB and improving quality of life. This study explored clinicians’ experiences learning and delivering a 12-month PBS intervention for adults with ABI and their family/carers.

Method: Semi-structured interviews were conducted with eight clinicians (neuropsychologists=4, occupational therapists=3, speech pathologist=2, psychologist=1), with experience in behaviour support (M = 10.16 years, SD = 6.71 years, R = 2–22 years). Interviews were thematically analysed.

Results: Three themes were identified regarding the impact of PBS on self; on clients; and on working environment. Participants experienced PBS as an approach which aligned with their values and changed their practice, e.g. increasing directedness with clients and comfort with their fallibility as clinicians. Participants found PBS deceptively difficult to learn and implement. PBS involved giving clients equal status in the clinician-client relationship. This was challenging when clients had less insight or families were not prepared for the responsibility inherent in such a relationship. Finally, PBS was perceived as difficult to implement in work settings involving high staff turnover or well-established working practices. Recommendations for future implementations included thorough training and supervision and setting of client expectations.

Conclusions: PBS is a multifaceted approach which involves personal, clinical and environmental strengths and challenges for clinicians. With increasing interest in PBS as an evidence-based approach for challenging behaviour after ABI, these findings will inform capacity-building projects for community clinicians.
How Does Complicated mTBI Compare with Moderate-Severe TBI and Uncomplicated mTBI (Single and Repeated): Age As A Factor

Ricki Ladowsky-Brooks¹, Albert Chan¹, Siu Yun Kua¹
¹RLB Neuropsychology Services, Toronto, Canada

Objective: The present study compared the neuropsychological test scores of individuals with uncomplicated MTBI (single and repeated), complicated MTBI, and moderate-severe TBI. The data was obtained from neuropsychological insurance evaluations.

Background: It has been suggested that complicated MTBI—which is classified by a Glasgow Coma Scale (GCS) score of 13-15, a loss of consciousness of less than 30 minutes, a PTA of less than 24 hours, and evidence of skull fracture or intracranial injury on radiological imaging—has cognitive outcomes that are similar in severity to moderate TBI (GCS 9-12). It has also been suggested that factors such as older age and a history of repeat mild concussion worsen the cognitive consequences of MTBI.

Method: Individuals who were seen for a neuropsychological examination were classified as having sustained an uncomplicated MTBI (n = 34), a complicated MTBI (n = 12), or moderate-severe TBI with GCS < 13 (n = 17). A small group of individuals with uncomplicated MTBI who reported a history of several lifetime concussions were examined separately (n = 8). Individuals were not included in the study if they scored below the criterion scores on either of two standard effort tests. Data collection took place over a two-year period and examinees gave consent for their de-identified data to be entered into an Excel spreadsheet for analysis. Demographic variables such as age and education level were included in the data, and age was further coded as either under 40, or 40 and over. There was no control for the effects of medication use, other injuries, or time since injury.

Results: The lowest mean scores were consistently in the moderate-severe TBI group. Post-hoc t-tests showed that the moderate-severe TBI group scored significantly below the uncomplicated and complicated MTBI groups on some tests, such as delayed memory recall for designs. However, age was also a factor. For example, in individuals under 40 years of age, the moderate-severe TBI group scored significantly lower than the uncomplicated and complicated MTBI groups on delayed recall of designs, whereas in individuals who were 40 years and older, the moderate-severe TBI group only scored significantly below the uncomplicated MTBI group. There were no differences between the repeat and single MTBI groups on the cognitive tests, although there was a significant difference on a metacognitive test in which individuals had to rate answer certainty.

Conclusions: In this limited clinical study based on neuropsychological insurance examinations, age appears to be a factor in determining the cognitive consequences of a complicated MTBI.
Feasibility of Transcutaneous Vagus Nerve Stimulation in Patients with Severe Traumatic Brain Injury

Christian Pilebæk Hansen, Melika Moghiseh, Christoffer Øland, Ingrid Poulsen, Anne Sabers

1Department of Neurorehabilitation, TBI Unit, Rigshospitalet, Hvidovre, Denmark, 2Department of Epilepsy, Rigshospitalet, Copenhagen, Denmark

Stimulation of the vagus nerve (VNS) has been used for treatment of epilepsy and depression for more than 20 years. Animal studies show that VNS increases the recovery from traumatic brain injury. In a recent case report of a patient in a vegetative state several years after traumatic brain injury (TBI) it was possible to increase the level of consciousness with VNS (1). However, VNS requires implantation of the stimulator around the vagus nerve under general anesthesia which is costly and may be risky.

In this pilot study we examine whether it is feasible to carry out transcutaneous stimulation of the vagus nerve (t-VNS) by stimulating the auricular branch of the vagal nerve. Furthermore, the possible effect of t-VNS on recovery of consciousness after TBI is studied.

The patients are admitted to the department of neurorehabilitation after neurosurgical treatment and intensive care. During the rehabilitation the level of patient observation varies from constant supervision to observation every second hour depending on the condition of the patient. The inclusion criteria for the study are adult patients in an unresponsive wakefulness syndrome/vegetative or minimally conscious state more than 28 days after traumatic brain injury, including diffuse axonal injury, demonstrated by cerebral MRI. The t-VNS is set to stimulate according to a fixed pulse program with up to 1 mA, four hours every day for eight weeks. Tolerability is investigated by blood pressure and pulse changes, pain score, and observation of the stimulated area of skin. The level of consciousness is assessed weekly with the Coma Recovery Scale-Revised (CRS-R).

We intend to include five TBI patients.

So far, three patients have finished the project period of eight weeks t-VNS. The preliminary observations show that in our setting it is possible to stimulate the auricular area daily for two months, but due to insufficient organization only 75% of the planned stimulation time was reached. In one patient it was difficult to keep the stimulator in the external ear. All patients tolerated the t-VNS well. In all three patients, the level of consciousness increased during the eight weeks of simulation. However, this uncontrolled study of a few patients does not allow us to distinguish between spontaneous recovery and recovery due to t-VNS.

It is concluded that t-VNS is feasible in patients with severe TBI. Future studies are needed to elucidate whether t-VNS increases the level of consciousness after TBI.

Reference:
Is Auditory Localization A Sign of Consciousness? Evidence from Neuroimaging and Electrophysiology

Manon Carrière¹, Helena Cassol¹, Charlène Aubinet¹, Rajanikant Panda¹, Géraldine Martens¹, Camille Chatelle¹, Aurore Thibaut¹, Steven Laureys¹, Olivia Gosseries¹

¹University of Liège, Liège, Belgium

Auditory localization is generally part of the clinical evaluation of post-comatose patients with disorders of consciousness (DOC). To date, there is however no consensus in the literature whether this response should be considered as a reflex or as a sign of consciousness. The aim of the current study is to provide evidence that would help answering this question, by investigating the proportion of patients showing auditory localization in a large sample of post-comatose patients and comparing preservation of brain metabolism and functional connectivity in patients clinically diagnosed as in unresponsive wakefulness syndrome (UWS) with and without auditory localization.

Using the Coma Recovery Scale-Revised (CRS-R), we assessed 208 patients with severe brain injury and looked at the proportion of patients showing auditory localization. A chi-squared test was used to determine if there was a significant relationship between the presence of an auditory localization and the level of consciousness. We then compared UWS patients with and without auditory localization and measured group differences in cerebral metabolism using 18F-FDG-PET and in brain connectivity using functional magnetic resonance imaging (fMRI) and high-density electroencephalography (hd-EEG).

Auditory localization was observed in 10% (8/79) of patients in a UWS, 44% (14/32) of patients in a minimally conscious state (MCS) minus (i.e., non-language related signs of consciousness), 60% (44/73) of patients in a MCS plus (i.e., preservation of language processing) and 75% (18/24) of patients who emerged from the MCS (EMCS). We found a relationship between the presence of auditory localization and the level of consciousness (χ² = 54.13, df = 3, p=0.001). UWS patients with auditory localization showed higher FDG-PET connectivity between the bilateral primary auditory cortex and the left superior temporal gyrus, left supramarginal gyrus and left fusiform gyrus than UWS patients without auditory localization. fMRI analyses also revealed higher connectivity in patients in a UWS showing auditory localization, both in the auditory, default-mode and external networks. Resting-state hd-EEG showed no significant power spectral changes between the two groups, but higher mean connectivity was found in the alpha band in the left hemisphere (p=0.055) in patients with auditory localization. These patients also had a higher participation coefficient (i.e., measure of network integration) in alpha frequency compared to patients without localization in the whole brain (p=0.001), in the left frontal (p=0.005), frontal midline (p=0.007) and right temporal (p=0.001) regions.

Together, these results suggest that auditory localization is associated with the level of consciousness, brain preservation and connectivity. Therefore, it supports the fact that auditory localization requires a conscious process and should be considered as a sign of consciousness. Future neuroimaging and neurophysiological studies on larger samples of UWS patients should be performed to confirm these results.
Rehabilitation Staff’s Perception of Communication with Patients in Post-Traumatic Confusional State

Annesofie Nielsen¹, Emma Power²,³, Lise Jensen⁴

¹Department of Neurorehabilitation, Traumatic Brain Injury Unit, Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark; ²University of Technology Sydney, Sydney, Australia; ³University of Sydney, Sydney, Australia; ⁴Department of Scandinavian Studies and Linguistics, University of Copenhagen, Copenhagen, Denmark

Objective: Communication difficulties are described as a key feature for people in Post-Traumatic Confusional State (PTCS) alongside cognitive and behavioural difficulties, but limited studies have been conducted on the experiences of their communication partners. The aim of the current study was to understand the experience of rehabilitation staff in their communication with patients in PTCS prior to an implementation study of communication partner training (CPT).

Methods: All clinical staff members from a subacute rehabilitation unit for patients with moderate to severe TBI were invited to complete a 10-item questionnaire. The questionnaire evaluated staff’s perception of communication with patients in PTCS in a variety of formats including yes-no questions, multiple-choice, 4-point scaled questions, and free text responses. The content covered (i) basic demographic information about respondents, (ii) knowledge of the patient group’s communication, (iii) respondents’ perception of their own interaction with patients in PTCS, (iv) their use of strategies in communication, and (v) a brief description of experiences with non-successful and successful communication. The responses were analysed with descriptive and inferential statistics and content analysis.

Results: 78 interdisciplinary staff were included (65% response rate). Respondents consisted of occupational therapists, physiotherapists, nurses, nurse assistants, doctors, porters, neuropsychologists, social workers, pedagogues and secretaries. The majority of respondents found communication difficult (72%) and time consuming (67%) and half of the respondents reported not feeling confident communicating with patients in PTCS. The level of perceived confidence in communication was not significantly different between professions or related to the length of clinical experience working with PTCS. Eighty-five percent of respondents reported using strategies to support communication, largely focused on (i) using objects to support verbal communication and to compensate (e.g. for cognitive difficulties) and (ii) structuring the environment (e.g. by limiting own speech and shielding the patient from external stimulation). The main reason for non-successful communication was attributed to patient behaviour with emphasis on negative emotional reactions (e.g. anger, frustration). In describing successful communication respondents’ answers focused on their own use of strategies and own behaviour (e.g. simplifying verbal language, being calm).

Conclusion and Implications for Clinical Practice: To our knowledge this is the first study to investigate rehabilitation staffs’ perception of communication in the subacute state with patients in PTCS. Overall, staff finds communication difficult and their level of confidence does not improve with length of experience. This suggests that educating and training staff in communication with this patient group is worth exploring. The strategies reported rarely involved use of writing or drawing to support verbal communication, suggesting that certain strategies for successful communication might possibly be augmented by an intervention.
Communication Partner Training and Post-Traumatic Confusion

Annesofie Nielsen1, Lise Jensen2, Emma Power3,4

1Department of Neurorehabilitation, Traumatic Brain Injury Unit, Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark, 2Department of Scandinavian Studies and Linguistics, University of Copenhagen, Copenhagen, Denmark, 3University of Technology Sydney, Sydney, Australia, 4University of Sydney, Sydney, Australia

Objective: Communication with patients in the Post-Traumatic Confusional State (PTCS) is challenging because of patients’ impaired level of consciousness. Impaired consciousness may lead to difficulties participating in effective procedural interactions (e.g. routines with staff) and conversations. Additionally, communication disorders associated with acquired brain injury may require the communication partner to take on the burden of managing the interaction to maximize communicative success and minimize confusion and its associated consequences (e.g., behavioral difficulties). Communication partner training such as TBIexpress™ has been shown to be successful in more chronic stages of TBI, and the effect of Supported Conversation for Adults with Aphasia (SCA™) has been demonstrated for subacute and chronic stages in patients with stroke induced aphasia. However, the effect and usefulness of CPT in subacute settings with patients in PTCS has yet to be explored. This study aims to evaluate a CPT program targeting interdisciplinary staff who works in a hospital with patients in PTCS.

Method: A pre-post survey design was used. A total of 104 interdisciplinary staff members at a subacute rehabilitation unit for patients with moderate to severe TBI attended a 3-hour SCA™ training course and subsequent implementation support, consisting e.g. of follow-up meetings in the inter- and monodisciplinary teams. Staff completed a pre and post implementation questionnaire. Items consisted of both quantitative (the degree of e.g. confidence in communication) and qualitative questions (e.g. perception of SCA techniques and non-successful/successful communication).

Results: CPT based on SCA™ successfully increases interdisciplinary staff’s perceived confidence and self-assessed ability to communicate with patients in PTCS. Even though communication is still experienced as difficult by participants, staff find it less time consuming, report communication to be more effective and to use tools and strategies related to the CPT. The nature of the strategies reported moved from more general approaches such as structuring the environment to more communication specific strategies such as writing to support verbal language. Participants found they could apply strategies to improve comprehension of information (reveal competence IN) and to confirm their understanding of a patient’s communication (VERIFY). However, participants reported applying strategies to enhance the patient’s own expression (reveal competence OUT) to be more challenging.

Conclusions and implications for clinical practice: The results contribute in narrowing the knowledge gap as to whether CPT/SCA™ is perceived by staff to support them in communication with patients in PTCS in the subacute setting. Training staff to manage difficult communication may enhance their confidence and ability to interact with patients in PTCS and this study offers strategies staff perceive as helpful in their interactions. Further training may be needed to equip staff with skills to support people in PTCS to communicate their needs.
Prefrontal tDCS in Patients with Disorders of Consciousness: Neurophysiological and Behavioural Outcomes

Manon Carrière, Alice Barra, Sepehr Mortaheb, Maria Chiara Binda Fossati, Géraldine Martens, Steven Laureys, Camille Chatelle, Aurore Thibaut

1 Université de Liège, Liège, Belgium

Prefrontal transcranial direct current stimulation (tDCS) has proved to be effective in improving signs of consciousness in 43% of patients in minimally conscious state (MCS) (Thibaut et al., 2014, 2017, Martens et al., 2018). However, brain mechanisms underlying tDCS effects remain poorly understood. In the present protocol, we aimed to assess the effects of prefrontal tDCS on neurophysiological and behavioral measures in patients with disorders of consciousness (DOC).

In a double-blind sham-controlled design, one anodal and one sham tDCS (2 mA, 20 minutes) were delivered in a randomized order in 3 chronic patients (1 in unresponsive wakefulness syndrome – UWS, 1 MCS, 1 in locked-in-syndrome – LIS). Ten minutes of high-density EEG (hd-EEG) were recorded directly before and after each tDCS session. Behavioral assessments were performed using the Coma Recovery Scale-Revised (CRS-R; Giacino et al., 2004) before and after each session by an investigator blinded to the treatment allocation.

The UWS patient showed significant power decrease in theta, alpha and beta bands after the active tDCS as compared to sham and no change in behaviors. This lack of clinical effect is supported by an absence of increase in any of the bandwidths, and consistent with previous studies in which no treatment effect was observed in UWS patients (Zhang et al., 2018).

For the MCS patient, a significant increase of power in the theta band and decrease of power in delta band were found after the active stimulation compared to sham with no behavioral changes. This absence of effects is concordant with the absence of power increase in alpha and beta bands, as what is usually observed in healthy subjects following tDCS (Mangia et al., 2014, Song et al., 2014). However, an increase in theta power was found. Therefore, it could be speculated that an increase in theta is not sufficient to induce behavioral improvements and an effect on alpha and/or beta could be necessary to induce such clinical changes. On the other hand, it is possible that one session was not sufficient to induce clinical enhancement and more sessions are required as it has been previously shown in DOC and other pathologies (Zhang et al., 2018, Estraneo et al., 2017, Fregni et al., 2006).

Finally, we found a significant global increase of power in alpha and beta bands for the LIS patient after tDCS as compared to the sham, but no behavioral improvement. This lack of behavioral improvement could be explained by a ceiling effect on the CRS-R. However, tDCS might have led to attentional or arousal changes that could not be detected with the CRS-R. Henceforth, more sensitive scales should be employed with LIS or patients who have emerged from the MCS (EMCS) to allow identification of cognitive changes.
Psychiatric Disorders and Return to Work after Mild Traumatic Brain Injury

Ivan Marinkovic1, Harri Isokuortti1, Antti Huovinen1, Antti Korvenoja2, Risto Vataja3, Susanna Melkas1

1Neurology, University of Helsinki and Helsinki University Hospital, Helsinki, Finland, 2HUS Medical Imaging Center, Radiology, University of Helsinki and Helsinki University Hospital, Helsinki, Finland, 3Psychiatry, University of Helsinki and Helsinki University Hospital, Helsinki, Finland

Objectives: The main objective of the study was to evaluate the prevalence of psychiatric disorders in an outpatient sample of mild traumatic brain injury (MTBI) patients. Secondly, we investigated the effect of psychiatric comorbidity on returning to work (RTW) after a MTBI.

Methods: The patient population of this study consisted of 91 MTBI patients who were recruited from the Brain Injury Outpatient Clinic of Helsinki University Hospital. MTBI was defined as GCS >12, loss of consciousness <30 minutes and posttraumatic amnesia <24 hours. At three months, the patients were evaluated by using the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I). The length of sick leave was recorded. The effect of psychiatric comorbidity on RTW was investigated by Kaplan-Meier log rank analyses. The symptoms of MTBI were assessed by Rivermead Post-concussion Symptom Questionnaire (RPQ) and the differences between patient groups were tested with Mann-Whitney U test.

Results: The mean age of patients was 39.5 years (SD 13.0). Prior to the TBI, 78(85.7%) was currently employed. A psychiatric disorder was diagnosed in 18(19.8%) patients. The most common disorders were depression (n=6), social anxiety disorder (n=5) and panic disorder (n=4). Most of the patients (n=77, 93.9%) had returned to work within 3 months from the TBI. At one year after the injury, 82 of the patients (90.1%) were employed. Kaplan-Meier log rank analysis did not differ between psychiatric and non-psychiatric patients (p=0.890). The RPQ scores differed significantly between patient groups. The median of RPQ was 9 (interquartile range [IQR] 3-14) in patients without psychiatric diagnoses and 15 (IQR 7.5-21.5) with psychiatric diagnoses, p=0.009

Conclusions: The likelihood of returning to work after MTBI is excellent. The co-occurrence of psychiatric disorder did not affect the RTW. The patients with psychiatric comorbidity reported more symptoms than patients without psychiatric disorders.

The most common disorders were depression (n=6), social anxiety disorder (n=5) and panic disorder (n=4). Most of the patients (n=77, 93.9%) had returned to work within 3 months from the TBI. At one year after the injury, 82 of the patients (90.1%) were employed. Kaplan-Meier log rank analysis did not differ between psychiatric and non-psychiatric patients (p=0.890). The RPQ scores differed significantly between patient groups. The median of RPQ was 9 (interquartile range [IQR] 3-14) in patients without psychiatric diagnoses and 15 (IQR 7.5-21.5) with psychiatric diagnoses, p=0.009

Conclusions: The likelihood of returning to work after MTBI is excellent. The co-occurrence of psychiatric disorder did not affect the RTW. The patients with psychiatric comorbidity reported more symptoms than patients without psychiatric disorders.
Temporal Profile of Brain Injury Biomarkers in Cerebrospinal Fluid During Cyclosporine Treatment in Severe TBI Patients

Magnus Hansson¹², Zhihui Yang³, Jesper Kelsen⁴, Michael Karlsson¹³, Matilda Hugerth¹, Ramona Astrand⁴, Kirsten Möller³, Marianne Juhler⁴, Kevin Wang³, Eskil Elmér¹²

¹Neurovive Pharmaceutical AB, Lund, Sweden, ²Mitochondrial Medicine, Department of Clinical Sciences, Lund University, Lund, Sweden, ³Program for Neurotrauma, Neuroproteomics and Biomarkers Research, Department of Emergency Medicine, University of Florida, Gainesville, United States, ⁴Department of Neurosurgery, Rigshospitalet, Copenhagen, Denmark, ⁵Department of Neuroanesthesiology, Rigshospitalet, Copenhagen, Denmark

Cyclosporine has shown promising neuroprotective properties in experimental models of traumatic brain injury (TBI). Cyclosporine protects the mitochondria and limits the secondary injury cascade. The Copenhagen Head Injury Ciclosporin (CHIC) study (NCT01825044) was a safety and pharmacokinetic study evaluating two dosing regimens of cyclosporine in patients with severe TBI, using a novel parenteral lipid emulsion formulation (NeuroSTAT®). The aim of the present explorative part of the study was to evaluate changes in the secondary injury cascade in these patients by assessing the temporal profile of brain injury biomarkers in cerebrospinal fluid (CSF).

Sixteen adult patients with severe TBI (GCS ≤ 8) and a clinical indication for external ventricular drainage were enrolled. All patients received an i.v. loading dose of 2.5 mg/kg of cyclosporine, 20 to 64 hours after the initial trauma, followed by a continuous infusion for 5 days. The first ten patients received 5 mg/kg/day, whereas the subsequent six patients received 10 mg/kg/day. Repeated CSF samples were drawn pre-dose, during the 5-day continuous infusion, and for 48 hours after dosing. The Quanterix SIMOA Neurology 4-plex assay was used to measure Glial Fibrillar Acidic Protein (GFAP, an astroglial injury marker), Neurofilament Light (NF-L, an axonal injury / neurodegeneration marker) and Ubiquitin Carboxy-terminal Hydrolase L1 (UCH-L1, a neuronal cell body injury marker).

All of the four brain injury biomarkers were substantially elevated at all time-points compared to samples from normal controls. Even though the temporal profiles for each marker showed individual differences in the studied heterogeneous TBI population, all four biomarkers showed consistent trends to decrease during the 5-day treatment period whereas the samples taken on the days after the treatment period showed higher values in the majority of patients. Mean slopes of changes were negative during the cyclosporine infusion period whereas they were positive for all markers 24 to 48 hours after end of study drug treatment. These breaks in trends were statistically significant for all markers; GFAP (p = 0.006), NF-L (p = 0.017), Tau (p = 0.027) and UCH-L1 (p = 0.002).

The temporal profile of the injury biomarkers in this study does not follow previously published data. For example, NF-L has been described to continuously rise in both serum and CSF for at least 10-12 days following severe TBI (Shahim et al Sci Rep. 2016;6:36791). The decreasing levels seen in this study indicates that the secondary brain injury can be attenuated by cyclosporine treatment. This is further supported by the significant breaks in trends seen after the end of treatment which suggests that these biomarkers may be useful as drug development tools to evaluate neuroprotection following TBI. Albeit intriguing, these findings need to be confirmed in a prospective placebo-controlled setting.
Relationships Between Cognitive Impairments and Functional Outcome Eight Years after Severe Traumatic Brain Injury: Results from the Paris-TBI Study

Claire Vallat-Azouvi¹, Marie Swaenepoël², Alexis Ruet⁴, Philippe Aegerter⁵, Layide Meaude⁵, James Charanton⁶, Pascale Pradat-Diehl⁷, Eleonore Bayen⁷, Claire Jourdan³, Philippe Azouvi¹
¹Raymond Poincare Hospital, Garches, France, ²University of Paris 8, Saint-Denis, France, ³CHU de Montpellier, Montpellier, France, ⁴CHU de Caen, Caen, France, ⁵URC Paris-Ouest, hôpital Ambroise Paré, Boulogne-Billancourt, France, ⁶Centre Ressource Francilien du Traumatisme Cranien, Paris, France, ⁷Hôpital de la Salpêtrière, Paris, France

Background/Objectives: Although the nature and frequency of cognitive impairments in patients who survive a severe traumatic brain injury (TBI) are well known, the relationships between such impairments and long-term functional outcome remain poorly understood (1). The aim of the present study was to address this issue in a longitudinal inception cohort study of patients eight years after a severe TBI (PariS-TBI study (2)).

Patients: This is a prospective observational study of adult patients with severe TBI in the Parisian area (PariS-TBI). Outcome was assessed 8 years post-injury. Out of 243 surviving patients, 86 were finally evaluated. They did not significantly differ from lost-to-follow up patients in terms of age, gender, initial injury severity, but the latter were more frequently students or unemployed before the injury. Mean age was 41.9y (SD 13.6), 79% were male, median initial Glasgow Coma Scale Score was 6.

Methods: Outcome measures included: the Glasgow Outcome Scale-extended, a functional independence questionnaire, employment outcome, the Hospital Anxiety and Depression Scale (HADS), the Fatigue Severity Scale and a visual-analog scale to assess subjective satisfaction with life. Cognition was assessed by two ways: i) with widely used neuropsychological tests of verbal memory, speed of processing, mental flexibility, planning and multitasking; ii) with questionnaires, completed both by the patient and by a close relative (Dysexecutive Questionnaire (DEX) and Brain Injury Complaint Questionnaire (BICoQ) (3)).

Results: No initial injury severity measure significantly correlated with neuropsychological outcome. After statistical correction for multiple comparisons, mood, fatigue and subjective quality of life appeared to be poorly related with cognitive testing (except for speed of processing), but were significantly related with patients’ scoring of both the DEX and the BICoQ. However, both cognitive testing (particularly speed of processing and verbal memory) and cognitive questionnaires were significantly related to functional independence, GOS-E and employment.

Conclusions: Cognitive impairments are significant indicators of functional outcome at a long-term post-injury, particularly regarding speed of processing and verbal memory. However, subjective self-rated questionnaires, such as the DEX and the BICoQ, appeared to be more strongly related to outcome than traditional neuropsychological tests.

Training of Attention During the First Year After Acquired Brain Injury

Azra Ramovic1, Aniko Bartfai1, Gabriela Markovic1
1Department of Clinical Sciences, Karolinska Institutet, Stockholm, Sweden

Background: Attention deficits is one of the most common consequences after ABI. Attention can be trained with attention process training, APT, golden standard for chronic condition of ABI. However, most patients undergo rehabilitation within one-year post injury. Results concerning attention training in the early stage are inconclusive.

Objective: Evaluate the efficacy of intensive attention training after ABI on attention and memory within 4-12 months post-injury in a randomized controlled trial.

Method: A group of patients (n=53) (75% stroke and 25% TBI) in interdisciplinary outpatient rehabilitation received additional 20 hours of APT versus activity-based attention training.

The following neuropsychological test were used Ruff 2&7(Ruff 2&7 Selective Attention Test), Digit Span, Letter-Number-Sequences and Block repetition (WAIS-IV), Rey auditory verbal learning task (RAVLT), the Color-word test (CWT) and the Trail Making Test (TMT) from Delis Kaplan Executive Function System (D-KEFS), Patients ratings were; Hospital Anxiety and Depression Scale (HADS), Behavioral Assessment of the Dysexecutive Syndrome (BADS) and The Cognitive Failures Questionnaire (CFQ). Assessments were administrated pre and post intervention and at 6 months follow-up.

Results: The results indicate that the largest gains for both groups over time were within the area of psychomotor speed (CWT, TMT and Ruff 2&7 speed but not accuracy), but there were no significant differences between treatments.

Behavioral self-ratings (CFQ and BADS) also improved over time, but no differences were observed between the two treatment groups.

Conclusion: There were no significant differences between the two training methods, as indicated by the present study design with pre-and post-measures. In a previous data set we have used a process measure to evaluate treatment effects. Differences between pre- and post-design and process measures will be discussed.
Implementation Fidelity in an RCT Evaluating Psychosocial Well-Being Following Stroke: An Explanatory Sequential Mixed Methods Study

**Line Kildal Bragstad**¹,², Berit Bronken³, Unni Sveen¹,⁴, Ellen Hjelle², Gabriele Kitzmüller⁵, Randi Martinsen³, Kari Kvigne³, Margrete Mangset¹, Marit Kirkevold²

¹Oslo University Hospital, Oslo, Norway, ²University of Oslo and Research Center for habilitation and rehabilitation services and models (CHARM), Oslo, Norway, ³Inland Norway University of Applied Sciences, Elverum, Norway, ⁴Oslo Metropolitan University, Oslo, Norway, ⁵UIT, the Arctic University of Norway, Narvik, Norway

**Background:** Process evaluation is an essential part of designing and testing complex interventions within randomized controlled trials in nursing and rehabilitation. Conducting a process evaluation alongside a clinical trial is thought to strengthen the overall quality of the trial and support the research team’s ability to understand the potential barriers to successful implementation. Key questions concerning the implementation of the intervention include how the intervention was delivered and what was delivered? Implementation is in this case closely related to the concept of assessing implementation fidelity which refers to the degree to which an intervention is consistently delivered according to protocol. In this study, a conceptual framework for implementation fidelity was applied to assess intervention adherence and potential moderating factors of adherence in an intervention promoting psychosocial well-being following stroke.

**Objective:** The aim of this study was to evaluate implementation fidelity of the RCT study “Promoting psychosocial well-being following stroke” to determine to which extent the intervention was delivered according to the protocol. The following research questions will be addressed in the presentation: How can the levels of fidelity be measured? To which level of fidelity was implementation adherence achieved? Which moderating factors influenced adherence and the overall implementation fidelity?

**Method:** The process evaluation was designed as a longitudinal mixed method study conducted alongside the RCT. The process evaluation comprises qualitative and quantitative data collected from the trial coordinators and intervention personnel. The data material consists of recruitment records, detailed intervention records, attrition records, qualitative interviews with patients and focus group interviews with intervention personnel. To clarify measurement of the levels of implementation fidelity a scoring system was devised to categorize the values of each of the variables within one of three fidelity categories; low fidelity, medium fidelity and high fidelity. The scoring system was based on reference values from the study protocol. Descriptive statistics was used to assess the content, coverage, frequency and duration of the intervention. The qualitative data sources were subsequently analyzed with a deductive approach using the conceptual framework of implementation fidelity.

**Results:** The results show high fidelity in implementation of content and coverage. Timeliness of ending the intervention in accordance with the protocol was challenging. In total, 80.1 % of the interventions in the RCT were conducted with high fidelity in terms of overall intervention adherence. Recruitment, participant responsiveness and strategies to facilitate implementation were especially important moderating factors in this study.

**Conclusion and Implication for Practice:** This assessment of implementation fidelity and the discussion of what constitutes high fidelity implementation of this intervention are crucial in understanding factors influencing the trial outcomes.
**Early Levels of GFAP and NF-L in Predicting the Outcome of Mild TBI**

Iftakher Hossain¹,²,³, Mehrbod Mohammadian²,³, Riikka Takala²,⁴, Olli Tenovuo²,³, Linnéa Lagerstedt⁵, Henna Ala-Seppäälä²,³, Mark van Gils⁶, Peter Hutchinson⁷, Ari Katila²,⁴, Henna-Riikka Maanpää¹,²,³, David Menon⁸, Virginia Newcombe⁸, Jussi Tallus¹,³,⁹, Kevin Hrusovsky¹⁰, David Wilson¹⁰, Kaj Blennow¹¹,¹², Jean-Charles Sanchez⁵, Henrik Zetterberg¹¹,¹²,¹³,¹⁴, **Jussi Posti¹,²,³**

¹Division of Clinical Neurosciences, Department of Neurosurgery, Turku University Hospital, Turku, Finland, ²Turku Brain Injury Centre, Turku University Hospital, Turku, Finland, ³Department of Neurology, University of Turku, Turku, Finland, ⁴Perioperative Services, Intensive Care Medicine and Pain Management, Turku University Hospital and University of Turku, Turku, Finland, ⁵Department of Human Protein Sciences, Faculty of Medicine, University of Geneva, Geneva, Switzerland, ⁶Department of Clinical Neurosciences, Neurosurgery Unit, University of Cambridge, Addenbrooke’s Hospital, Cambridge, United Kingdom, ⁷VTT Technical Research Centre of Finland Ltd., Tampere, Finland, ⁸Department of Radiology, Turku University Hospital, Turku, Finland, ⁹Division of Anaesthesia, University of Cambridge, Addenbrooke’s Hospital, Cambridge, United Kingdom, ¹⁰Quanterix Corporation, Lexington, United States, ¹¹Institute of Neuroscience and Physiology, Department of Psychiatry and Neurochemistry, The Sahlgrenska Academy at the University of Gothenburg, Mölndal, Sweden, Gothenburg, Sweden, ¹²Clinical Neurochemistry Laboratory, Sahlgrenska University Hospital, Mölndal, Gothenburg, Sweden, ¹³Department of Molecular Neuroscience, UCL Institute of Neurology, Queen Square, London, United Kingdom, ¹⁴UK Dementia Research Institute at UCL, University College London, London, United Kingdom

**Objectives:** The purpose of this study was to correlate the early levels of glial fibrillary acidic protein (GFAP) and neurofilament light protein (NF-L) with outcome in patients with mild traumatic brain injury (mTBI).

**Methods:** 107 patients with mTBI [Glasgow Coma Scale (GCS) ≥13] having the blood samples for GFAP and NF-L available within 24 hrs from arrival were included. Patients with mTBI were divided into computed tomography (CT)-positive and CT-negative groups. Glasgow Outcome Scale extended (GOSE) was used to assess the outcome. Outcomes were defined as complete (GOSE 8) vs. incomplete (GOSE <8), and favorable (GOSE 5–8) vs. unfavorable (GOSE 1–4). GFAP and NF-L concentrations in blood were measured using ultrasensitive single molecule array (Simoa) technology.

**Results:** Patients with incomplete recovery had significantly higher levels of NF-L compared to those with complete recovery (p=0.005). The levels of GFAP and NF-L were significantly higher in patients with unfavorable outcome than in patients with favorable outcome (p=0.002 for GFAP and p <0.001 for NF-L). For predicting favorable outcome, the area under the ROC curve for GFAP and NF-L was 0.755 and 0.826, respectively. In a multivariate logistic regression model, the level of NF-L was still a significant predictor for complete recovery (OR=1.008, 95%CI, 1.000-1.016). Moreover, the level of NF-L was a significant predictor for complete recovery in CT-positive patients (OR=1.009, 95%CI, 1.001-1.016).

**Conclusion:** The early levels of GFAP and NF-L are significantly correlated with the outcome in patients with mTBI. The level of NF-L within 24 hrs from arrival has a significant predictive value in mTBI also in a multivariate model.
End-of-Life Practices: Report of a Questionnaire from the CENTER-TBI Study

Ernest van Veen¹, Mathieu van der Jagt¹, Hester Lingsma¹, Jelle Epker¹; Erwin Kompanje¹
¹Erasmus University Medical Center, Rotterdam, Netherlands

Background: We aimed to study variability concerning end-of-life (EoL) practices on the intensive care unit (ICU).

Methods: Respondents from 67 Collaborative European NeuroTrauma Effectiveness Research in Traumatic Brain Injury (CENTER-TBI) study centers completed several questionnaires (response rate: 99%). Through these questionnaires, we asked for specific EoL practices, such as the initiation of palliative sedation and the role of patient age in the decision-making process.

Results: We found considerable variability in EoL practices among European and Israeli neurotrauma centers. Regarding the prevalence of withdrawing life-sustaining measures (LSM), in 60% of the centers, the minority (≤50%) of all patients with severe neurological damage who die on the intensive care unit (ICU), die after withdrawal of LSM, while in 40% of the centers, this is the majority (≥50%). Concerning the EoL-decision-making process, we found that the decision to withhold/withdraw LSM was made following multidisciplinary consensus in 100% of the centers. Legal representatives had input in this process in 40% of the centers, while they had no input in 19% of the centers. In 82% of the centers, age played a role in the decision to withhold/withdraw LSM. Regarding the practices before withholding/withdrawing LSM, sedatives and opioids were preemptively administered in 52% of the centers if the decision was reached to withdraw LSM in a comatose severely injured traumatic brain injury patient. Palliative care was initiated in 79% of the centers after the decision of withdrawing LSM was made. Last, concerning which LSM to withhold/withdraw and when to do so, vasoactive medication was stopped in almost all centers (93%). In general, there was an increase in considering withholding/withdrawal LSM after more time has passed, in a patient with TBI, who was in a very poor prognostic condition.

Conclusions: Our study showed differences regarding EoL practices on the ICU. Our results may contribute to continued discussions on optimal EoL practices and point to important variability which may inform comparative effectiveness research on EoL practices and outcomes in Europe and Israel.
The Epidemiology of Concussions in 20 United States High School Sports, 2013/14-2017/18 Academic Years

Zachary Kerr1, Avinash Chandran1, Aliza Nedimyer1, Alan Arakkal2, Scott Zuckerman3, Lauren Pierpoint2, R. Dawn Comstock3

1University of North Carolina at Chapel Hill, Chapel Hill, United States, 2University of Colorado Anschutz, Aurora, United States, 3Vanderbilt University, Nashville, United States

Objective: High school sports participation continues to increase in the United States. Updated estimates of concussion incidence are needed to help develop and refine concussion prevention strategies. This study examined the epidemiology of sport-related concussions in 20 high school sports during the 2013/14-2017/18 academic years using data from the National High School Sports-Related Injury Surveillance Study [HS RIO(TM)].

Methods: A convenience sample of athletic trainers (ATs) reported concussion and athlete-exposure (AE) data to HS RIO(TM) for 20 sports during the 2013/14-2017/18 academic years. Concussion diagnosis relied upon the expertise of the ATs and other present medical staff. The number of participating teams varied by sport and year. ATs provided information regarding event type (competition/practice), injury mechanism, and injury history (new/recurrent) for each concussion. Concussion rates per 10,000AE with 95% confidence intervals (CI) and distributions were calculated. Injury rate ratios (IRR) and injury proportion ratios (IPR) compared concussion rates and distributions by event type, and by sex in sex-comparable sports (i.e., soccer, basketball, baseball/softball, cross country, track, and swimming). IRR and IPR with 95%CI excluding 1.00 were deemed significant.

Results: Overall, 9,542 concussions and 22,870,364AE were reported, resulting in an overall concussion rate of 4.17/10,000AE (95%CI: 4.09-4.26). Most concussions occurred during competition (63.7%) and were due to contact with another person (62.3%), followed by surface contact (17.5%) and equipment contact (15.8%); also, 8.3% were recurrent. Football had the highest overall concussion rate (10.40/10,000AE), followed by girls’ soccer (8.19/10,000AE) and boys’ ice hockey (7.69/10,000AE). Across the five-year study period, football competition concussion rates increased from 33.19 to 39.07/10,000AE; football practice concussion rates decreased from 5.47 to 4.44/10,000AE. Concussion rates were generally higher in competitions than practices (10.37 versus 2.04/10,000AE; IRR=5.09; 95%CI: 4.89-5.31), with the exception of cheerleading (2.22 versus 3.60/10,000AE; IRR=0.62; 95%CI: 0.48-0.79). Cheerleading had the second highest practice concussion rate behind football. Among sex-comparable sports, differences in concussion rates and proportions were found. Concussion rates were higher in females than males (3.35 versus 1.51/10,000AE; IRR=2.22; 95%CI: 2.07-2.39). The proportion of concussions that were recurrent was higher in females than males (9.3% versus 6.4%; IPR=1.44; 95%CI: 1.11-1.88). Whereas the proportion of concussions due to contact with another person was higher in boys than girls (54.5% versus 42.1%; IPR=1.29; 95%CI: 1.20-1.39), the proportion due to equipment contact was higher in girls than boys (33.6% versus 23.5%; IPR=1.43; 95%CI: 1.27-1.62).

Conclusion: Our findings suggest that football continues to have the highest concussion rate in high school sports, highlighting the need for targeted prevention strategies, particularly in competitions where rates may have increased. However, concussion prevention must be considered for all sport settings. Areas of further focus include prevention of recurrent and equipment contact-related concussions among female student-athletes and practice-related concussions among cheerleaders.
A Community-Based Intervention Program in the Chronic Phase of TBI: A Feasibility Trial for A Randomized Controlled Trial

Ida Maria Henriksen Borgen1,2, Solveig Lægreid Hauger2,3, Marianne Løvstad2,3, Cecilie Røe1,4, Marit Forslund1, Solrun Sigurdardottir3, Laraine Winter6,7, Ingerid Klefelfård1

1Department of Physical Medicine and Rehabilitation, Oslo University Hospital, Norway, Oslo, Norway, 2Department of Psychology, Faculty of Social Sciences, University of Oslo, Oslo, Norway, 3Department of Research, Sunnaas Rehabilitation Hospital, Nesoddtangen, Norway, 4Institute of Clinical Medicine, Faculty of Medicine, University of Oslo, Oslo, Norway, 5Center for Habilitation and Rehabilitation Models and Services (CHARM), Department of Health and Society, Faculty of Medicine, University of Oslo, Oslo, Norway, 6Philadelphia Research and Education Foundation, Philadelphia, United States, 7Nursing Service, Department of Veterans Affairs Medical Center, Philadelphia, United States

Background: Traumatic brain injury (TBI) often leads to persistent difficulties with cognitive, emotional and vocational functioning, as well as reduced community integration and quality of life. Although many receive targeted rehabilitation services in the acute and sub-acute phase, studies have documented high levels of unmet needs for health care services in the chronic phase of TBI, frequently in emotional, vocational and cognitive domains. In the chronic phase, services are often provided in a primary care context, and should thus be tailored to the individual difficulties, including perspectives such as participation, community reintegration, social support and family functioning. Research on effective treatment options delivered in the community setting is, however, lacking. An innovative, home-based and individual goal-oriented intervention program performed in close collaboration with family members was developed in the US by Winter and colleagues. The intervention is currently being evaluated in a Norwegian population, within the context of a universal health coverage and a public health care system. In preparation for a future definite randomized controlled trial (RCT) evaluating the effectiveness of this intervention, the feasibility of the study protocol was assessed in line with recommendations for complex interventions from the Medical Research Council, UK.

Methods: This feasibility trial applied a one group pre-post design, including a baseline assessment (T1) and follow up assessment immediately after the intervention (T2). Six adults with severe TBI (5 males, time since injury 7.5–8.5 years) in metropolitan Oslo, Norway, were recruited and received the intervention. The intervention was manualized and consisted of six in-home visits and two telephone contacts, delivered over a period of 4 months. Three of the participants had participating family members. Primary feasibility objectives were to evaluate (i) recruitment and screening procedures, (ii) baseline and follow-up assessments, (iii) intervention delivery, (iv) order of primary and secondary outcome measures, and (v) acceptability.

Results: Evaluation of the recruitment and screening procedures showed need of inclusion criteria adjustments. Baseline assessment was found to be too time consuming and was abbreviated to decrease participant burden. Intervention delivery was feasible. Outcome measures were reviewed, and amendments were deemed necessary. Acceptability was high, with no drop outs. The participants showed high goal attainment at the end of the intervention. All participants said they would be willing to participate in a similar study at a later point in time.

Discussion: The intervention was deemed feasible in a population of severe TBI and preliminary results seem promising. The feasibility trial led to important amendments to inclusion criteria, baseline assessment and outcome measures before commencement of the full-scale RCT. Importantly, results showed high
acceptability and high goal attainment at an individual level, strengthening the feasibility and utility of the intervention. The RCT-study recruitment started in June 2018.
Fatigue is Associated with Long-Term Participation Outcome in Patients with Aneurysmal Subarachnoid Hemorrhage

Lianne de Vries¹², Wendy Boerboom¹, Rita van den Berg-Emons², Fop van Kooten³, Gerard Ribbers¹², Majanka Heijenbrok-Kal¹²

¹Rijndam Rehabilitation, Rotterdam, Netherlands, ²Department of Rehabilitation Medicine, Erasmus MC, University Medical Center Rotterdam, Rotterdam, Netherlands, ³Department of Neurology, Erasmus MC, University Medical Center Rotterdam, Rotterdam, Netherlands

Background: Aneurysmal subarachnoid hemorrhage (a-SAH) accounts for about 5% of all strokes. Although the majority of a-SAH survivors regains functional independence, many of them experience participation restrictions. In order to improve participation in this population, gaining insight in factors that are related to participation is a prerequisite. Fatigue is one of the most common long-term symptoms of a-SAH and may play a role in participation outcome.

Objective: To explore the role of fatigue in long-term participation outcome in patients with a-SAH.

Methods: Participation was assessed with (1) the Sickness Impact Profile-68 (SIP-68), expressed in a total, physical and psychosocial score, (2) the 6 domains of the Impact on Participation and Autonomy (IPA) questionnaire (autonomy indoors, family role, autonomy outdoors, social relations, work and education, and problem experience) and (3) the Community Integration Questionnaire (CIQ), expressed in a total, home competency, social integration, and productive activity score. Fatigue was assessed with the Fatigue Severity Scale (FSS), using a cut-off score of 4 or higher to indicate the presence of fatigue. Independent t-tests and Chi-square tests were performed to detect differences in participation outcomes between fatigued and non-fatigued patients. Univariable and multivariable regression analyses were performed to examine relationships between fatigue and participation outcomes (SIP-68 total, CIQ total and IPA problem experience), adjusted for patient characteristics and depression.

Results: In total, 59 patients with a-SAH were included, with a mean age of 53.0 years (SD 10.8 years) and a male proportion of 35.6%. Mean time post SAH onset was 3.9 years (SD 0.8 years) and fatigue was present in 35 patients (59.3%). Patients with fatigue had significantly worse participation scores on the SIP-68 total (13.9 vs 4.2, p < 0.001) and on the physical (4.7 vs 1.0, p = 0.001) and psychosocial (9.2 vs 3.1, p < 0.001) scales than patients without fatigue. Also, on the IPA autonomy indoors (0.8 vs 0.3, p = 0.001), autonomy outdoors (1.5 vs 0.8, p = 0.002) and problem experience (0.5 vs 0.2, p = 0.001) domains, fatigued patients scored worse than non-fatigued patients. Adjusted for age and depression, a higher fatigue score was independently related to worse participation outcome measured with the SIP-68 total (B = 2.79, p < 0.001) and with the IPA problem experience (B = 0.08, p = 0.003), but not with the CIQ total.

Conclusion: Fatigue is associated with several participation outcomes four years post a-SAH onset, independent of age and depression. These results suggest that a rehabilitation program aimed at reducing fatigue might be beneficial to improve participation in the long term after a-SAH.
Patient-Specific Management of Severe TBI Depending on Age and Cerebrovascular Autoregulation Status

Aidanas Preiksaitis, Saulius Rocka, Vytautas Petkus, Edvinas Chaleckas, Solventa Krakauskaite, Erika Zubaviciute, Saulius Vosylius, Daiva Rastenyte, Arminas Ragauskas

1Kaunas University of Technology, Kaunas, Lithuania, 2Lithuanian University of Health Sciences, Academy of Medicine, Department of Neurology, Kaunas, Lithuania, 3Vilnius University, Faculty of Medicine, Clinic of Neurology and Neurosurgery, Vilnius, Lithuania, 4Republic Vilnius University Hospital, Department of Neurosurgery, Vilnius, Lithuania

Background: Determination of proper choice of patient-specific management methodology is crucial for patients with traumatic brain injury (TBI). The treatment outcomes of TBI patients depend on cerebral blood flow autoregulation impairments which can also be affected by patients’ age, brain injury grade or pharmacological influences (anaesthetics, sedation, etc.). The objective of the prospective study was to explore the influence of various factors (dynamics of cerebrovascular autoregulation (CA) status, cerebral perfusion pressure (CPP) declination from optimal CPP value (ΔCPPopt), TBI severity, age, glucose level in blood, etc.) on the TBI patients’ outcome.

Methods: Multimodal ABP, ICP, CPP and CA monitoring of 81 TBI patients has been performed in Republic Vilnius University Hospital (Lithuania). ICM+ software (Cambridge, UK) was used for continuous CA status assessment by calculating Pressure Reactivity Index (PRx) and for identification of patient-specific optimal CPP (optCPP). The post-hoc analysis of associations between the patients' outcome and complex influence monitored parameters was performed by creating multifactorial model of predicting TBI patient’s outcome and determining the most important factors affecting outcome.

Results: The multifactorial logistic regression model showed that the most significant factors affecting TBI patient’s outcome are age, Glasgow Coma Scale (GCS), glucose level in blood serum samples (determined within 24 hours after admission), Helsinki CT (HCT) score and duration of longest CA impairment when PRx(t)>0.5 within 24 hours after admission. The modelled accuracies for mortality and unfavorable outcome prediction were 82% and 86% respectively. The age>45 years (P=0.034, χ²=17.48) and HCT>7 (P=0.14, χ²=15.13) were found statistically significantly associated with unfavorable outcome or mortality. OptCPP-targeted management was found statistically significantly associated with better outcome for younger patients (age<45 years). The critical values of averaged ΔCPPopt<-5 mmHg, percentage time when ΔCPPopt<-5 mmHg exceeds 55%, averaged value of PRx>0.36 and duration of LCAI >100 min (P=0.043, χ²=18.00) were found associated with mortality for younger patients’ group (<45 years). The critical values of averaged PRx>0.26 (P=0.005, χ²=7.80) and duration of LCAI >61 min (P=0.019, χ²=5.44) were founded associated with mortality for elderly patients’ group (>45 years). However, we found no statistical differences between survivals and not survivals comparing their percentage time ΔCPPopt<-5 mmHg and averaged values of ΔCPPopt for elderly patients’ group.

Conclusion: The main factors affecting TBI treatment outcomes are patient’s age, HCT, GCS, blood glucose level and the CA status during first day after patient admission. The optCPP-targeted patient-specific management is useful for stabilizing CA in severe TBI patients as well as for improving outcome for younger patients with age<45. However, additional research is needed in order to prove applicability of optCPP-targeted therapy for elderly patients.

Acknowledgement: This research has been funded by the grant MIP087/2015 of Research Council of Lithuania.
Effect of Tobacco Smoking on Mental Health Among Those with Significant Brain Injury

Francisco Ramirez1, Neil Nedley1
1Nedley Clinic, Weimar, United States

Background: Smoking tends to be common habit worldwide, we explore the effect that smoking has among those with a background of brain injury and that participated in an educational intervention.

Methods: Previously trained facilitators ran an 8-week educational program that took placed in 4 continents; the program didn't create a doctor-patient relationship. Participants met once a week for 8 weeks for a 2-hour program that includes a 45-minute presentation and small group discussions with weekly assignments. The 85 question Depression and Anxiety Assessment Test (DAAT) was used to assess depression using a modified PHQ-9 (Patient Health Questionnaire), it inquired about demographics, history of brain injury, tobacco usage among other questions. The questionnaire was administered at baseline and completion. The depression was classified according into 4 categories as none (0-6), mild (7-10), moderate (11-19) or severe (20 or more). During the program they were taught various healthy lifestyle habits including nutrition, exercise, bright light, sleep, and avoiding addictive habits among other healthy habits.

Results: From n=5,991 participants that finished the 8-week program, n=275 had a history of significant head injury, n=196 (71%) were females. The group’s mean age was 52.9 (SD 15.7).

Those with history of head injury that were smoking at baseline were n=46 and had a mean depression score of 17.5 (SD 7.2), median 19.5, mode 24. Regarding the depression severity at baseline 13% had no depression, 6.5% mild, 30% moderate and 50% severe depression. By the end of the 8 weeks that group had a mean depression score of 9.8 (SD 6.4), median 11, mode 13. The end depression distribution was 39% none depression, 8.6% mild, 45.6% moderate and 6.5% Severe depression and 17% had quit smoking by the end. The before and after depression scores were significant with a t (45) =7.32 with a p<0.001.

Among those that had brain injury but did not smoke at baseline were n=229, their baseline mean depression was 14.8 (SD 7.1), median 16, mode 21. The baseline depression distribution was 15% none, 17.4% mild, 35.8% moderate and 31.4% severe. By the end of the program the mean depression score of that group was 8.9 (SD 6.8), median 8, mode 2. End depression distribution of this group 44% had no depression, 17% mild, 30% moderate and 8.7% Severe. Depression scores for this group were significant with a t test (228) =14.19 with a p<.001.

Conclusion: These results seem to indicate that those who have injury and smoked seem to have more depression. The intervention benefited both groups. Long term follow up is being done to see how long the improvement last.
The Effect of A Dialogue-Based Intervention on Psychosocial Well-Being 12 Months After Stroke: A Multicentre Prospective Randomized Controlled Trial

**Line Kildal Bragstad**1,2, Ellen Hjelle2, Manuela Zucknick3, Unni Sveen1,4, Bente Thommessen5, Berit Bronken6, Randi Martinsen6, Gabriele Kitzmüller7, Margrete Mangset1, Kari Kvigne6, Marit Kirkevold2

1Oslo University Hospital, Oslo, Norway, 2University of Oslo and Research Center for habilitation and rehabilitation services and models (CHARM), Oslo, Norway, 3University of Oslo, Oslo Centre for Biostatistics and Epidemiology, Oslo, Norway, 4Oslo Metropolitan University, Oslo, Norway, 5Akershus University Hospital, Lørenskog, Norway, 6Inland Norway University of Applied Sciences, Elverum, Norway, 7UIT, the Arctic University of Norway, Narvik, Norway

**Background and Aim:** Depressive symptoms, anxiety, and social isolation are prevalent after stroke. Psychosocial difficulties may influence long-term functioning and quality of life, reduce the effects of rehabilitation services, and lead to higher mortality rates. This study aimed to evaluate the effect of a dialogue-based intervention to promote psychosocial well-being at 12 months post-stroke.

**Methods:** Trial design and participants: This is a multicenter prospective randomized controlled trial with two parallel groups. Inclusion criteria: aged ≥18, acute stroke within the last month, medically stable, sufficient cognitive functioning, able to understand and speak Norwegian before stroke onset, able to give informed consent. Patients with moderate to severe dementia or other serious somatic or psychiatric diseases, significant expressive or expressive aphasia were excluded. Eleven hospitals in South-Eastern Norway enrolled patients from November 2014 to November 2016. All participants were assessed at baseline (1-month post-stroke) and at 6- and 12-months post-stroke.

**Usual Care:** All participants received evidence-based comprehensive stroke treatment in the acute phase and stroke rehabilitation in accordance with the Norwegian guideline for treatment and rehabilitation of stroke.

**Dialogue-based Intervention:** In addition to standard care, the intervention group was offered a dialogue-based intervention. The intervention was based on Antonovsky’s sense of coherence theory, narrative theory, and ideas from the guided self-determination method. The intervention consisted of eight individual 1-1 ½-hour sessions between the participant and a specially certified nurse or occupational therapist during the period of 1-month post-stroke to 6 months post-stroke. The intervention was delivered in the participant’s home.

**Outcomes:** The primary outcome was psychological distress and depressive and anxiety symptoms at 12 months post-stroke measured by the General Health Questionnaire-28 (GHQ-28). Secondary outcomes included the Stroke and Aphasia Quality of Life Scale-39 (SAQOL-39g), Sense of coherence (SOC-13), and depression (Yale-Brown single-item questionnaire).

**Statistical Analyses:** Logistic regression, independent samples t-tests, and paired samples t-tests were used to assess within- and between group differences. A generalized linear mixed model (GLMM) was used to model the repeated measures at 6 and 12 months with fixed and random predictors.

**Results:** In total, 322 patients were randomized into the intervention (n=166) and the control group (n=156). Baseline demographics and clinical characteristics were similar in both groups with the exception of depression. Relative to baseline, both groups improved significantly on the primary outcome, GHQ-28, and...
the secondary outcome, SAQOL-39g, at 12 months. There were no significant changes in SOC-13 or depression at 12 months relative to baseline in either group. There was no between-group difference in psychosocial well-being at 12 months post-stroke. The results of the GLMM are still pending and will be presented at the conference.

Conclusions: The dialogue-based intervention did not improve psychosocial well-being compared with standard care at 12 months post-stroke.
The Lifetime Prevalence of Hospitalised Head Injury in Scottish Prisons: A Population Study

Tom McMillan\textsuperscript{1}, Danny McKay\textsuperscript{1}, Lesley Graham\textsuperscript{1}, Jill Pell\textsuperscript{1}, Alex McConnachie\textsuperscript{1}

\textsuperscript{1}University of Glasgow, Glasgow, United Kingdom

Background: There is a need to understand the epidemiology of head injury in prisoners in order to plan interventions to reduce associated disability and risk of reoffending. This is the first study to determine the lifetime prevalence of hospitalised head injury (HHI) in a national population of prisoners and is part of a programme of research associated with the implementation of a health service for people with brain injury in the criminal justice system in Scotland\textsuperscript{1}.

Methods: Whole life hospital records of everyone aged 35 years or younger and resident in a prison in Scotland on a census day in 2015 were electronically linked via their unique NHS identifier and checked for ICD-9 and 10 codes for head injury (excluding extracranial injury codes). Using a case control design, these data were compared with a sample from the general population matched 3:1 for age, gender and area-based social deprivation. The likelihood of having sustained a ‘more severe’ brain injury was estimated in two ways. The presence of ICD codes for intracranial injury excluding concussion or having more than two hospital admissions with a head injury diagnosis.

Results: HHI was found in 24.6% of 4,374 prisoners and was significantly more prevalent than the 17.9% of 13,122 individuals with HHI in the matched general population sample (OR 2.13; 95%CI, 1.90, 2.39). Having three or more HHI was more common in prisoners (OR 3.04; 95%CI 2.33, 3.97) as were HHI with ICD codes for intracranial injuries (OR 1.51; 95%CI 1.28, 1.79), suggesting that more severe HHI is more prevalent in prisoners than the general population. Overall 10.9% of prisoners had at least one indicator of having sustained a ‘more severe’ brain injury.

Conclusion: Prisoners in Scotland aged 35 years or younger have a higher lifetime prevalence of HHI than a demographically matched general population and are more likely to have had repeated HI or intracranial injuries. Further work is required to elucidate relationships between self-report of HI and hospitalised records and to ascertain persisting effects of HI in prisoners and the need for services to reduce effects of associated disability and on the risk of reoffending.

The Prevalence and Management of Head Injury in Police Custody: A Pilot Study

Tom McMillan¹, Lin Mclean¹, Fiona Bell²
¹University of Glasgow, Glasgow, United Kingdom, ²Criminal Justice Services Division, Police Scotland, Glasgow, Glasgow, Scotland

There is increasing interest and awareness of associations between brain injury and offending. In a police custody setting, screening for recent head injury (HI) may be a relevant factor in relation to safe management of potentially life-threatening damage, and management of behaviour and legal processing of individuals who may have resulting cognitive impairment. However, little has been published on the need for or outcome of routinely asking a specific question about recent HI in police custody settings.

In Scotland a vulnerability risk assessment (VRA) of health is routinely carried out in police custody by police sergeants. For example, this includes questions about mental health, medication and drug use. It allows the police to consider whether the individual needs hospital attention, to be seen by forensic nurses or doctors linked to the police station or to be placed in an observation cell. In this pilot study an additional question about the occurrence of a HI in the previous 48 hours was added to the VRA. A research worker observed and noted responses to the question and the actions taken by the police as a consequence. Perceptions of the usefulness of the question about HI was obtained from the police sergeants involved.

Of 100 people processed in police custody in Glasgow, 13% reported sustaining a HI within the past 48 hours. Most of the HI occurred on the day of detention (9/13), were caused by an assault or fall (11/13) and the detainee was often intoxicated (9/12). Five were referred to the forensic nurse service and of these two were placed in a police observation cell. All police sergeants reported that a question on HI was a useful addition to the VRA.

The HI in this pilot study were ostensibly mild, but if representative, would translate to more than 18,000 people with a recent HI being processed in police custody in Scotland each year. At this scale there is high risk of a minority having significant HI. The inclusion of a HI question in the VRA is recommended and is now included in police custody settings in Scotland. This study is part of an initiative to provide a health service to people with brain injury throughout the criminal justice system in Scotland1.

Long-Term Follow-Up Observation Study 7 Years after Severe Traumatic Brain Injury in Northern Sweden

Maud Stenberg1, Britt-Marie Stålnacke1, Britt-Inger Saveman2

1Department of Community Medicine And Rehabilitation, Rehabilitation Medicine, Umeå University, Umeå, Sweden, Umeå, Sweden, 2Department of Nursing, Umeå University, Umeå, Sweden

Background: Brain injury caused by trauma is common and affects approximately 100-500/100,000 people per year seeking hospital care. People suffering from the most severe form of traumatic brain injury constitute a small proportion, but this group is most affected by extensive consequences, highest mortality and highest care needs, which also affects their close relatives. Recently, medical care in the emergency phase has undergone an increase in efficiency, which has resulted in more people surviving severe traumatic brain injury (STBI). This implies increased demands on health care and rehabilitation. We have previously studied 37 patients with STBI from the northern health care region in Sweden in the acute phase and at one year follow up. Since there is a need to also study long-term course following STBI the aim of this study was to follow up the same patients, about 7 years after the injury.

Methods: This study is a follow-up study after 7 years of a prospective, total population, cohort study conducted 2010-2011 in the northern healthcare region in Sweden. Inclusion criteria were patients with STBI, age at injury were 18–65 years. They were assessed with Glasgow Outcome Scale Extended (GOSE) at 3 months, 1 year and 7 year. Patients were administered the Barrow Neurological Institute Screen for Higher Cerebral Functions (BNIS) if they were able to complete a brief screening test with BNIS prescreening at 3 months, 1 year and 7 year. The Hospital Anxiety and Depression Scale (HADS) was used to screen for presence and degree of anxiety and depression at the same time points.

Results: Out of the 37 patients with STBI included in previous studies, 9 were deceased during the follow up 7 years after the injury, 2 people could not be identified, and 4 people refused to participate in the project. Thus, in the current study, 22 people (15 men, 7 women) were included. They were aged 18-64 at the time of injury (average: 41 years). We present some preliminary results. From 3 month to 1-year GOSE were significantly improved (p=0.003). No significant improvement from 1 year to 7 years (p=0.137). BNIS no significant improvement 3 month to 1 year (p=0.090) or 1 year to 7 years (p=0.363). HADS anxiety were close to significant improvement at 1 year (p=0.059) but no significant differences at 7 year (p=0.699). HADS depression no significant differences at 1 year and 7 years.

Conclusion: Patients were improved one year after the injury especially on the GOSE, no further improvement was found after 7 years. These results indicate the need of long-time rehabilitation interventions and follow up by health care.
Trajectories of Fatigue following Mild Traumatic Brain Injury: A Six-Month Prospective Cohort Study

Sandra Rakers1, Marieke Timmerman2, Myrthe Scheenen1, Myrthe de Koning3, Harm van der Horn3, Joukje van der Naalt3, Jacoba Spikman1

1Department of Neuropsychology, University Medical Center Groningen, Groningen, Netherlands, 2Department of Psychometrics and Statistics, University of Groningen, Groningen, Netherlands, 3Department of Neurology, University Medical Center Groningen, Groningen, Netherlands

Introduction: The main objective of the current study was to examine the prevalence, severity and course of fatigue over a six-month period following mild traumatic brain injury (mTBI). We examined whether distinct fatigue trajectories over time can be identified, using multilevel growth mixture modeling (MGMM). Variables that are often associated with fatigue were also taken into account, including emotional distress (anxiety, depression, post-traumatic stress) and coping style (active and passive coping).

Methods: Within the context of the UPFRONT study, 456 mTBI patients were included who all completed questionnaires at 2 weeks, 3 months and 6 months post injury. Fatigue was assessed with the Checklist Individual Strength (CIS). Furthermore, we examined anxiety and depression (Hospital Anxiety and Depression Scale), post-traumatic stress (Impact of Event Scale) and coping styles (Utrecht Coping List). Additionally, the Glasgow Coma Scale (GCS) score was determined during neurological examination. For MGMM analysis, all outcome variables were modeled simultaneously in order to identify clusters of patients (latent classes) with trajectories that show similar longitudinal courses across these domains of fatigue, emotional distress and coping.

Results: Four clusters were identified. The first subgroup comprised 27% of the mTBI patients and showed persistent fatigue, low levels of emotional distress and a trend of increasing levels of passive coping. The second subgroup comprised 30% of the mTBI patients with already a low level of fatigue at 2 weeks, recovering further over time, together with low levels of emotional distress and a predominant reliance on active coping. The third subgroup, comprising 18% of the mTBI patients, shows high and persistent levels of fatigue as well as high and stable levels of emotional distress, together with a high and significantly increasing use of passive coping. Lastly, the fourth cluster, comprising 25% of the mTBI patients, shows a pattern of decreasing levels of fatigue, together with decreasing use of passive coping over time. The four identified clusters differed significantly with regard to gender, educational level and GCS score, with clusters showing higher and more persistent levels of fatigue mainly consisting of women with lower GCS scores and lower educational levels.

Conclusion: Qualitatively different fatigue trajectories over time following mTBI can be identified. Of all patients, a subgroup of 30% recovers well from fatigue. Another subgroup shows improvement for fatigue with increasing use of constructive coping. However, almost half of the mTBI patients experiences high and persistent levels of fatigue, of which a subgroup is characterized by high levels of emotional distress and increasing use of passive coping. Hence, high risk for an adverse fatigue trajectory can be signaled early, based on a combination of fatigue, emotional distress and coping characteristics together with demographic and injury severity characteristics, allowing timely treatment.
Precision-Tinted Spectral Filters Reduce TBI-Related Migraines and Visual Cortical Sensitivity

Sandra Tosta\textsuperscript{1}, \textbf{Adam Anderson}\textsuperscript{2}
\textsuperscript{1}Irlen Institute, Long Beach, United States, \textsuperscript{2}Cornell University, Ithaca, United States

Background: The lingering effects of TBI can continue for months or years, especially with regard to headaches and migraines. These issues can be frustrating and debilitating, especially when they are unresponsive to standard courses of treatment. Increasing evidence suggests light wavelength regulates brain activity in ways extending beyond color perception. Here we investigated the use of precision-tinted spectral filters on brain activity and their application to persistent headaches and migraines as a result of brain or head trauma that have not been successfully remediated through standard medical and alternative treatment, including medications.

Methods: Study 1. 184 participants diagnosed with medically resistant headaches and migraines as a result of brain or head trauma completed the Headache Impact Test\textsuperscript{™} (HIT\textsuperscript{-6\textsuperscript{™}}) before and after treatment with precision-tinted spectral filters, worn as glasses for 4-12 weeks. The HIT\textsuperscript{-6\textsuperscript{™}} is designed to capture the impact of headache and its treatment on an individual’s functional health and well-being and is considered useful both for screening and monitoring change in headache impact. Participants also reported on migraine frequency. Study 2. A pilot study (n=7) of individuals with abnormal light sensitivity and history of headaches were administered retinotopic mapping fMRI scans with spectral filters or blank lenses to examine regulation of neural hypersensitivity to visual stimulation.

Results: Pre versus post comparison of migraine frequency, medication usage, and scores on the HIT-6\textsuperscript{™} showed that there was significant reduction in migraine frequency (M=18.8, SD=22.0 vs. M=2.0, SD=6.0); \textit{t}(181) = 10.6, \textit{p}=.000. There was also significant improvement (M=66.0, SD=8.0 vs. M=41.6, SD=9.9) in terms of impact of headaches on functional health and well-being, \textit{t}(183) = 32.9, \textit{p}=.000. Precision-tinted spectral versus blank filters reduced within primary and secondary visual regions as well as fronto-parietal attentional networks, consistent with reduced hyperactivity to visual stimulation and reduced recruitment of neural networks outside of the visual system proper. These results suggest that precision-tinted spectral filters can reduce migraine frequency with headaches reduced from having a significant negative impact to having little or no impact on subjects’ health and well-being. Preliminary evidence supports reduced uncontrolled cortical excitability to patterned light stimulation as a potential mechanism of action.

Conclusions: For individuals who have suffered head trauma resulting in light sensitivity and chronic headaches and migraines that fail to respond to standard interventions, precision-tinted spectral filters may provide relief that translates to improved functional health and well-being by regulating neural responses to light.
Can a Single Session Psychoeducation Program Improve Knowledge About Traumatic Brain Injury in Adult Male Prisoners?

Louise Buchan\(^1\), Hira Aslam\(^1\), Tom McMillan\(^1\)

\(^1\)University of Glasgow, Glasgow, United Kingdom

Introduction: Although traumatic brain injury (TBI) has been identified as a pervasive problem in incarcerated populations, there remains an unmet need for interventions and services targeting TBI in the prison healthcare system. Clinical guidelines suggest that an educational approach that emphasises information and reassurance can be effective. The present study examines the efficacy of a simple, single session psychoeducation intervention for people with TBI that might be appropriate for delivery in prisons. We present here preliminary data from one of a series of projects in Scotland that are associated with the development of a health service for people with HI in the criminal justice system. This study explores prisoners' knowledge of the consequences and long-term effects of HI, as well as self-reported aggression and impulsivity, before and after the intervention and at follow-up.

Methods: Adult male offenders were recruited from two prisons in Scotland. The study comprised three stages: a screening appointment (T1; n=34), a one-hour group intervention (T2; n=19), and a one-month follow-up appointment (T3; n=11). At T1, participants were administered a vignette illustrating the circumstances of a fictitious acquired TBI and had to indicate what the persisting effects/outcome might be. They also completed symptom checklists designed to evaluate their knowledge of typical post-TBI sequelae and questionnaires about their own aggression, impulsivity, TBI, and offending history. T2 consisted of a one-hour interactive group session on TBI and its persisting effects; participants again responded to vignettes and completed symptom checklists immediately after the psychoeducation session and received written guidance about TBI. At the one-month follow-up (T3), participants completed the measures administered previously once more.

Results: There was a significant improvement in knowledge about TBI both immediately following the psychoeducation session (p<0.01), and at follow-up (p<0.01). All participants self-reported having had a head injury (n=33), and all but one having had multiple HIs. There was no change in self-reported aggression and impulsivity. Further analyses comparing those self-reporting mild HI (n=20) and moderate-severe HI (n=13) suggest that knowledge improved more in those reporting mild HI after the psychoeducation intervention (p<0.05).

Conclusion: A single session a psychoeducation program improved knowledge about TBI in male prisoners including at follow-up, particularly in those who self-reported mild HI. This study demonstrates that delivering a brief psychoeducation program to offenders is a feasible way of delivering unmet support needs for HI in prisons.

1 https://www.nes.scot.nhs.uk/media/3325330/matrix_-_neurologicaltables.pdf

Comparison of the Utility of the BISI and OSU-TBI, in Screening for Disability, Cognitive Impairment and Mental Health in Incarcerated Male Offenders

Abi McGinley¹, Hira Aslam¹, Vicky Walker¹, Tom McMillan¹
¹University of Glasgow, Glasgow, United Kingdom

Introduction: Given the estimates of a high prevalence of head injury (HI) in prisoners, there is a need for screening tools to assess the likelihood of significant traumatic brain injury which has had persisting disabling consequences. There is an initiative in Scotland to develop a health service for people with brain injury in the criminal justice system and as part of this, two screening tools were compared in relation to their practicality of use and validity in predicting disability associated with HI (the Ohio State University Traumatic Brain Injury Identification Method (OSU TBI-ID) and the Brain Injury Screening Index (BISI)).

Method: A preliminary sample of 82 male offenders were recruited from a Scottish prison and randomly allocated to administration of either the OSU TBI-ID (n=41) or the BISI (n=41) self-report measures. Outcome measures were the Glasgow Outcome at Discharge Scale for disability, scores on cognitive tests (Symbol Digit Modalities, Auditory Verbal Learning Test, Trail Making Test, and Hayling Sentence Completion Test, Word Memory Test), and the Hospital Anxiety and Depression Scale (HADS). Researchers noted the length of time taken for each screening tool and any difficulties or benefits in administration.

Results: The OSU TBI-ID flagged 90% of screened participants (n=34) as ‘likely to have ongoing problems’, and the BISI identified 81% of participants (n=37) as having ‘moderate-severe HI’. The OSU TBI-ID was significantly associated (p=0.01) with a measure of processing speed, disability rating, as well as anxiety and depression. The BISI was not significantly associated with any of the outcome measures. The OSU TBI-ID took longer (minutes; Mdn = 7.43; p<0.05) to administer than the BISI (Mdn = 5.47), although in practice the time difference was small. The BISI required further explanation /prompting more frequently (49%) than the OSU (39%, p<0.05), possibly due to its less structured administration format and greater dependence on free recall.

Conclusions: The OSU TBI-ID and the BISI detected disability, cognitive impairment, and mental health issues associated with self-report of HI. However, the OSU TBI-ID was better at predicting outcome than the BISI and required less prompting/further explanation when administering the tool. This is an on-going study hence these are preliminary results.

Head Injury and Associated Disability in Male Prisoners

Abi McGinley¹, Hira Aslam¹, Vicky Walker¹, Tom McMillan¹

¹University of Glasgow, Glasgow, United Kingdom

Introduction: Meta-analyses of self-report in offenders suggest that 50-60% have sustained a head injury (HI). However, there is little reported evidence about persisting effects and service need is not clear. We present here preliminary data from one of a series of projects in Scotland that are associated with the development of a health service for people with HI in the criminal justice system¹.

Methods: A cross-sectional, between-subjects methodology considered disability outcome in 81 males incarcerated in prisons in Scotland. Participants were screened for occurrence and severity of HI. Outcome measures were the Glasgow Outcome at Discharge Scale for disability, cognitive tests (Symbol Digit Modalities, Auditory Verbal Learning Test, Trail Making Test, and Hayling Sentence Completion Test, Word Memory Test), and the Hospital Anxiety and Depression Scale. Severity of HI was determined by duration of loss of consciousness (LoC), where moderate-severe groupings had indicated LoC of greater than 30 minutes, and by the total number of HIs sustained. Group scores were compared to assess disability and cognitive impairment as a function of HI severity and to estimate level of need.

Results: Most of the sample (74%) of 81 offenders lived in areas of high social deprivation before sentencing and were representative of the prison population in Scotland with respect to age and socioeconomic background. All but one self-reported at least one HI, and of these, most (88%) reported more than one HI, with a further 20% self-reporting a moderate-severe HI. The average age of first HI was 10 years. The majority had been convicted of violent offences (84%), and 88% had sustained a HI prior to their first conviction. Multivariable regression indicated that longer duration of LoC was associated with poorer scores on Symbol Digit Modalities, higher anxiety, and with disability after adjusting for covariates (age, years of education, effort score and previous problematic alcohol and/or substance use). Overall, 31-56% of prisoners with moderate-severe HI had cognitive deficits, anxiety, and disability.

Conclusion: These initial data tentatively suggest that about 20% of male prisoners with HI require assessment and a further half of these require intervention because of persisting cognitive impairment and/or disability. This is an on-going study hence these are preliminary results.

Functional MRI in Patients with Frontal Lesions after Mild to Moderate Traumatic Brain Injury

**Sandra Rakers**, Harm van der Horn, Edith Liemburg, Jacoba Spikman, Joukje van der Naalt

1Department of Neuropsychology, University Medical Center Groningen, Groningen, Netherlands, 2Department of Neurology, University Medical Center Groningen, Groningen, Netherlands, 3BCN Neuroimaging Center of the Department of Neuroscience, University of Groningen, University Medical Center Groningen, Groningen, Netherlands

Introduction: The main objective of the present study was to examine brain network function during resting-state fMRI in patients with mild to moderate traumatic brain injury (TBI) with frontal lesions, in the subacute phase after injury. Additionally, comparisons were made with patients with mild TBI without frontal lesions, and with a group of healthy controls. The role of these brain networks with regard to levels of fatigue and executive functioning was examined.

Methods: We included 17 mild to moderate TBI patients with frontal lesions, 30 mild TBI patients without frontal lesions and 20 healthy controls. At three months post-injury, functional MRI scans were made and fatigue (Checklist Individual Strength) and executive performances (Trail Making Test and Controlled Oral Word Association Test) were measured. Independent component analysis (ICA) was performed and activity of components as well as connectivity between components were compared between the different groups and related to fatigue and executive functioning.

Results: ICA resulted in six components including an anterior and posterior part of the default mode network, the left and right frontoparietal network, dorsal attention network and salience network. There were no significant differences between groups with regard to activity and connectivity between the components. The frontal lesions group experienced significantly lower levels of fatigue compared to patients without frontal lesions. Furthermore, patients with frontal lesions performed significantly worse on a mental flexibility task in comparison to patients without frontal lesions and on a task measuring executive control compared to healthy controls. No significant relationship between brain networks and levels of fatigue or executive performances were found.

Conclusions: When comparing fMRI findings of patients with mild to moderate TBI with frontal lesions and mild TBI patients without frontal lesions, no apparent differences can be found. Moreover, both groups neither seem to differ significantly from a group of healthy controls. Yet, patients with frontal lesions did perform worse on a neuropsychological test for mental flexibility in comparison to patients without frontal lesions. These findings indicate that neuropsychological assessment might be more sensitive to specific frontal oriented network deficits when compared to fMRI measurement. Further research using other imaging techniques should be undertaken to explore the relationship between structural integrity of frontal white matters tracts and outcome following mild to moderate TBI.
Fast Resolution of Chronic TBI Symptoms by Improving Brain Resilience

Grant McFetridge\textsuperscript{1}, Mary Pellicer\textsuperscript{1}, Kirsten Lykkegaard\textsuperscript{1}, Shayne McKenzie\textsuperscript{1}, Karen Haworth\textsuperscript{1}, Aneta Lesniewska\textsuperscript{1}

\textsuperscript{1}Institute for The Study of Peak States, Hornby Island, Canada

This presentation is about a totally new and non-drug approach to eliminating the symptoms following a traumatic brain injury (TBI). This could be head injuries caused by blows to the head from falls, being struck in the head, car accidents, sports injuries, or exposure to explosions during military combat. While most people naturally recover from a mild or moderate traumatic brain injury, some people are left with chronic issues such as physical, sensory, cognitive, emotional, or behavioral symptoms. The outcome of our treatment is simple. In most cases, all of the symptoms caused by the TBI event either disappear or improve significantly. This is achieved by using a psychological type approach that repairs the original growth pattern of the brain to create the optimal resiliency of the brain. Once resiliency of the brain is restored the chronic TBI symptoms disappear.

In this presentation, we will share case studies that demonstrate the change in TBI symptoms using this approach and an overview of the treatment protocol to achieve these results.

We are currently testing our treatment on 9 TBI patients; 3 males and 6 females with an average age of 49 years (range 28-67 years). The traumas causing the TBI symptoms are: Motor vehicle accident (n=4), blunt force trauma (n=2), hit by a car (n=1), sports related concussion (n=1), and multiple head injuries (n=1). Based on the patient’s own experience, the main 2-3 pre-treatment TBI symptoms were recorded. Most common were cognitive symptoms (n=12) such as memory problems, difficulty concentrating and difficulty finding words, followed by physical symptoms (n=9) such as headache, neck pain, and fatigue, and lastly sensory symptoms (n=5) such as sensitivity to light and sound. At this point, 3 patients still need further treatment but post-treatment data from all 9 patients are included here. So far, treatment lengths varied from 5 to 18 hours, with an average of 9 hours. Post-treatment, one patient had all 3 major TBI symptoms resolve, five patients had 2 out of 3 and one patient had 1 out of 3 major TBI symptoms resolve. Two patients had none of their major symptoms fully resolve. However, all patients had significant improvements to the remaining non-resolved pre-treatment TBI symptoms (based on patient satisfaction). In cases where a symptom is improved but not fully resolved we suspect that full brain resiliency has not yet been achieved and thus further treatment is needed. Or that symptoms are not actually from head injury but from other causes (e.g. spinal injury) or it is simply not a TBI caused symptom but related to another “disease” process.

In conclusion, our new and non-drug approach to eliminating the symptoms following a TBI is both very effective, quick and simple.
Variability in Constraint Induced Movement Therapy Outcome in low-to-moderate chronic hemiparesis

Phil JA Dean¹, Andre Szameitat², Adriana Conforto³, Joao Sato⁴, Gilson Vieira⁴, Shan Shen⁵, Annette Sterr¹
¹University of Surrey, Guildford, United Kingdom, ²University of Brunel, London, United Kingdom, ³University of Sao Paulo, Sao Paulo, Brazil, ⁴ABC Federal, Sao Paulo, Brazil, ⁵University of Reading, Reading, United Kingdom

Stroke is one of the leading causes of disability worldwide, with an estimated 85% of survivors sustaining upper limb hemiparesis, and 30-60% experiencing permanent impairments of motor function (van der Lee, 2003). Training-based interventions designed to improve long-term outcome have had good success in some patients, but have been variable in efficacy across patients, particularly in those with more severe hemiparesis.

We hypothesised that the variability in outcome and lack of neural effect may be due to inherent variability within the sample, with lesion side, dominant hand paresis, residual ability, mirror movements and spasticity all effecting the efficacy of CIMT. This pilot study maps the effect of these factors within the same patient cohort.

31 patients (mean age: 57.1±1.9) with moderate-severe chronic (mean 44.4±7.5mths) upper-limb hemiparesis following mixed lesions were tested before and after a two-week period of one-to-one CIMT. The CIMT protocol comprised 3 or 1.5h of daily shaping training, as described in (Sterr et al 2014). Treatment efficacy was assessed through objective (FAT/WMFT) and subjective (MAL) measures. A power grip task adapted from (Ward et al 2003) was used to look at motor execution with concurrent fMRI acquisition.

Younger patients had greater motor ability report after therapy (MAL-AU: ρ(31)=-0.36, p=0.048), but there was no correlation with chronicity and no outcome difference based on gender (19 Male, 12 Female), lesion side (15 Right Hemisphere, 16 Left), dominant hand paresis (15 Dominant [14 Right Hemiparetic], 16, Non-Dominant [14 Left]), or lesion location (19 Subcortical, 12 CorticoSubcortical).

8 patients demonstrated mirror movements of the non-paretic hand in the grip task (3 Pre only; 1 Post only and 4 Both). Overall, this group had lower motor ability pre-therapy (WMFT-TT: t(29)=-2.9, p=0.008, WMFT-FAS: t(29)=2.2, p=0.037), and showed greater improvement after therapy (WMFT-TT: t(29)=2.1, p=0.042). This effect was seen in all sub-groups, (Pre only Reliable Change Index (RCI): -1.3; Post only RCI: -1.6; Both: -0.9, compared to 0.04 for rest of group).

11 patients demonstrated spasticity in the grip task (5 Pre only; 2 Post only and 4 Both). Overall, less improvement was seen after therapy (WMFT-FAS: t(29)=2.7, p=0.013), and this was also seen in all sub-groups (Pre RCI: 0.6, Post RCI: 0.4, Both: -0.2) compared to the rest of the cohort (RCI: 1.7).

Age, mirror movements and spasticity may all have an effect on motor outcome after CIMT. Of particular interest are mirror movements as they might reflect a different strategy used by these patients in achieving greater speed of movement by using the non-lesioned hemisphere to a greater extent. An analysis of the fMRI data accompanying the grip force data may uncover what is occurring in these patients.
fMRI Effects of Constraint Induced Movement Therapy in Low- to Moderate Chronic Hemiparesis

**Annette Sterr**1, Andre Szameitat2, Adriana Conforto3, Gilson Vieira4, Joao Sato4, Shan Shen5, Phil JA Dean1

1University of Surrey, Guildford, United Kingdom, 2University of Brunel, London, United Kingdom, 3University of Sao Paulo, Sao Paulo, Brazil, 4ABC federal, Sao Paulo, Brazil, 5University of Reading, Reading, United Kingdom

Stroke is one of the leading causes of disability worldwide, with an estimated 85% of survivors sustaining upper limb hemiparesis, and 30-60% experiencing permanent impairments of motor function [1]. In recent years, training-based interventions, designed to improve long-term outcome, have been developed with good success in patients with relatively good levels of residual recovery. In patients with more severe hemiparesis, the clinical evidence is much patchier.

The concept of constraint induced movement therapy, CIMT, has by far the strongest evidence as an effective intervention for hemiparesis. Recent evidence from our own group suggests that CIMT is feasible and effective in severe chronic hemiparesis. In the present study we explored the neural signature of clinical CIMT benefits. We hypothesised that functional changes in brain regions associated with motor control would be related to clinical benefit.

31 patients aged 29-73 (mean 57.1±1.9) with moderate-severe chronic (9-179mths; mean 44.4±7.5mths) upper-limb hemiparesis following mixed lesions were tested before and after a two-week period of one-to-one CIMT. The CIMT protocol comprised 3 or 1.5h of daily shaping training, as described in Sterr et al 2014.

Functional activation in the motor system was induced through a power grip task adapted from Ward et al 2003 and captured with 3T MRI using standard sequences. Seven healthy age-matched (44-64, mean 56.2±2.4) controls also completed the fMRI task. Treatment efficacy was assessed through objective (FAT/WMFT) and subjective (MAL) measures. The fMRI BOLD response was analysed to determine treatment-related changes in neural activation.

On the behavioural level significant improvements were observed for all three measures (FAT-5: t(30)=3.5, p=0.001; WMFT-FAS: t(30)=4.3, p<0.001; MAL-QOM: t(30)=7.9, p<0.001; MAL-AU: t(30)=5.6, p<0.001) after the intervention. This improvement did not change at the 6-month (FAT-5: t(13)=0.3, p=0.8; WMFT-FAS: t(13)=1.2, p=0.3; MAL-QOM: t(16)=1.9, p=0.07; MAL-AU: t(16)=1.0, p=0.3) and 12-month follow up (FAT-5: t(8)=0.7, p=0.5; WMFT-FAS: t(9)=2.7, p=0.02; MAL-QOM: t(11)=0.4, p=0.7; MAL-AU: t(11)=1.0, p=0.3). On the functional level, motor system activation was clearly observed, but no systematic changes in relation to the intervention were found.

Although CIMT effectively improved motor ability for up to 12 months, these treatment benefits do not appear to be driven by neuroplastic changes detectable in the BOLD response. This null-result may suggest that the therapy effect in more severely affected hemiparesis is mediated by mechanisms other than changes in functional activation patterns. However, the lack of such systematic activation changes may also reflect indirect therapeutic effects, such as a reduction of mirror movements and changes in spasticity, as well as generally greater variability in this patient group. The latter may make the detection of group-level differences more difficult. Future research will need to determine individual differences in treatment mechanisms to maximise CIMT benefit.
Language Related Brain Potentials in Patients with Disorder of Consciousness to Unveil “Covert” Language Disorders (Covert Aphasia)

Rita Formisano1, Jlenia Topp1,2, Monica Risetti3, Marta Aloisi1, Marianna Contrada1,4, Paola Ciurli1, Chiara Falletta Caravasso5, Giacomo Luccichenti5, Laura Astolfi2,3, Febo Cincotti2,3, Donatella Mattia3

1IRCCS Fondazione Santa Lucia, Rome, Italy, 2Dept. of Computer, Control and Management Engineering, Sapienza University of Rome, Rome, Italy, 3Neuroelectrical Imaging and BCI Laboratory, Fondazione Santa Lucia, Rome, Italy, 4Dept. of Psychology, Sapienza University of Rome, Rome, Italy, 5Radiology Department, Fondazione Santa Lucia, Rome, Italy

Background: The presence of concomitant language disorders could interfere with the behavioral assessment of responsiveness in patients with disorder of consciousness (DoC).

Objective: In this study we aimed at investigating semantic information processing in patients with DoC by means of language related brain potentials to detect neurophysiological markers of language processing (N400) to be eventually associated to the presence of language disorders diagnosed at a long-term clinical follow up in those patients who emerged from Minimally Conscious State (E-MCS).

Methods: We examined the event-related potentials (ERPs) elicited by an auditory sentences task in a sample of DoC patients (n=15) and 10 healthy subjects. All DoC patients were clinically followed up for at least one-year and those who emerged from MCS (E-MCS) were assessed by means of a neuropsychological evaluation also for language functions.

Results: Healthy controls showed N400 ERP component in response to the ill-formed sentences characterized by the typical centro-parietal topography in 9 out 10 cases. Nine out of 14 patients showed a significant N400 component regardless the type of DoC (VS/UWS-MCS). None of the E-MCS patients showing a language disorder at the clinical follow-up elicited a N400 ERP component during the neurophysiological screening during DoC in the post-acute rehabilitation phase. Moreover, the presence/absence of the N400-ERP component was consistent with the left-brain lesion side and significantly related to patient’s clinical outcome.

Conclusion: These preliminary findings indicate that the N400 component could be elicited in 64% of DoC patients and its absence was significantly associated with the presence of “covert aphasia” as diagnosed at the clinical long-term follow up. Since Coma Recovery Scale-Revised (CRS-R) still remains the gold standard of behavioral responsiveness assessment of DoC patients, specific advanced neurophysiological examinations, such as N400, should be proposed as paraclinical tests to unveil not only covert cognition but also “covert aphasia”.

A Systematic Review of Training for Communication Partners of People with Traumatic Brain Injury (TBI)

Nicholas Behn¹, Jill Francis¹, Leanne Togher², Ellie Hatch¹, Katerina Hilari¹
¹City, University of London, London, United Kingdom, ²The University of Sydney, Sydney, Australia

Background: Communication impairments are prevalent after traumatic brain injury (TBI) with incidence rates commonly above 75%. Provision of education and training to communication partners is considered a key part of the rehabilitation process for people with TBI. Training can help to improve communication skills and facilitate communicative competence in people with TBI. Objective: To summarise the current evidence on communication partner training and its effectiveness for improving outcomes for people with TBI and/or their communication partners.

Method: A systematic literature search was conducted across nine databases (AMED, CINAHL, EMBASE, Medline/EBSCOHOST, PsycINFO, PsycBITE, PsycARTICLES, PubMed, Scopus) from database inception to August 2018. Studies reported in English articles were included if they described an intervention directed at adult communication partners where the primary focus of the program was on improving the communication skills for adults following TBI. From included studies, data was extracted for author, year of publication, participants, setting, design, intervention, outcome measures and findings. Studies were critically appraised using the Physiotherapy Evidence Database (PEDro) scale, Risk Of Bias in N-of-1 Trials (ROBiNT) or Critical Appraisal Skills Programme (CASP) tools for qualitative studies. Interventions were described in detail using the Template for Intervention Description and Replication (TIDieR) framework.

Results: Eleven articles met eligibility criteria. These articles reported on six studies including: three RCTs, two non-randomised group comparisons and one single-case experimental design. These studies included 340 communication partners and 270 people with TBI. A wide range of outcome measures were used (e.g. conversational rating scales, linguistic analyses). Only two studies used similar outcomes that included blinded ratings of conversation and a questionnaire of perceived communicative ability. All studies reported some positive change in the skills of the person with TBI and/or their communication partner, who included family members, police officers, paid carers and sales assistants. Three (of six) studies reported some maintenance of skills in a period of up to six months from post-treatment to follow-up. The methodological quality of the studies was varied and intervention description poor. Two articles from two studies provided additional qualitative evidence for the effectiveness of communication partner training.

Conclusions: The articles provided some quantitative and qualitative evidence for the effectiveness of training communication partners. However, greater methodological rigour is needed, more clearly described interventions to ensure replication into clinical practice, and more consistent follow-up post-treatment. As a result, further research is warranted in this field.
Adjustment Post-Stroke and Aphasia: Protocol for the SUpporting Well-Being Through PEeR-Befriending (SUPERB Trial)

Katerina Hilari¹, Nicholas Behn¹, Jane Marshall¹, Alan Simpson¹, Shirley Thomas², Chris Flood¹, Sarah Northcott¹, Kimberley Goldsmith³, Sally McVicker¹

¹City, University of London, London, United Kingdom, ²University of Nottingham, Nottingham, United Kingdom, ³King’s College London, London, United Kingdom

Background and Aims: Stroke and aphasia can have a profound impact on people’s lives. There is a need to systematically evaluate interventions that aim to improve psychosocial wellbeing for people with stroke and aphasia, who are often excluded from stroke studies. SUPERB will evaluate the feasibility of a study on the clinical and cost-effectiveness of one-to-one peer befriending for people with aphasia post-stroke and provide the necessary parameters to plan a definitive trial.

Methods: Design: Single blind, mixed methods, parallel group phase II RCT comparing peer-befriending vs. usual care, starting at discharge from hospital. The design has been informed by the MRC framework for complex interventions. The study will deliver on four work packages: development phase; RCT; qualitative study; economic evaluation. Participants (n=60) will be assessed three times up to 10 months post-randomisation

Results: We will assess feasibility of recruitment to a definitive trial (proportion screened who meet criteria; proportion who consent; rate of consent); participant, significant other, peer befriender views on acceptability of procedures (qualitative study); number of missing/incomplete data on outcome measures; attrition rate at follow-up; potential value of conducting main trial using value of information analysis (economic evaluation); description of usual care; intervention fidelity of peer-befriending. Patient-reported outcomes will include mood, confidence, participation, social support, quality of life.

Conclusion: This study will provide evidence for one-to-one peer befriending; and provide the necessary parameters and information to plan a definitive trial. Peer befriending is worth exploring as it has the potential, pending positive outcomes of a definitive trial, to improve service provision for people with stroke and aphasia.
White Matter Changes Following Mild Traumatic Brain Injury Are Associated with Outcome

Mehrbod Mohammadian, Timo Roine, Jussi Hirvonen, Timo Kurki, Olli Tenovuo

1Department of Neurology, University of Turku, Turku, Finland, 2Division of Clinical Neurosciences, Traumatic Brain Injury Centre, Turku University Hospital, Turku, Finland, 3Turku Brain and Mind Center, University of Turku, Turku, Finland, 4Turku PET Centre, Turku University Hospital, Turku, Finland, 5Department of Radiology, University of Turku, Turku, Finland

Objective: To investigate brain white matter changes in patients with mild traumatic brain injury (mTBI) compared to orthopedic trauma controls using diffusion tensor imaging (DTI).

Methods: Eighty-five patients with mTBI (aged 47±20) underwent diffusion-weighted (DW) MRI on average 251 days post-injury. 30 orthopedic trauma controls (aged 50±20) were scanned for comparison. DW-MRI images were acquired in 64 directions, b-value 1000 s.mm-2. Patients were divided into full recovery (GOSE=8) and incomplete recovery (GOSE<8). Images were analyzed using voxel-wise tract based spatial statistics (TBSS) method in FMRIB Software Library (FSL). Fractional anisotropy (FA), mean diffusivity (MD), radial diffusivity (RD) and axial diffusivity (AD) were calculated along the white matter skeleton. Age and Fazekas scale were used as covariates in the statistical analysis using randomise tool in FSL, and 5000 permutations were performed using threshold-free cluster enhancement. Results were corrected for multiple comparisons using family-wise error rate (FWE). Statistically significant (p<0.05) clusters with more than 10 voxels were studied in more detail. JHU DTI-based white matter atlas was used to define studied brain regions.

Results: Fully recovered patients with mTBI did not differ from controls. Patients with mTBI and incomplete recovery showed significant differences in all diffusivity measures in several brain regions compared to controls. Reduced FA (p=0.005 – 0.029) was found in:
- Sagittal stratum,
- Medial lemniscus
- Corona radiata (a+p)
- Cingulum (hippocampus)
- Superior longitudinal fasciculus
- Fornix
- Cerebellar peduncle
- Posterior limb of internal capsule
- Pontine crossing tract
- Cingulate gyrus

Increased MD (p=0.003 – 0.036) was found in the same regions (excluding pontine crossing tract) + uncinate fasciculus and posterior thalamic radiation. RD was increased (p=0.003 – 0.047) also in the same regions + splenium of corpus callosum. Higher AD was found only in left uncinate fasciculus (p=0.043).

Conclusion: After mTBI, white matter changes were observed only in patients with incomplete recovery. These patients had significantly lower FA and higher diffusivity values in several regions compared to orthopedic trauma controls.
EEG-Based Graph Theory Indices as Biomarkers of Disorders of Consciousness

Jlenia Toppi¹,², Angela Riccio², Rita Formisano³, Febo Cincotti¹,², Laura Astolfi¹,², Donatella Mattia²
¹Dept. Computer, Control and Management Engineering, Sapienza University of Rome, Rome, Italy, ²Neuroelectrical Imaging and Brain Computer Interface, Fondazione Santa Lucia, Rome, Italy, ³Post-Coma Unit, Fondazione Santa Lucia, Rome, Italy

Background: The current gold-standard in diagnosis of DOC patients is the JFK Coma Recovery Scale Revised (CRS-R). Relying on behavioral assessment, CRS-R scale, however, may lead to a misdiagnosis up to 40% (in Vegetative State - VS). EEG-based measures have been gaining a growing interest as a tool that may—in perspective—support the diagnosis of different DoCs (Vegetative State - VS or Minimally Consciousness State – MCS) by circumventing the need for behavioral responses. EEG shows invaluable advantages with respect to other neuroimaging techniques since it allows to capture the dynamics of brain connectivity and yet it is viable to handle severely disabled patients even with bedside testing.

Objective: In this study, we applied a graph theoretical approach to extract EEG-based indices describing the properties of resting state networks in DOC [15]. The aim was to provide reliable EEG-based indices that can corroborate clinical diagnosis with high level of accuracy, even in absence of behavioral signs of consciousness.

Methods: We included in the study fifteen patients (50±16 years, 8 males; lesions: 5 left, 5 right, 5 bilateral; etiology: 7 stroke and 8 TBI, 6 VS and 9 MCS), all recruited at the Post-Coma Unit of Fondazione Santa Lucia, Rome, Italy. Patients underwent a session of EEG recorded during 2 minutes of eyes-closed resting condition (19 electrodes, reference on earlobes, fs=250Hz). EEG signals were pre-processed and then used to extract resting brain networks by means of Partial Directed Coherence. Graph theoretical approach was used to extract global and local properties of such networks. Indices were statistically compared between the two groups (VS/UWS vs MCS) and then used as features of a linear classifier (Support Vector Machine) built for discriminating between the two classes. The most significant indices were correlated with the CRS-R scores.

Results: We found a lower functional involvement of the frontal regions and a lower communication efficiency in VS/UWS resting brain networks with respect to those of MCS in delta and theta bands. No differences between the two groups as for the indices of functional interhemispheric communication were found. The use of such indices as features of a classifier allowed to discriminate VS/UWS from MCS conditions with accuracy above 80%. A significant positive correlation (R=0.6, p=0.024) between the index describing the involvement of anterior areas and the CRS-r scores was observed only in the delta band.

Discussion: Our findings, if confirmed in a larger group of DOC patients, indicate how surrogate measures of consciousness disorders based on EEG might allow to improve the accuracy of the gold-standard clinical instruments for diagnosis. This can be achieved with just few minutes of EEG signal recording without requiring any voluntary contribution by the patient.
Assessing Outcome after TBI across Europe – Further Experiences from CENTER-TBI

Nicole von Steinbuechel¹, Anastasia Gorbunova¹, Haghish Ebad Fardzadeh¹, Ewout Steyerberg², Suzanne Polinder³, Lindsay Wilson⁴, Ruben Real¹, Andrew Maas⁵, David Menon⁶

¹Institute of Medical Psychology and Medical Sociology, Goettingen, Germany, ²Leiden University Medical Center LUMC, Leiden, Netherlands, ³Erasmus Medical Center, Rotterdam, Netherlands, ⁴University of Sterling, Stirling, United Kingdom, ⁵University Hospital Antwerp, Edegem, Belgium, ⁶University of Cambridge, Queen’s College, Cambridge, United Kingdom

Background: CENTER-TBI is a large, prospective European study, that includes core observational (N>4500) and registry (N>22000) cohorts. It is designed to improve disease characterization, clinical, neuropsychological, and psychosocial outcome assessment, and care for patients after TBI. For this outcome assessment original instruments are translated into 18 languages, internationally harmonized and psychometrically validated. These results and preliminary analyses on identification of recovery patterns of post-concussion symptoms, neuropsychological and psychosocial outcome, including effects of selected predictors are reported.

Methods: For international language validations classical and modern test theoretical methods are applied to inform about quality of all translations and meaningfulness of data aggregation over all outcomes. For longitudinal analysis of outcome at 3-, 6 and 12 month a mixed modelling approach is used. To predict outcomes at six months post injury linear and (cumulative) mixed logistic regression models are applied.

Results: Many, yet not all of the psychometric characteristics of translated instruments are similar and invariant across languages. The possible impact of any differences on subsequent outcome analyses are put into perspective.

Over two thirds of patients recruited have a baseline GCS of 13 to 15. Most outcomes show significant small improvement between 3 and 6 months with little change thereafter. Uni- and multivariate analyses of predictors (age, gender, GCS pre-injury mental health status) especially indicate a strong negative effect of preinjury mental state on outcomes.

Conclusion: Investigating and facilitating comparability of patients’ responses across translations may enhance the meaningfulness of results of internationally pooled data, and our understanding of the association between TBI and psychosocial outcome will be furthered. Results stress the requirement for additional psychological care to improve patients’ lives after TBI. Future detailed clinical subgroup analyses of our data will differentiate this picture.
Age and Gender Effects on Resting State Networks after Mild Traumatic Brain Injury

Mayra Bittencourt-Villalpando¹, Harm van der Horn¹, Edith Liemburg¹, Natasha Maurits¹, Joukje van der Naalt¹
²Umcg, Groningen, Netherlands

Introduction: Cognitive complaints are common within the first weeks after mild traumatic brain injury (mTBI) and may persist for months to years in a subgroup (~20%). Age-related cognitive decline can worsen these symptoms. However, effects of age on mTBI sequela have scarcely been investigated.

Methods: Fifty-four patients (mean age: 37 years, range 19-64 years, 67% male) and twenty healthy controls (HCs) (mean age: 36 years, range: 18-61 years, 70% male), group-matched for age and gender were included. Functional magnetic resonance imaging (fMRI) was performed during 10 minutes rest. Independent component analysis (ICA) was used to identify resting state networks (RSNs). A multivariate approach was executed to evaluate the effects of age and gender on the RSNs in terms of the three main outcome measures: a) spatial map intensity, b) time-course spectral power, and c) functional network connectivity.

Results: Age-related effects were identified for all three measures, indicating a) significant intensity decreases for increasing age in the default mode network (DMN), b) significant power spectral decrease within the 0-0.15 Hz range for increasing age in the DMN, frontoparietal network (FPN) and dorsal attention network (DAN), which is consistent with previous studies on healthy participants, and c) significant power spectral increase within the 0.15-0.25 Hz range for increasing age in the DMN, FPN and DAN. Additionally, a significant connectivity increase between the orbitofrontal and language networks was found for increasing age. Gender effects of smaller magnitude were found on spatial maps, with greater intensity found for males in the posterior part of the DMN, specifically within the cuneus. The significance threshold was set at $p<0.05$, with correction for multiple comparisons.

Conclusions: This study on mTBI patients and healthy controls showed age- and gender-related effects on brain networks that have previously been suggested to be involved in cognitive functioning. How these effects are related to patients’ cognitive functioning in comparison to the healthy control group is still not clear and requires further investigation.
Rehabilitation Interventions After Traumatic Brain Injury: A Scoping Review

Unni Sveen¹,², Rikke Guldager³,⁴, Helene Lundgaard Søberg¹,², Tone Alm Andreassen⁵, Ingrid Egerod⁶, Ingrid Poulsen³,⁷

¹Department of Physical Medicine and Rehabilitation, Oslo University Hospital, Oslo, Norway, ²Faculty of Health Sciences, Oslo Metropolitan University, Oslo, Norway, ³Department of Neurorehabilitation, Traumatic Brain Injury Unit, Copenhagen University Hospital, Rigshospitalet, Copenhagen, Denmark, ⁴Department of Learning and Philosophy, Aalborg University, Aalborg, Denmark, ⁵Centre for the Study of Professions, Oslo Metropolitan University, Oslo, Norway, ⁶Intensive Care Unit, University of Copenhagen, Rigshospitalet, Copenhagen, Denmark, ⁷Section of Nursing Science, Health, Aarhus University, Aarhus, Denmark

Objective: The objective of the scoping review was to 1) identify interventions in traumatic brain injury (TBI) rehabilitation, 2) describe knowledge gaps, and 3) uncover further needs for TBI rehabilitation intervention research for patients and families.

Methods: We searched five databases from January 2006 to April 2017 and screened 1281 articles after removing duplicates. Titles and abstracts were screened for relevance, yielding 572 articles for full-text review. Of these, 353 were included as relevant to the goals of the scoping review. The methodological framework of Arksey and O'Malley guided the process (1). During the process of synthesizing the research literature, a user panel was invited to discuss the results of the scoping review and identify potential knowledge gaps.

Results: Articles meeting the scope of the review in developing and/or evaluating TBI rehabilitation interventions increased from 15 articles in 2006 to 54 in 2016. Most studies were on moderate and severe TBI (47.3%), or mixed severity groups (28.6%), whereas only 10.7% included mild TBI.

Few studies described rehabilitation interventions in acute TBI (5.8%), i.e. up to 6 weeks post injury. Hospital was the rehabilitation setting in 47.6% of the articles, while 38.9% studied rehabilitation interventions in primary health care. Studies including the family/carers as target group for the intervention were 35 (11.3%). Leisure and sports interventions amounted to only 12 (3.8%).

Among 59 studies on return-to-work, 24 (40.7%) had an additional focus on cognition and 17 (28.8%) on emotions. Five of the return-to-work studies had an additional focus on the family (8.5%), eight on the network (13.6%), and 23 on ADLs (30%). Return-to-work intervention studies performed in the context of school or workplace, was limited to 14 (5%).

Knowledge gaps identified during the user panel’s discussions were further needs for interventions to improve the quality of rehabilitation services, including inter-disciplinary care and long-term care. Additionally, the importance of designing holistic services addressing the injured person’s individual needs was stressed, as well as well-functioning transitions between levels and sectors. The users emphasized the need for interventions supporting return-to-work after injury and including spouses and families in TBI research. More knowledge on how to support the individual in coming to terms with a transformed life was addresses.

Conclusion: We identified a growing number of studies addressing TBI rehabilitation interventions. However, there were gaps particularly regarding return-to-work interventions in a natural setting/context,
as well as interventions including the family and targeting leisure activities. The findings are alarming, as the typical TBI cases are people of working age. High quality research is needed on return-to-work interventions, as well as interventions contributing to a fulfilling life after injury, in a long-term perspective.

Improving Upper Limb Function after Chronic TBI through a Home-based Self-initiated Therapy

Peili Chen1,4, Irene Ward2,4, Grace Kim3, Gretchen March2, Parichat Pintong1, Nikita Janodia1, Viktorya Landar2
1Kessler Foundation, West Orange, United States, 2Kessler Institute for Rehabilitation, West Orange, United States, 3New York University, New York, United States, 4Rutgers University, Newark, United States

Background and objective: Upper limb dysfunction can persist years after traumatic brain injury (TBI) and take a toll on quality of life. This study examines the home-based arm and hand exercise (HAHE) protocol. The protocol integrates four key elements, including person-centered outcome measures, high-dosage task-specific visuomotor training, individualized activities, and a reminder system.

Participants: Four individuals (one female) participated. They were 36-61 years of age, and time post injury ranged from 2.6 to 14.1 years. Level of impairment of the affected arm was at Brunstrom Stage 3 or 4. All were right-hand dominant prior to injury. None received botulinum toxin injection treatment for spasticity within the past three months before study participation. They were assessed at baseline (T0), after therapy (T1) and one month after therapy (T2) with primary outcome measures including Box and Blocks Test (BBT), Wolf Motor Function Test (WMFT), and personal goals based on the WMFT.

Methods: The intervention started with therapist-guided daily sessions for a week. The therapist selected activities from a pre-determined catalog that best matched the participant’s functional level. The objective was to prepare the patient to perform at least six activities by themselves in a home-based session. In the last therapist-guided session, the patient was provided with customized activities, a daily log, a motion detector, and materials necessary to carry out the activities at home. Participants were instructed to start the home-based therapy the next day and complete two one-hour sessions daily for 14 consecutive days. During each home-based session, participants were instructed to wear a motion detector on their affected wrist. The detector made a sharp, loud noise if no motion was detected for two minutes. The patient received phone calls and text messages every other day as additional reminders.

Results: Participants 2 and 4 completed the HAHE protocol, responded to all the reminders, documented activities in the daily log, completed two one-hour sessions every day, and wore the motion detector during each session. Participants 2 and 4 achieved improvement in WMFT and personal goals. Participant 2 improved in grip strength while participant 4 improved on BBT scores. Participant 1 did not complete any home-based session, or assessments at T1 and T2. Participant 3 did not use the daily log and was not responsive to reminders but did complete assessments at T1 and T2. Participant 3 experienced minimal improvement in grip strength.

Discussion: This case series study demonstrated a great potential of the HAHE protocol in improving upper limb function in persons with chronic TBI. The study results suggest that greater degree of adherence to the HAHE protocol was associated with greater improvement. Integrating effective strategies encouraging therapy adherence may be critical to implementation of home-based self-initiated therapy.
Depressive Symptoms and Cognitive Sequelae Registered Within A Year After Moderate to Severe Traumatic Brain Injury Among Adolescents and Young Adults

Trine Ryttersgaard1,4, Jens Østergaard Riis2, Søren Paaske Johnsen3,4, Poul Henning Mogensen1, Carsten Reidies Bjarkam2,4
1Department of Neurology, Aalborg University Hospital, Aalborg, Denmark, 2Department of Neurosurgery, Aalborg University Hospital, Aalborg, Denmark, 3Danish Center for Clinical Health Services Research, Aalborg University Hospital, Aalborg, Denmark, 4Institute of Clinical Medicine, Aalborg University, Aalborg, Denmark

Background: Only few studies have focused on depression after TBI among adolescents and young adults, even though they seem to be especially vulnerable undergoing psychological and social distress associated with the transition from parent-supported infanthood to independent adult life.

Aim: To determine the proportion of depressive disorder and cognitive sequelae among young (age 15-30 years) Danish survivors of moderate to severe TBI, less than a year after diagnosis. Furthermore, the aim is to examine whether an association between depression and cognitive sequelae exits in the generated cohort.

Method: ‘Danish register for young adults with acquired brain injury’ (Danish acronym DRUE) contains data about all young Danes (age 15-30 years) with an acquired brain injury referred to a regional outpatient clinic in the period August 2013–August 2017. All subjects underwent interdisciplinary examination containing neuropsychological tests and subjective screening for depression, including Major Depression Inventory (MDI), Trail Making A and B, Fluency, 10-words list with selective reminding and parts of Wechslers Adult Intelligence Scale version 4.

Exact hypothesis test for binomial random variables was used to calculate whether the sample differentiate from the expected proportion of subjects performing below 1.5SD from the mean. Fisher’s exact test and Chi2-test were used to examine the relationship between depression and cognitive sequelae and the relationship between psychological distress and cognitive sequelae.

Results: During the study period 188 patients with a moderate to severe TBI were referred within a year after their injury. Of these 65 were excluded from further analysis due to non-attendance (n=15) and incomplete data (n=50). No significant difference on age and gender was found between included and excluded subjects. Among the 123 included subjects, 12.2% (95%CI: 7.0-19.3) fulfilled the ICD-10 criteria for depression. Additionally, 16.3% (95%CI: 10.2-23.9) reported clinically significant depressive symptoms. Impaired cognition, defined as a performance 1.5SD below the Danish population norm-based mean on minimum three neuropsychological tests was noted among 23.6% (95% CI: 16.4-32.1). This was significantly higher (p<0.0001) than the known background age-group prevalence of 6.7%. No significant relationship between depression and cognitive sequelae (p=0.343) or between psychological distress and cognitive sequelae (p=0.436) was demonstrated.

Conclusion: Nearly one third of all Danish survivors of moderate to severe TBI display within a year a diagnosis of depression or significant depressive symptoms, while nearly quarter display cognitive impairment. Although the two conditions seem to be unrelated their high individual preponderance necessitate the need for increased neuropsychological surveillance and rehabilitation measures after moderate to severe TBI among adolescents and young adults.
Global Trends in Acquired Brain Injury Randomized Controlled Trials: An Update

Pavlina Faltynek¹,², Brooke Benton¹,², Tristan Duffy¹,²,³, Shannon Janzen¹,², Magdalena Mirkowski¹,², Robert Teasell¹,²,³
¹Lawson Health Research Institute, London, Canada, ²St. Joseph’s Health Care, London, Canada, ³University of Western Ontario, London, Canada

Objectives: To compare published randomized controlled trials (RCTs) within the acquired brain injury (ABI) acute and rehabilitation research literature by world economic region with respect to their number, sample size, and methodological quality.

Data Sources: A literature search was conducted using PubMed, PsycINFO, CINAHL, and EMBASE for RCTs evaluating any intervention for ABI, published in English up to December 2017.

Study Selection: Studies were included if (1) participants had a moderate or severe ABI and comprised more than 50% of the study population, (2) there were three or more participants in the study sample, and (3) the study was published in English.

Data Extraction: For each RCT, data on the author, country of investigation, journal, sample size, year of publication, and methodological quality were extracted. Quality was assessed using the Physiotherapy Evidence Database (PEDro) tool.

Data Synthesis: A total of 363 studies were published between 1978 and 2017 which met our inclusion criteria. North America accounted for more than half of all RCT publications (N=188), while Sub-Saharan Africa accounted for the least (N=1). Over each half decade the overall number of published RCTs steadily increased, primarily driven by three economic regions; North America, East Asia and Pacific, and Europe and Central Asia. While mean sample sizes showed no major trends over time, all regions showed an increase in mean PEDro scores over time.

Conclusions: Despite the globalization of ABI research, the publication of RCTs varies largely between world groups, with North America being the most predominant region. RCT quality may be improving over time with respect to PEDro scores, however there is still a shortage of large multi-centered trials internationally. North America, compared to other major contributing regions of publications, began publishing RCTs sooner and with better quality. In contrast, other regions with a high number of publications have done so with lower mean PEDro scores. Given the limited number of RCTs in ABI compared to other neurological conditions, such as stroke, continuing efforts should focus on improving both the quality and quantity of research.
Quality of Life Following Traumatic Brain Injury: CROCFLAME
Decompressive Craniectomy and Neurorehabilitation Are Relevant for Good Outcome

Katrin Rauen1,2,3, Lara Reichelt2,3, Philipp Probst4, Barbara Schäpers3, Friedemann Müller3, Klaus Jahn3,5, Nikolaus Plesnila2,6
1Institute for Regenerative Medicine, University of Zurich, Zurich, Switzerland, 2Institute for Stroke and Dementia Research, University of Munich Medical Center, Munich, Germany, 3Schoen Clinic Bad Aibling, Bad Aibling, Germany, 4Institute for Medical Informatics, Biometry and Epidemiology (IBE), Munich, Germany, 5German Center for Vertigo and Balance Disorders, University of Munich Medical Center, Germany, 6Munich Cluster for Systems Neurology (Synergy), Germany

Introduction: Traumatic brain injury (TBI) results in heterogeneous long-term sequelae and approximately one-third of TBI patients present with ongoing functional and/or cognitive decline, suggesting a chronic and progressive pathophysiology. In contrast to stroke, decompressive craniectomy (DC) is not the first-line recommendation after TBI although very little is known about its long-term effects. Thus, we assessed health-related quality of life (HRQoL) to elucidate predicting factors for good long-term outcome in chronic TBI patients.

Methods: In this cross-sectional study, a representative sample of 135 out of 439 patients reported HRQoL up to 10 years after mild, moderate or severe TBI using the QOLIBRI questionnaire (Quality of Life after Brain Injury) with a total score of 0-100 representing lowest and best HRQoL, respectively. HRQoL was quantified (%; mean ± SD) and correlated to TBI severity, etiology, age at TBI, age at survey, sex, DC, ICP monitoring, tracheostomy, time to onset and duration of neurorehabilitation, and functional status (mobile/immobile: mRS 0-3/mRS 4-5) at admission/discharge (%) using multiple linear regression via backward selection. Numerical and categorical variables were analyzed using Wilcoxon-Mann-Whitney and Fisher test, respectively.

Results: TBI severity is not a strong predictor for HRQoL (p=0.04; adj. R²=0.02). 64% reported good HRQoL with a mean QOLIBRI total score of 65.5 ± 22.57 (± SD). 36% reported poor HRQoL (QOLIBRI total score <60) with an increased risk for one (20%) or two (16%) psychiatric comorbidities. 30% of TBI patients (n=41) underwent DC. 59% of non-craniectomized (DC-) and 76% of craniectomized patients (DC+) reported good HRQoL with a median QOLIBRI total score of 65 in DC- and 76 in DC+ patients (p=0.049). The most beneficial effect was observed in initially mild classified TBI patients with a QOLIBRI total score of 54 (DC-) and 84 (DC+) (p=0.001; adj. R²=0.45), during the first year after TBI with a score of 50 (DC-) and 76 (DC+) (p=0.13), and in the 61-85-year-olds with a score of 62 (DC-) and 79 (DC+), respectively (p=0.02). Risk for one or even two psychiatric comorbidities differed between DC- and DC+ groups: 22% (DC-) versus 15% (DC+) and 18% (DC-) versus 9% (DC+), respectively. Shorter neurorehabilitation correlated positive with a better HRQoL (p=0.001; r=0.037). Neurorehabilitation improved functional outcome (immobile at admission/discharge: 81%/33%; mobile at admission/discharge: 19%/67%).

Conclusion: TBI severity is not a strong predictor for HRQoL up to 10 years following TBI. DC and shorter duration of neurorehabilitation are associated with better HRQoL. DC particularly improves HRQoL in patients being prone to secondary brain injury. More than one-third of patients reported insufficient HRQoL. Thus, our data underline the relevance of DC for good long-term outcome following TBI and the need for an early psychiatric approach to improve HRQoL in chronic TBI patients.
Language Comprehension after Mild Traumatic Brain Injury: The Role of Speed

Rocio Norman\(^1\), Manish Shah\(^2\), Lyn Turkstra\(^1\)
\(^1\)University of Wisconsin-Madison, Department of Communication Sciences and Disorders, Madison, United States,
\(^2\)University of Wisconsin-Madison, Department of Emergency Medicine, Madison, United States

Background: Research has shown that adults with mild traumatic brain injury (mTBI) report language comprehension problems. However, published studies have generally used inadequate measures. The current study aimed to characterize language comprehension after mTBI. We hypothesized that language problems after mTBI are consistent with reduced speed of information processing, resulting from the inability to allocate attentional resources. We predicted that adults with mTBI would perform worse than a group of adults with orthopedic injuries (OI) on an experimental task requiring comprehension of syntactically complex sentences under strict temporal response windows.

Method: The study employed a prospective experimental design. Participants were adults with mTBI (n=19) and orthopedic injury (OI) (n=19) between 18-55 years. Participants had presented to an emergency department at a large academic medical center and had been diagnosed with mTBI or OI by a medical provider. After initial evaluation and care, participants were discharged to home and they participated in the study 3-12 weeks after their injuries. The primary measure was the Whatdunit task, an experimental sentence completion task administered in speeded and unspeeded conditions. The Whatdunit is a sentence agent selection task, validated for use with individuals with resource capacity and allocation difficulties.

Results: Participants with mTBI tended to take longer than OI participants to interpret the sentences in the speeded condition (M=468 ms, SD=403 ms vs M=459.04 ms, SD=428 ms) and in the unspeeded condition (M=1140.04 ms, SD=1230.80 vs M=834.35, SD=914) but this finding was not statistically significant. In the speeded condition, the TBI group performed with lower accuracy (M=79.80, SD=20.60) than the OI group (M=83.55, SD=16.17), however this difference did not reach statistical significance F (1,36) =.391, p=.268. In the unspeeded condition, the mTBI group had a higher mean accuracy (M=89.46, SD=11.93) than the OI group (M=82.49, SD=19.15) and this was marginally significant (p=.09). There was a marginally significant interaction of sentence type by group for interpretation time in the speeded condition Lambda= .833 F (1,36) =2.14, p=.08, \( \eta^2 = 17 \).

Conclusions: Our findings demonstrate that syntactic complexity performance within strict temporal response windows can be a potential method for further study of language comprehension. The evidence of high accuracy levels for participants with mTBI with longer processing times in the unspeeded condition hints at the possible use of self-generated compensatory strategy-use after mTBI.

This study expands the current knowledge regarding language comprehension after mTBI by viewing it within the experience of general trauma. The overall similarities in performance between both groups have clinical implications. Further research in this area is needed to determine whether language changes are likely to surface as a result of experiencing trauma, regardless of etiology.
The Development of a Prognostic Model for Health-Related Quality of Life in Patients with Traumatic Brain Injury

Isabel Retel Helmrich, Simone Dijkland, Maryse Cnossen, Suzanne Polinder, Benjamin Gravesteijn, Daan Nieboer, Nicole von Steinbuechel, Ruben Real, Lindsay Wilson, Andrew Maas, Ewout Steyerberg, Hester Lingsma

Background: Traumatic brain injury (TBI) is a leading cause of long-term impairments and disabilities in functional, physical, emotional, cognitive, and social domains. To capture the patient’s subjective experience of their problems there is growing interest in health-related quality of life (HRQoL) as an outcome in TBI research. Although high-quality and well-validated prognostic models exist to predict functional outcome after TBI, a prognostic model for HRQoL in TBI has not been developed yet.

Objective: The aim of the study was therefore to develop a prognostic model for HRQoL after TBI.

Methods: We used data from Collaborative European NeuroTrauma Effectiveness Research in Traumatic Brain Injury (CENTER-TBI), a multicenter, longitudinal, observational study. Data was collected from patients with a clinical diagnosis for TBI and an indication for computed tomography (CT) presenting within 24 hours of injury between November 2014 and January 2015 in participating centers in 22 countries across Europe and Israel. The primary outcome measure was the QoLIBRI at 3, 6- and 12-months post-injury. We considered 9 patient and injury characteristics as candidate predictors. Mixed linear effect analysis (with random intercepts for patient number) were conducted. Backward stepwise selection with a p-value of <0.20 was used to select variables for inclusion in the multivariable model. To quantify the predictor effects coefficients (betas) were reported with a 95 percent confidence interval (CI).

Results: In total, 2319 adult patients were included. Patients had a median age of 51 (IQR = 33-64). More than half (64.5%) of patients were male, and most (76.1%) were diagnosed with mild TBI. Multivariable analysis showed that the strongest predictors of lower HRQoL after TBI were having a history of mental health problems (beta = 8.58, 95% CI = 6.27-10.89), major extracranial injury (beta = 3.63, 95% CI = 2.24-5.02), comorbidities (beta = 1.43, 95% CI = -0.28-3.14) and having a history of substance abuse (beta = 1.32, 95% CI = 0.16-2.48). Other predictors included in the multivariable model were sex, living situation, and employment.

Conclusion: To our knowledge, this is the first study describing the development of a prognostic model for HRQoL after TBI. Whereas predictors for functional outcome after TBI are mainly medical and injury related characteristics, our results suggest that psychosocial variables are of substantial importance for the prediction of lower HRQoL after TBI. Validation of the proposed prognostic model is required to evaluate its ability to support clinical decision-making in TBI.

Keywords: Prognostic modeling, Traumatic Brain Injury, Health Related Quality of Life, QoLIBRI.
Audiologists: A Vital Team Member for Clients with Traumatic Brain Injury

Gregory Noel1,2
1Dalhousie University School of Communication Sciences and Disorders, Halifax, Canada, 2Nova Scotia Hearing and Speech Centres, Halifax, Canada

Research has demonstrated that concussion and mild traumatic brain injury has been shown to result in central hearing disorders. A large majority of these clients have normal hearing sensitivity but demonstrate a variety of auditory complaints. Such functional difficulties include hearing in noise or reverberant conditions, sound sensitivities, localization of sounds, difficulty on the phone or when the speakers face is not seen, decreased music appreciation, difficulty following group conversation and/or auditory fatigue. While complex, such processes are thought to be processed by the classical and non-classical central auditory system. The classical central auditory system includes the cochlear nucleus, superior olivary complex, lateral lemniscus, inferior colliculus, medial geniculate, subcortical and cortical structures in the temporal lobe along with connections to the corpus callosum as well as the auditory efferent system. The non-classical auditory system is connected to other brain centres, such as the amygdala, hippocampus and reticular activation system, among others, which help integrate our auditory system into our human connectedness. It stands to reason that trauma that can impact the brain and affect other sensory and cognitive mechanisms can therefore impact the function of the central auditory nervous system. While diagnostic imaging provides a structural view of the brain and can often be normal in such cases, audiological measures provide functional information that can shape a communication profile for the individual. The Canadian guidelines on auditory processing disorders establish the protocol that audiologists can follow in assessing and managing clients with auditory processing disorders. Using behavioural and electrophysiological procedures, it is possible to document auditory processing deficits as a result of head trauma and provide rehabilitative measures and monitor outcomes. While vestibular issues have been well documented as a result of head trauma, concussion guidelines neglect to focus on the communication deficits from auditory processing disorders caused by head trauma. If such communication issues are not investigated and addressed, social isolation and reduced adherence to other rehabilitation plans may result. The audiologist working with other team members can assist with rehabilitative measures, which may include auditory training, environmental and compensatory strategies that may support the individual to re-enter the work force or attempt to improve often impaired communicative efforts. Illustrative cases will be used to highlight the audiologist’s role in working with clients suffering from auditory deficits related to head trauma.
Uncomplicated Versus Complicated Mild Traumatic Brain Injury: Is there a Difference in Cognitive and Occupational Functioning?

Angela Sekely1, Avi Orner2, Karen Seward, Konstantine Zakzanis1

1University of Toronto Scarborough, Toronto, Canada, 2Scarborough Health Network, Scarborough, Canada

The goal of the current study is to articulate differences in cognitive and occupational functioning in patients who sustained a mild traumatic brain injury (mTBI) with (i.e., complicated mTBI) and without (i.e., uncomplicated mTBI) positive neuroimaging findings in the post-acute stage of recovery. It was hypothesized that intracranial injury as evinced on neuroimaging (i.e., complicated mTBI group), would perform more poorly than the uncomplicated mTBI group, across select cognitive domains and in terms of occupational functioning.

Archival data from a random sample of individuals were obtained from a larger sample of litigating patients who were referred for neuropsychological examination secondary to mTBI. Participants were included if they had completed the Neuropsychological Assessment Battery Screening Module, and if their neuropsychological test performance was deemed to be credible as evidenced by validity measures. All participants met criteria for mTBI according to the World Health Organization standards (i.e., shared the same acute injury characteristics except for the presence or absence of intracranial injury.) The final sample consisted of 99 individuals (39 complicated and 60 uncomplicated mTBI). Participants were assessed approximately 32 months’ (SD=14) post-injury.

No significant differences were found between groups on attention (U=1033, p=.326, d=.34), executive function (U=810.5, p=.077, d=.46), language (U=1143, p=.846, d=.17), memory (U=1027, p=.831, d=.03), or visuospatial (U=902, p=.055, d=.22) domains. No significant differences were found between groups in terms of return to work status ($\chi^2$(2)=1.023, p=.600).

Our findings indicate no differences in cognitive or occupational functioning between those who have sustained an uncomplicated and complicated mTBI in the post-acute period.
The Effectiveness of Pharmacological and Non-pharmacological Interventions for Depression in Patients with Moderate to Severe Traumatic Brain Injury: Systematic Review and Meta-analysis

Lianne Peppel1,2, Gerard Ribbers1,2, Majanka Heijenbrok-Kal1,2
1Rijndam Rehabilitation, Rotterdam, Netherlands, 2Erasmus Medical Center, Rotterdam, Netherlands

Traumatic brain injury (TBI) often leads to depression and/or depressive symptoms, which is a major cause of disability and the most common psychiatric disease after TBI. During rehabilitation for TBI, several therapies are offered for the treatment of depression, such as cognitive-behavioural therapy (CBT), telephone interventions and Sertraline use. Treatments can be divided in either pharmacological or non-pharmacological. Until today no meta-analysis has been published in which both kind of treatments are directly compared.

Objective: to systematically review the literature on the effectiveness of pharmacological and non-pharmacological interventions for depression in patients with moderate to severe TBI.

Data collection: Databases searched were: Embase, Medline Epub, PsycInfo, Cochrane Central, Web of Science, Google Scholar. Randomized controlled trials (RCTs) addressing subacute and long-term interventions for depression or depressive symptoms were included. The target population included patients with moderate to severe TBI of at least 16 years old at time of injury. The primary outcome was depression score on a self-report questionnaire measured at baseline and follow-up. Studies in which all respondents had post-traumatic stress disorder and studies with less than ten participants or less than five per group were excluded. Outcomes were collected at baseline and at the first follow-up moment. Data extraction was executed independently by two researchers.

Design: Systematic review and meta-analysis of randomized controlled trials (RCTs).

Results: Eleven studies were identified; two pharmacological and nine non-pharmacological. Treatments investigated were sertraline, methylphenidate, CBT, two physical interventions, a telephone intervention, two counselling programs and an EEG based therapy. Although not all individual studies had significant results, the overall effect size (ES) was -.39, p=.002, indicating that interventions lowered the depressive symptoms/depression scores in patients with TBI. The effect was stronger for pharmacological interventions compared with non-pharmacological interventions (ES respectively: -.76, P = .001 and -.31, P = .036).

Conclusion: Although RCTs targeting interventions for depression after TBI are scarce, pharmacological and non-pharmacological interventions seemed to be effective in treating depressive symptoms/depression after TBI. There is a need for large studies in which the add-on effects of pharmacological and non-pharmacological interventions are investigated.
Brain Gain: An Exploration of the Utility of Technology-Infused Cognitive Intervention for Kids with Brain Injuries

Sara Stevens¹,², Lisa Kakonge¹, Elaine Widgett¹, Elaine Biddiss¹,²
¹Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, ²Bloorview Research Institute, Toronto, Canada

The Brain Injury Rehabilitation Team (BIRT) at Holland Bloorview Kids Rehabilitation Hospital provides rehabilitation therapy to children and adolescents who have sustained a brain injury of varying etiologies, including traumatic injuries, strokes, and tumours. For more than 25 years, cognitive group therapies have been provided to clients as part of their rehabilitation; through a senior cognitive group for adolescents between the ages of 13 to 18 years and a junior cognitive group for younger children ages 7 to 12 years. These groups are facilitated by an interdisciplinary team of clinicians including Occupational Therapists, Speech-Language Pathologists, and Psychologists. The cognitive group setting allows for simulated practice of various therapy goals, including divided attention, memory, and social communication within a peer-group environment.

The BIRT cognitive groups have traditionally included activities such as playing games to support cognitive strategies, and a number of paper and pencil activities. Research has shown that today’s youth thrive in technology-supported learning environments and that technology can be used to facilitate collaborative learning and better mirror real-life interactions. In 2015, the Brain Gain project was initiated to infuse technology and ‘gamified’ approaches within the BIRT cognitive groups at Holland Bloorview. This was a clinician driven initiative and collaboration with the Possibility Engineering and Research Lab (PEARL) team, to ensure evidence-based cognitive therapy opportunities are provided to children and adolescents with brain injuries. The specific focus of Brain Gain has been a quality-improvement initiative to build and incorporate technology and apps that complement educational curriculum; create hands-on ‘gamified’ activities; develop a web-based platform to present the cognitive curriculum; and to standardize the education delivery.

The goals of this presentation are to share knowledge on the development of Brain Gain and the outcomes of the quality improvement initiative using the Plan-Study-Do-Act cycle. An overview of the cognitive education curriculum will also be provided, through the web-based platform and apps. In addition, the Brain Gain team has undertaken the process of designing focus groups to review the client and family experience with the web-based platform used in junior cognitive group. This will ensure a better understanding of the needs of clients and family members as they transition home, and to update resources to assist the continued cognitive needs of clients within their communities.
Girls, Women, and the Injured Brain: New Information, New Interventions

Eden Dales

Eden Dales Social Work and Counselling Services, Toronto, Canada

This presentation reveals that there are key differences which health care professionals need to consider when assessing and developing a treatment plan specific to females following concussion and traumatic brain injury (TBI).

The participants of this presentation will gain a deeper understanding of women’s health and functioning, both from a psycho-social and functional perspective, as well as the post-concussion and TBI recovery process for females and how it is different than recovery for males. Detailed assessment and therapeutic strategies, as well as key differences in treatment protocols unique to females will be offered, from both a functional and psycho-emotional perspective.

This presentation will explore the unique needs of females, both non-concussed and concussed, which should be considered and prioritized following head injury.

There will be a specific focus on treatment modalities, both related to social work and occupational therapy management of females following concussion and TBI, and a detailed review of areas which are unique to females will be explored. Resources for support and education, available locally and internationally, specific to females and TBI will be provided in detail. The presenters will review the current literature published, demonstrating evidence to support differences in how females experience head injuries, and recover differently from males.

Also, a review of the challenges faced by females (both concussed and non-concussed) will be provided, categorized over the life span, while focusing specifically on developmental stages. We will review risk factors faced by females, which contribute to delayed and complex recovery from TBI.

Details related to the overall health and functioning for females following head injury will be explored. This evidence-based research will be reviewed from the perspective, and supplemented by the clinical experience, of clinicians with a combined 20 years of experience in social work and occupational therapy.

The topics include (but not limited to) the following:

- Hormonal changes in females specific to TBI
- Complexities related to puberty, pregnancy and menopause
- Risk factors for repeated concussions, multiple concussions, and complex recovery from TBI for females
- Challenges in life roles (e.g., vocational, parenting, inter-personal relationships)
- Complications post TBI in physical, cognitive, psycho-emotional and social functioning
- Evidence supporting concussion and TBI outcomes based on timing of injury relative to menstrual cycle

Results: Health professionals treating women following concussion must take into consideration unique aspects of women’s health and gain a deep understanding of the vast differences in how females recover differently from males, post TBI, in all areas of functioning and across the life span, focusing on each developmental life stage. Through awareness and education for providers about current research and evidence supporting the differences in how females recover from TBI, treatment of females following TBI can change immediately.
Combined Effects of Transcranial Direct Current Stimulation and Virtual Reality Promotes Clinically Meaningful Improvements on Severely Impaired Upper Limb Function in Individuals with Chronic Stroke

María Antonia Fuentes2, Adrián Borrego1, Mariano Alcañiz1, Regina Ciscar2, Raúl López2, Carolina Colomer2, Enrique Noé2, Joan Ferri2, Roberto Llorens1,2

1Universitat Politècnica De València, Valencia, España, 2NeuroRHB - Servicio de Neurorrehabilitación de Hospitales Vithas, Valencia, Spain

Introduction: Functional recovery of arm hemiparesis after a stroke is a major challenge for rehabilitation programs per se. Inherent complications of this process are exacerbated when voluntary movements are not possible, as active task-oriented movements are necessary to promote neural reorganization that support functional improvement. Conventional approaches focus on mobilizing those segments where movement is not preserved and assist movements where certain degree of activity persist. A few alternatives exist that aim to elicit cortical representations of arm movements, for instance, by mentally imaging arm movements (motor imagery) or by tricking the brain using mirrored movements of the contralateral arm (mirror therapy) or projected computer-generated virtual arms (virtual reality), with promising but non-conclusive results. Interestingly, cortical excitability can be modulated administering non-invasive low-intensity currents on the scalp.

The aim of this study is to determine the effectiveness of an experimental intervention combining a virtual reality-based arm reaching task with concurrent transcranial direct current stimulation (tDCS) and conventional physical therapy, in comparison to conventional physical therapy alone.

Materials and Methods: Thirty chronic post-stroke individuals with severe hemiparesis were randomly assigned either to an experimental or a control group. All the participants underwent 24 one-hour sessions, administered 3 to 5 times a week. Participants in the experimental group combined 20 minutes of the experimental intervention, which consisted of a virtual apple-picking task triggered by gaze fixation and muscular contraction while receiving tDCS (Anode: C3/C4; Cathode: Fp2/Fp1; I=2 mA), with 40 minutes of conventional physical therapy. Participants in the control group completed 60 minutes of conventional physical therapy. Participants were assessed before and after the intervention with the Upper Extremity subscale of the Fugl-Meyer Motor Assessment and the Wolf-Motor Function Test.

Results: Participants in the experimental group evidenced greater improvements not only in the Fugl-Meyer Motor Assessment (5.1±3.9), but also in the time (-105.9±139.3 s) and ability subscales (2.2±2.6) of the Wolf-Motor Function Test. Participants in the control group, in contrast, presented limited or no improvement in the three scales (0.2±1.0, -22.6±43.1 s, 0.7±0.9, respectively).

Conclusions: Improvements after an experimental intervention combining tDCS and virtual reality significantly exceeded those provided by conventional physical therapy, and, more importantly, overtook the minimally clinically importance threshold in global arm function, speed and ability, in spite of the chronicity of the participants and the severity of the hemiparesis. These results evidence the effectiveness of the intervention and support its use as a feasible alternative to the scant existing therapeutic options available to these subjects, which have proved limited effects and may require high attentional and cognitive demands.
Acknowledgements: This study was funded by Ministerio de Economía y Competitividad of Spain (Project REACT, TIN2014-61975-EXP, and Grant BES-2014-068218) and by Universitat Politècnica de València (Grant PAID-10-14 and PAID-10-16).
An Assessment and Rehabilitation Model for Post-concussion Syndrome (PCS) in Adults

Lisa Powell\textsuperscript{2,3,4}, Heather Batey\textsuperscript{1}
\textsuperscript{1}Reach Personal Injury Services, Ripon, United Kingdom, \textsuperscript{2}Royal College of Occupational Therapists, United Kingdom, \textsuperscript{3}British Association of Occupational Therapists, United Kingdom, \textsuperscript{4}Health and Care Professionals Council, United Kingdom

Introduction: Definition of PCS — “A syndrome that occurs following head trauma (usually sufficiently severe to result in loss of consciousness) and includes a number of disparate symptoms such as headache, fatigue, irritability, difficulty in concentrating and performing mental tasks, impairment of memory, insomnia, and reduced tolerance to stress, emotional excitement, or alcohol” (WHO, 2010).

Diagnosis of PCS is symptom-based, as conventional neuro-imaging techniques do not always show evidence of injury. Symptoms are often longer term resulting in loss of relationship and loss of employment.

For 5 years |reach| (our company) have been carrying out assessments and short targeted home-based rehabilitation programs for adults identified as most likely to be suffering from PCS and gaining excellent results.

Assessment Process: Our unique assessment is evidence-based and carried out by a Neuro-occupational therapist. It comprises of a semi-structured interview, observations and a range of standardised assessment tools which are selected for their relevance to the client and their situation.

The interview and observations are used to establish current situation and abilities, and any changes post-injury in the following areas:
- Self-maintenance
- Daily routines
- Cognitive status
- Physical / sensory
- Sleep and fatigue
- Behaviour and mood
- Social dimension
- Occupational performance

The standardised assessments include a range of tools to establish awareness, mood, fatigue and cognitive failures, as well as outcome scales to indicate the rehabilitation potential.

A report provides the outcome of the assessment and recommendations for rehabilitation where appropriate.

Rehabilitation Model: |reach| rehabilitation programmes are individually tailored to need, but in general consist of 8 sessions and a review. An educational approach is used, along with introduction of compensatory strategies and technology to promote independence, whilst working towards individual goals. The plan is to provide a tool box of strategies to ensure continued progression. A rehabilitation programme typically includes:
- Fatigue Management and sleep hygiene
- Attention
- Memory
Planning and organisation
Mood
Anxiety
Vocational considerations

Outcomes and Discussions
Reach developed this approach to meet a clinical need which is usually not available through UK statutory services. Over the past 5 years our outcomes have shown all clients returned to employment/education/voluntary work and have been able to sustain such activity.

Using standardised assessments, enables us to chart progress and identify barriers for continued progression. Many patients use their tool box of strategies on a long-term basis, allowing them to optimise their rehabilitation potential and re-engage with pre-PCS activities.

We are keen to share our working experience and outcome data with colleagues as this client group and the demand on UK statutory services is ever increasing. Currently, we are developing a similar service for paediatrics and adolescents, based on evidence-based practice.
Between Empowerment and Research Utility. Reflections on the Purpose and Form of User Involvement in a Rehabilitation Research Project

Unni Sveen\textsuperscript{1,2}, Helene Lundgaard Søberg\textsuperscript{1,2}, Grace Inga Romsland\textsuperscript{1}, Tone Alm Andreassen\textsuperscript{3}

\textsuperscript{1}Faculty of Health Sciences, Oslo Metropolitan University, Oslo, Norway, \textsuperscript{2}Department of Physical Medicine and Rehabilitation, Oslo University Hospital, Oslo, Norway, \textsuperscript{3}Centre for the Study of Professions, Oslo Metropolitan University, Oslo, Norway

Background and Aim: User involvement in rehabilitation research is relevant and important and may increase quality and relevance of the knowledge production, as well as empower users (1). "Transitions in Rehabilitation" studying rehabilitation after traumatic brain injury and multi-trauma, included a user panel throughout the research process. The members of the panel, three women and three men recruited from user organizations, all had personal experience with life after injury. The idea was that their experiences as injured or parents, would contribute with unique knowledge regarding the rehabilitation process, and their experiences with the health- and social/vocational service system.

The aim of the user involvement study was to explore user interaction in research and gain knowledge on the process of user involvement alongside the project. How do the users influence the stages of the research process? What are the users’ and researchers’ perceptions on the interaction process?

Methods: The panel met four times a year, from December 2013 till date. Early in the “Transitions in rehabilitation” project process, researchers and user panel members decided that the user interaction should be studied. All involved in meetings, user representatives, senior researchers and PhD fellows, gave their consent.

Topics Discussed Were: recruiting participants, developing interview-guides, and a vignette for focus group interviews with service professionals. Aspects of the research process were presented: qualitative methods, conducting interviews, analyses, and requirements for publishing. Other discussions evolved around analyses of interview-material and dissemination of results. Meetings also focused on topics regarding organization and implementation of user involvement and analyses of the process of user-involvement. The analysed material consisted of minutes and audio recordings, transcribed verbatim, from meetings. The findings have been discussed with the user panel both as a sketch and draft.

Results: Themes from the analyses: Topic 1: A research lead collaboration process? The agendas for meetings were researcher-lead, but the users voiced opinions about the form and contents of the meetings and the collaboration. Topic 2: Consultation or dialogue? An independent user voice. The meetings between two different but equitable knowledge-bases gave fruitful discussions, that alternated between consultation, dialogue and opinions on e.g. interpretation of interview-material. Topic 3: Empowering users or influencing research output? Quoting one of the users: “It’s through the project’s increased quality that you feel you give important and useful contributions. If focusing exclusively on empowerment, without ultimately benefiting research, how can you feel you contribute?”

Conclusions: Benefits to the research process and empowerment of the users are not contradictory achievements. Rather, empowerment is achieved when the users’ contributions benefit the research process.

Key words: user involvement, empowerment, consultation
Examination of Specific Acute mTBI Symptoms in Predicting Prolonged Recovery in Pediatric Patients

Sarah Ostrowski-Delahanty
1
1 Akron Children's Hospital, Akron, United States

Background: Approximately 145,000 children and adolescents are living with lasting cognitive, physical, or behavioral effects of TBIs. While moderate and severe TBIs account for the majority of TBI-related deaths, 80–90% of all pediatric TBIs are mild in severity. The specific factors that contribute to persistent post-concussive symptoms are poorly understood and are likely the result of coexisting and/or confounding factors that may not be explained solely by brain pathology. Misattribution of health- and cognitive-related disabilities and functional impairments to brain injury alone has the potentially detrimental implication that recovery from mTBI depends predominantly on neurologic factors. Failure to consider mental health symptoms may lead to inappropriate or inefficient treatment of symptoms and prolonged recovery.

Objective: The purpose of this study was to examine the predictive utility of specific post-concussive symptoms reported during the Emergency Department (ED) visit in the acute aftermath of a mTBI predicted prolonged recovery of more than 10 days.

Methods: Data was retrieved through retrospective chart review of patients treated in the ED for post-concussive symptoms and followed up with Sports Medicine or Neurology. Participants included pediatric patients age 9–18 years who were administered the Acute Concussion Evaluation (ACE) during their ED visit. Patients were excluded if they were admitted or had abnormal CT scans, or had a history of neurologic disorders, personal history of migraines, developmental disorders, or psychiatric history as there has been suggestion that these factors may predispose patients to having prolonged symptoms. Prolonged recovery was determined as time until determined able to “return to normal activity” by the medical provider.

Results: One hundred and twenty-four children were included in analyses. The average age was 14.1 years and the average time to follow up in the subspecialist clinic was 9.6 days. Sixty-three children (50.8%) had reported significant levels of post-concussive symptoms 10 days post-injury. Logistical regression analyses indicated that children with symptoms of loss of consciousness, dizziness, and nausea at initial ED evaluation were not more likely to have prolonged symptoms than those who did not report these symptoms (p>0.05). However, children who reported nervousness or sadness (p=0.04 and p=0.05 respectively) in the ED were more likely to have prolonged recovery.

Implications: Findings underscore the importance of considering psychological symptoms in the assessment and treatment of mTBI. However, findings are limited by the retrospective nature of the study and lack of standardized outcome measures. Additional prospective research is needed examining the various trajectories of mTBI recovery and how specific post-concussive symptoms may interact over time to prolong a child’s recovery. Furthermore, research should test ways in which ED’s can implement ways to help children cope with emotional lability as a way to improve recovery from concussion.
Ability to Identify Facial Expressions of Emotion and Visual Behaviour are Impaired after A Brain Injury

Belén Moliner², Anny Maza¹, Jorge Latorre¹, María Navarro², Enrique Noé², Joan Ferri², Roberto Llorens¹²

¹Universitat Politècnica De València, Valencia, España, ²NeuroRHB - Servicio de Neurorrehabilitación de Hospitales Vithas, Valencia, Spain

Introduction: The ability to discriminate emotions in other people is one of the most relevant skills to establish proper social relationships. Certain brain lesions may reduce this innate human skill and cause, among other disabilities, impairments in social interaction. The aim of this study was to investigate visual behaviour while identifying facial expressions of emotions in a sample of individuals with an acquired brain injury (ABI) and to determine possible differences with healthy subjects.

Materials and Methods: A total sample of 76 individuals with ABI (44 males, 32 females) and 75 healthy individuals (34 males, 41 females) participated in this study. Participants were asked to identify the expressed emotion of 28 facial expressions from images extracted from the Karolinska Directed Emotional Faces database. Facial expressions represented fear, angry, disgust, happiness, sadness, surprise, or absence of emotion (neutrality). Images were randomly displayed during 5 seconds in a 23” screen, and participants were given a maximum of 30 seconds to select the emotion that better match the picture. Visual behaviour was acquired with the Tobii TX300 eye-tracker. Analysis focused on gaze parameters (total number and duration of fixations) in the eyes, nose, and mouth, which have been reported as the most relevant areas during visual facial scanning.

Results: Significant differences emerged in facial expression recognition for all emotions between individuals with ABI and healthy subjects. Participants with ABI showed less ability to identify fear, angry, sadness, disgust, and neutrality, and were less noticeable in happiness and surprise (positively-valenced emotions). Compared with healthy subjects, individuals with ABI made more fixations and for more time in the nose and presented the opposite tendency in the mouth. No significant differences between both groups were detected in the eyes.

Conclusions: The results of this study showed that individuals with ABI are less capable to identify emotions from facial expressions in comparison with healthy individuals, especially those emotions with negative valence. This impaired ability, which could negatively influence social cognition after an injury to the brain, could be partially explained by alterations in visual behaviour during visual facial scanning.
Brain Injury Associations - The Ultimate Safety Net

Ruth Wilcock

1Ontario Brain Injury Association, St. Catharines, Canada

The financial costs of brain injury are measured in the hundreds of millions of dollars for medical care rehabilitation and lifelong supports. The public health care dollars for services and rehabilitation for brain injury are being stretched, along with fiscal restraints from private insurers. However, to measure the financial costs of brain injury is one thing but does not compare to the devastation, losses, heartaches and hardships that happens to an individual and their families. This is immeasurable. In many cases the injuries are invisible, and the survivors suffer in silence. What happens when publicly funded services are depleted or when insurance dollars run out? Even if there are services available, are there any free supports available that can complement client or patient treatment plans? Yes, there is! Brain Injury Associations are the Ultimate Safety Net. The Ontario Brain Injury Association has been helping and supporting people living with brain injury for over 30 years and a number of its programs have been sought out internationally. Programs include Province-wide Peer Support Program (independently evaluated), Province-wide Online Concussion Support, and Caregiver Education, ongoing Research Study (measuring long term outcomes for people living with ABI), 1-800 helpline and personal advocacy. This information will be of benefit to physicians, neurologists, psychologists, social workers, nurses, case managers, legal professionals who are working in the field of brain injury. Furthermore, this session will not only inform what supports and services the Ontario Brain Injury Association provides, but insight and ideas of what can be replicated internationally to further support people living with brain injury and their families.
Multiple Canal Benign Paroxysmal Positional Vertigo in an Elderly Patient with Labyrinthine Concussion: A Case Study

Carrie Barrett, Donald Hoover

Background: 50 million worldwide each year sustain mild traumatic brain injury (mTBI), or concussion, and the cost of case management is estimated at over $60 billion annually in the United States alone. Persistent symptoms greater than 1 month, commonly known as post-concussion syndrome (PCS), can occur in approximately 44%. Symptoms include 3 or more of the following: headache, dizziness, irritability, memory limitations, poor concentration, insomnia, and fatigue. Benign paroxysmal positional vertigo (BPPV) can occur in up to 28% of those with concussion. Individuals with labyrinthine concussion have a higher chance of multiple canal BPPV as a sequela. BPPV can cause symptoms and signs of dizziness, nausea, and disequilibrium that can be masked by symptoms of PCS. Given the overlap of symptoms in PCS and BPPV and the need for different treatment regimens, clinicians should carefully screen all concussed patients. This case study highlights an elderly man diagnosed with labyrinthine concussion after a mTBI, treated in outpatient physical therapy.

Case description: A 70-year-old man presented to outpatient physical therapist (PT) 23 days after falling backwards off a ladder and hitting his head. At the initial PT visit he reported since the fall the following symptoms: visual distances, memory difficulty, dizziness, balance problems, and inability to walk with stability. In the initial PT evaluation, due to the severity of symptoms, the patient was unable to participate in assessment of gait and other gross motor function. The PT cleared him for oculomotor and vestibular system limitations, but he demonstrated a positive geotropic roll test for lateral canal involvement. He was treated with a berque roll technique for right side involvement. Although the PT suspected combined posterior canal involvement, the patient was unable to tolerate further testing with Dix-Hallpike in visit 1. In visit 2, the roll test was negative, and Dix-Hallpike was positive in his left posterior canal. He was treated with the Epley maneuver for left posterior canal involvement. In retest, both Dix-Hallpike and roll test were negative bilaterally.

Outcomes: Follow up PT assessment revealed symptoms were markedly better, with measures of sit to stand, walking and mobility improved by 99%. The patient also reported resumption of all pre-fall activities.

Discussion: Several cohort studies and case series have reported recovery rates from 50% to 100% with canith repositioning techniques. Canalith repositioning treatment is a safe, low cost, and effective treatment for BPPV. Early diagnosis and treatment of BPPV after concussion may assist in medical cost reduction and potentially improved timeframe of symptom recovery. Large scale RCT is needed on testing for and treating of adults with mTBI for BPPV as soon as medically cleared.
Agreement Between Parents and Teachers' Ratings of Behavioral and Emotional Problems in Adolescents Following Developmental and Acquired Neurological Impairments

Tamar Silberg1,2, Ayelet Bord1,2, Orly Polak1,2, Janna Landa2, Amichai Brezner2, Bruria Ben-Zeev2, Jaana Ahonniska-Assa2,3

1Bar Ilan University, Ramat-Gan, Israel, 2Edmond and Lily Children's Hospital, Tel-Hashomer, Israel, 3The Academic Collage of Tel-Aviv Jaffo, , Israel

Background: Emotional and behavioral problems are often reported among adolescents with various neurological conditions. The Achenbach System of Empirically Based Assessment (ASEBA), a valid and reliable instrument for measuring children's mental health, is available in parent (CBCL) and teacher (TRF) versions, making it an ideal tool for assessing behavioral and emotional problems in children and adolescents. However, few studies have evaluated agreement between parents and teachers of children with various neurological conditions. Furthermore, studies on ASEBA inter-rater agreement usually only reflect degree of correlation, leaving the agreement between raters unknown.

Objectives: The aims of the present study were twofold: [I] examine differences in emotional and behavioral problems among adolescents with developmental and acquired neurological impairments, according to different informants (parents/teachers) reports; and [II] examine the degree of agreement between parent and teachers' reports on child's emotional and behavioral problems in relation to child's neurological condition.

Methods: Data were obtained from the Pediatric Rehabilitation Department and the Pediatric Neurological Unit at the Sheba Medical Center, Israel. The sample comprised 398 adolescents aged 10-18 years, diagnosed with: Cerebral Palsy (CP) (N=81), Traumatic Brain Injury (TBI) (N=132), Epilepsy (N=155) and Posterior Fossa tumors (PF) (N=32). Parents and teachers completed the CBCL and TRF respectively, as part of a routine neuropsychological evaluation. Differences between raters according to the neurological diagnosis was examined using a repeated measure analysis of variance. Evaluation of the level of agreement between parents and teachers' reports on the CBCL and TRF was calculated using Inter-class correlations (ICCs) estimates and their 95% confident intervals.

Results: Parents and teachers of children following TBI reported the highest levels of emotional and behavioral problems on all summary scales, compared to children with other neurological conditions. Poorest level of agreement between parent and teacher ratings was found for the Internalizing Summary Scale (ICC 0.11 - 0.40), with fair/good agreement on the Externalizing Summary Scale (ICC 0.44- 0.63) and poor/fair agreement on the Total Problems Scale (ICC 0.26 – 0.51), above and beyond clinical group. Highest levels of agreement between parents and teachers were found for children diagnosed with CP on all summary scales.

Conclusions: Low inter-rater agreement between parent and teacher ratings suggests that information from both teachers and parents is important when using the CBCL and TRF as a method to identify emotional and behavioral problems in adolescents with various neurological conditions. Differences in levels of agreement between raters of children with developmental (CP) and acquired (TBI, PF and epilepsy) brain pathologies may reflect the effect of the time elapsed since diagnosis on potentially conflicting or incongruent information between raters.
H-FABP, NF-L, IL-10 and S100b in the Acute Diagnostics of TBI

Pia Koivikko1, Jussi Posti2,3,4, Mehrbod Mohammadian3,4, Linnéa Lagerstedt5, Leire Azurmendi5, Iftakher Hossain2,3,4, Ari Katila1, Henrik Zetterberg6,7,8,9, Kaj Blennow6,7, Olli Tenovuo3,4, Jean-Charles Sanchez5, Riikka Takala1

1Perioperative Services, Intensive Care Medicine, and Pain Management, University Hospital Turku and University of Turku, Finland, Turku, Finland, 2Division of Clinical Neurosciences, Department of Neurosurgery, Turku University Hospital, Finland, Turku, Finland, 3Turku Brain Injury Centre, Turku University Hospital, Finland, Turku, Finland, 4Department of Neurology, University of Turku, Finland, 5Department of Specialties of Internal Medicine, Faculty of Medicine, University of Geneva, Geneva, Switzerland, 6Department of Psychiatry and Neurochemistry, Institute of Neuroscience and Physiology, the Sahlgrenska Academy at the University of Gothenburg, Malmö, Sweden, Gothenburg, Sweden, 7Clinical Neurochemistry Laboratory, Sahlgrenska University Hospital, Malmö, Sweden, Malmö, Sweden, 8Department of Neurodegenerative Disease, UCL Queen Square Institute of Neurology, Queen Square, London, UK, London, United Kingdom, 9UK Dementia Research Institute at UCL, London, UK, London, United Kingdom

Aim: To study the ability of blood levels of 4 protein biomarkers - calcium-binding protein B (S100b), heart-type fatty acid binding protein (H-FABP), neurofilament-light (NF-L) and interleukin-10 (IL-10) - to assess the severity of traumatic brain injury (TBI) upon admission. In addition, we investigated the ability of these biomarkers to distinguish patients with mild TBI (mTBI) from patients with acute orthopedic injuries.

Methods: This prospective study was part of the EU-funded TBIcare project. Patients with all severities of TBI (N=175 having NF-L levels and 184 for other biomarkers) as well as orthopedic controls (N=39) were recruited at the Turku University Hospital, Turku, Finland. Serum samples were collected within 24 hours of admission. NF-L was analyzed using the ultrasensitive single molecule array (Simoa) technology and the other biomarkers with commercial kits. The severity of TBI was assessed using the worst recorded Glasgow Coma Scale (GCS) score between the scene of accident and the hospital emergency department: GCS 13-15, mTBI; GCS 9-12 moderate TBI (moTBI); GCS 3-8, severe TBI (sTBI). Kruskal-Wallis H and consequent post-hoc tests were used to assess biomarker level differences between the groups. Furthermore, multinomial logistic regressions were performed to evaluate the ability of biomarkers to distinguish the different severity classes.

Results: There were statistically significant differences in the levels (median (IQR)) of all biomarkers between the severity classes (S100b 78.05 (44.36, 114.39), 168.24 (63.15, 278.95) and 184.45 (69.02, 498.87) pg/ml, p<0.0001; H-FABP 5.17 (3.78, 10.41), 8.67 (5.47, 21.25) and 12.66 (8.37, 46.11) ng/ml, p<0.0001; NF-L 12.35 (7.52, 19.02), 70.95 (49.75, 154.70) and 79.4 (41.7, 179) pg/ml, p<0.0001; IL-10 0.436 (0.251, 0.892), 1.41 (0.666, 5.36) and 1.38 (0.62, 4.33) pg/ml, p<0.0001, for mTBI, moTBI and sTBI respectively). Those patients with mTBI who were discharged from the emergency department, had lower levels of IL-10 and H-FABP (Spearman rho -0.200, p=0.042 and -0.214, p=0.029, respectively) compared to those admitted to a neurosurgical ward.

The ability of IL-10, S100B, H-FABP and NF-L was poor in distinguishing patients with mTBI from the orthopedic patients with AUCs of 0.531 (95% CI 0.428-0.634), 0.532 (95% CI 0.422-0.553), 0.595 (95% CI 0.501-0.689) and 0.521 (95% CI 0.413-0.629), respectively.

Conclusions: All studied biomarkers showed significantly lower levels in patients with mTBI compared to more severe TBIs, but they were not able to separate moTBI from sTBI reliably. In addition, these biomarkers were unable to separate patients with mTBI from orthopedic controls.
The Concussion Harmonization Project: A National Approach to Concussion Recognition & Management in Canada

Stephanie Cowle¹, Pamela Fuselli¹
¹Parachute, Toronto, Canada

Sport participation is a common cause of head injuries, especially in youth. In Canada, sport activities are the third leading cause of traumatic brain injury admissions to hospital. With increasing attention on concussion in recent years, there has been an increase in available resources on the subject, but a lack of harmonization or availability of standardized, evidence-based information. Based on the need to strategically build a common approach to concussion across the country, Parachute has led the development of national concussion guidelines and protocols to better equip coaches, athletes, parents, educators, and medical professionals.

Based on the 5th Consensus Statement on Concussion in Sport and developed with Canada’s leading concussion experts, Parachute published the first-ever Canadian Guideline on Concussion in Sport in 2017. To drive uptake of this best practice guidance in Canada’s amateur sport system, Parachute worked directly with National Sport Organizations (NSOs) to develop updated concussion protocols and sport-specific Return-to-Sport Strategies.

The Project has resulted in more than 40 NSOs directly applying the Guideline in their concussion policies to-date. Success in the project has been attributable to: cross-sector collaboration between health and sport; government buy-in; efforts to understand the heterogeneous contexts, capacities, and needs of sport organizations; and the development of audience-specific tools to improve self-efficacy for sport organizations in the area of concussion policy. Key practices recommended in the Guideline - early recognition and removal from play, access to timely care, and appropriate progression back to sport – are expected to improve outcomes for athletes who sustain concussions. The harmonization of sport-specific concussion protocols across the country will positively affect the health of Canadians by clearly defining processes for better concussion management and ultimately reducing the long-term impact of concussions.
Post-injury Administration of Pifithrins Alleviates Traumatic Brain Injury and Subsequent Fibrotic Changes in the Lung

Jia-Yi Wang¹, Yu-Chio Wang¹
¹Taipei Medical University, Taipei, Taiwan

Patients with traumatic brain injury (TBI) frequently develop acute lung injury (ALI). The association of TBI and subsequent ALI is increasingly recognized. TBI results in the release of danger-associated molecular patterns (DAMPs) from the site of brain injury and activation of the receptor for advanced glycation end product (RAGE) in lungs. High-mobility group box-1 (HMGB1) is the most studied DAMPs. Receptors for HMGB1 in lung tissue include Toll-like receptor 4 (TLR4) and RAGE. RAGE activation also results in increased expression of transforming growth factor-β (TGF-β), resulting in fibrotic changes in lung. We have previously found that p53 inhibitors pifithrins (PFTs) ameliorate brain injury and neurological deficits following TBI. In this study we compared their effects on lung injury and apoptosis and autophagy signaling in alveolar epithelial cells. The extent of ALI by assessing lung injury score and the relative mRNA levels of pro-inflammatory cytokines and collagen among sham, TBI and TBI + PFTs animals at 24 h and 7 days after TBI.

Our results suggested that intravenous administration of Pifithrins (2mg/kg) at 5 hr after TBI significantly lowered the lung injury score compared to TBI animals. PFTs administration resulted in reduced collagen, α-SMA and TGF-β protein deposition and distribution in lung tissue by microscopic examination of immunohistochemical staining. Results from western blot showed decreased RAGE expression after treatment of PFTs, indicating the suppressive effects on the HMGB1-RAGE pathway. Levels of mRNA expression of COL1A1, pro-inflammatory cytokines and TLR-4 significantly decreased in the TBI + Pifithrins animals compared to TBI animals.

We conclude that intravenous administration of Pifithrins alleviates lung injuries and fibrotic changes through affecting the HMGB1 signaling pathway in lung tissue at 24 h and 7d in the animal model of TBI.
There are Ups and Downs While Slowly Moving Forward, In a Way: Stories of Improvement and Treatment After Mild and Moderate Traumatic Brain Injury

Anne-Margrethe Linnestad1, Marianne Løvstad2,3, Emilie Howe2,7, Silje Fure2,7, Øystein Spjelkavik6, Heidi Enehaug6, Karen Groven4,5, Unni Sveen2,5, Nada Andelic2,7

1Sunnaas Rehabilitation Hospital, Nesoddtangen, Norway, 2Department of Physical Medicine and Rehabilitation Oslo University Hospital, Oslo, Norway, 3Dept. of Psychology, University of Oslo, Oslo, Norway, 4Dept. of Health Sciences, Inst. of Health and Society, University of Oslo, Oslo, Norway, 5Faculty of Health Sciences, Oslo Metropolitan University, Oslo, Norway, 6Work Research Institute, Centre for Welfare and Labour Research, Oslo Metropolitan University, Oslo, Norway, 7Faculty of Medicine, University of Oslo, Oslo, Norway

Background: Patients who sustain mild and moderate traumatic brain injury (TBI) may experience long-lasting somatic, cognitive, and emotional symptoms affecting the ability to perform in activities of daily life and return-to-work (RTW). Despite a growing body of research on treatment options after TBI, there is limited knowledge regarding patients’ lived experiences, particularly regarding experiences with treatment efforts offered in the early phase after injury (1). Objectives: The main aim was to explore how persons with mild and moderate TBI describe and make sense of their injury and their “recovery” process. In particular, we focus on the rehabilitation process; how treatment approaches, including Compensatory Cognitive Training (CCT) (2), have influenced how the patients make sense of their “recovery” process. The patients’ “recovery” process in relation to their everyday lives, including RTW, is addressed, as well.

Methods: This study is part of an ongoing randomized controlled trial (RCT) examining the efficacy of a complex intervention after mild and moderate TBI on RTW, work stability and productivity (3). The intervention consists of group-based cognitive training (CCT) and supported employment (SE). This qualitative sub-study consists of in-depth interviews with 8 patients recruited from the RCT. Three women and five men, 27-55 years old were interviewed immediately after completing 10 weekly sessions of CCT, 4-6 months after injury. At this early stage of the RTW-process experience with SE is not yet a topic. The interviews lasted from 50 to 90 minutes.

Results: The patients expressed the importance of gaining increased knowledge by own reflections, within family, employer’s and health professionals, and information shared in group sessions. Several patients searched advice from many sources. They described receiving conflicting and sometimes confusing advice, such as to do as little as possible, but also to stay as active as possible. They described feeling left alone having to navigate a field where little evidence-based knowledge was available. The patients experienced the strategies they acquired in the CCT intervention as useful, but also challenging. They expressed that increasing the duration of the CCT intervention, to have more time to integrate new strategies into daily life, would be helpful. There was much ambivalence as to whether time alone would result in healing, and if the learned strategies were helpful in the RTW-process. Most patients felt that meeting others in a similar situation had been very helpful. Some missed more help with physical symptoms like balance problems, vestibular symptoms and visual impairments.

Conclusion: As this study is ongoing, these results are preliminary. A thematic analysis is conducted, and final results will be presented at the IBIA congress.

Cognitive Impairments in Patients with Cushing’s Syndrome in Remission – Case Reports

Espen Edvardsen¹, Hildegun Snekkevik¹, Victoria Vogt¹, Line Eide¹, Anne-Kristine Schanke²
¹Department of Brain Injuries, Cognitive Rehabilitation unit, Sunnaas Rehabilitation Hospital, Nesodden, Norway,
²Department of Research, Sunnaas Rehabilitation Hospital, Nesodden, Norway

Background and Aims: Cushing’s syndrome occurs when the body is exposed to high levels of cortisol over a long period of time, also called hypercortisolism. Studies have showed that brain abnormalities may occur from the hypercortisolism, which in turn may mediate changes in cognition, mood and quality of life. While most patients show improvement of symptoms from hypercortisolism after treatment (surgery and/or medication), some still report cognitive deficits in remission. Studies have reported cognitive deficits such as impaired mental efficiency, verbal fluency, reading speed, attentional processing and memory. Although it is known that patients might struggle with behavioral impairments after treatment, they have so far not been referred to rehabilitation units addressing such deficits in Norway. This study will explore the need for cognitive rehabilitation in patients with Cushing’s syndrome in long term remission.

Design: The study is an ongoing serial case study of patients with Cushing’s syndrome in remission, who reports cognitive symptoms affecting everyday life. The patients are referred from the Department of Endocrinology, Morbid Obesity and Preventive medicine, Oslo University Hospital, to an interdisciplinary five hours assessment at Sunnaas Rehabilitation Hospital. So far, four patients are included: 2 males and 2 females (age 53 + 5 years), treated for Cushing’s syndrome, where 3 had pituitary adenoma and 1 had cortisol producing adrenal adenoma. Time since surgery varied from 8-45 years. The assessment included a medical examination, a neuropsychological screening (neuropsychological tests, fatigue screening (FSS), screening for symptoms of psychopathology (SCL 90-R) and self-reported memory difficulties in everyday life (EMQ)), and screening with an occupational therapist with focus on cognitive impairment in daily life functioning (COPM), occupational status and fatigue (MFS). The patients received a multidisciplinary feedback after the assessment that included advice on how to cope with cognitive difficulties. The patients gave their written consent to participate in the study.

Results: The preliminary data from the four patients included, shows that they report high levels of fatigue, cognitive and emotional difficulties in their everyday life. The neuropsychological data showed variance between the patients, with moderate cognitive impairments in verbal working memory, psychomotor and mental speed, and verbal/visual memory. All patients reported difficulties with activity performance in their everyday life, where all were partly or fully unemployed.

Conclusions: Preliminary data confirms that cognitive impairments occur in patients with Cushing’s syndrome in remission, and that this, combined with increased levels of fatigue and emotional distress, has an impact on their activities and daily life functioning, warranting inclusion in holistic rehabilitation programs regarding their impairments in a biopsychosocial perspective. Another 2 – 3 patients will be examined before conclusions about future rehabilitation are made.
Exploring Verbal Memory in TBI Patients in Acute Care Using the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)

Maude Laguë-Beauvais, Arielle Belisle, Natalia Rojas, Julie Lamoureux, Elaine de Guise

Identifying the type of neuropsychological symptoms early post TBI is necessary in order to properly guide the patient at discharge of the acute care hospital and start rehabilitation as early as possible. Memory problems are important in this population and are linked to the patients' orientation in time and space as well as the length of the post-traumatic amnesia. The RBANS (FAB) assesses verbal memory through a list learning task (10 words repeated four times) and a short story learning task (12 items put within a context repeated twice) using an immediate and delayed recall. TBI patients were assessed using the RBANS in order to compare memory deficits according to TBI severity and link deficits to lesion localization.

While admitted to a tertiary care center following a TBI, 72 TBI patients between 18 and 76 years of age (M=43.7±4.7) and of which 34.4% (n=31) were females were tested. The number of days between the accident and the evaluation varied between 1 and 55 days (M=7.4, SD=±5.6). There was no significant relationship between the severity of the TBI and the number of days between the accident and testing (χ²=3.12, p=.21). Most of the patients had a GCS score of 14 or 15 at the time of accident (n=68, 75.6%), indicating a mild TBI, and most had experienced loss of consciousness (n=67, 75.3%). On the List Learning Task, patients recalled a total average of 25.4±5.7 words over fours trials and recalled 4.7±2.7 of the 10 words during the delayed recall. As for the Story Learning Task, they recalled 16.5±4.4 items over two trials during the immediate recall and recalled 8.1±2.8 out of the 12 possible items later. When controlling for age, there was no significant difference between TBI severity levels in the immediate recalls of the List Learning (F(2,67) = 1.12, p = .331) and the Story Learning (F(2,67) = .47, p = .627) tests. However, as the TBI severity increased, the average delayed recall of the List Learning task decreased marginally (F(2,64)=3.11, p=.051). As for the Story delayed recall, no significant difference was found between TBI severity (χ²²df =.930, p=.628). Moreover, there was no statistically significant difference between Marshall category groups (i.e., classification of brain lesion localization) between the combined scores of the immediate recalls of both tasks (F(4,63)=.53, p=.711), nor in their delayed recall (χ²⁴df=3.515, p=.515).

Thus, the delayed recall of the List Learning task may be the most sensitive measure between TBI severity levels. Although these results are below the norms expected for healthy controls as provided by the original RBANS publication, they also reveal that TBI severity classification and brain lesions localization should not be based on memory testing even early on in the acute phase.
Traumatic Brain Injury and Early Life Trauma are Associated with Distinct Patterns of Cortical Volumetric Change and Deficits in Functional Outcomes in Combat Veterans.

Meghan Pierce, Emma Brown, Catherine Fortier, William Milberg, Regina McGlinchey

Translational Research Center for TBI and Stress Disorders, VA Boston Healthcare System, Boston, United States, Department of Psychiatry, Harvard Medical School, Boston, United States, Neuroimaging Research for Veterans, VA Boston Healthcare Center, Boston, United States

Mild traumatic brain injury (mTBI) is the most prevalent injury experienced by Veterans of Afghanistan and Iraq. Previous research indicates the combination of mTBI, posttraumatic stress disorder, and mood disorders produces more profound deficits in functional outcomes than any one disorder alone. However, the mechanisms underlying these differences have not been clearly elucidated. Furthermore, the experience of traumatic events early in life and repeated exposure to traumatic events throughout the life span are predictive of subsequent PTSD and mood disorders. The current study investigated how early life trauma (ELT) impacts functional outcomes in combat Veterans and how this may relate to brain morphometry.

Participants were 37 women and 415 men. All participants completed a battery of surveys, structured clinical interviews, neuropsychological testing, and MRI scanning. Neurobehavioral symptoms were measured with the Neurobehavioral Symptom Inventory (NSI) and functional outcomes were measured with the World Health Organization Disability Assessment Scale (WHODAS). The Depression Anxiety Stress Scales (DASS) was used to measure intensity of depression, anxiety, and stress symptoms.

Participants were grouped into individuals with a lifetime history of TBI (n = 324) and no history of TBI (n = 128). Individuals who had experienced a TBI had higher anxiety, t(452) = -3.54, p = .007, stress t(452) = 3.77, p = .007, neurobehavioral symptoms t(452) = -3.77, p = .007 and PTSD symptom severity t(452) = -6.32, p = .007. Individuals with TBI also experienced more early life traumatic events t(452) = -2.86, p = .028, and had worse functional outcomes, t(452) = -4.86, p = .007. A Bonferroni correction was used to account for multiple comparisons.

We then investigated cortical volume in brain regions that have been associated with dysregulated stress responding and PTSD. Here we found that, after controlling for intracranial volume, early life trauma was associated with decreased volume in the right medial orbitofrontal cortex, r(146) = -.215, p = .008, and increased volume of the left amygdala was associated with increased stress r(108) = .260, p = .006 and worse WHODAS functional outcomes, r(108) = .199, p = .036 in individuals with lifetime TBI. These same patterns of volumetric changes were not significantly associated with any variable in individuals without TBI.

Our results provide evidence that a lifetime history of TBI and ELT may increase the impact of deployment on psychological and functional outcomes. This was further supported by reduced volume in subcortical structures involved in stress and PTSD. Our results indicate a clear need to understand how trauma experienced throughout the lifespan compounds to affect resilience and recovery from combat-related pathology.
Impact of Menstrual Phase on Outcomes of Females with Concussion

Graziella Richandi¹, Mark Bayley¹,², Paul Comper¹,², Angela Colantonio¹,²
¹Toronto Rehabilitation Institute, Toronto, Canada, ²University of Toronto, Toronto, Canada

Introduction: Concussions are a pervasive and growing problem with long term implications that affect a wide range of the population. Although prominent sex differences have been shown in concussion outcomes, few have explored why such differences exist. Further, there is a paucity of information on the acute phase of concussion (e.g. up to 2 weeks post injury) with most studies looking at outcomes 2 – 3 months post-injury.

Aim: This study examined the impact of menstrual phase, oral contraceptive use and post-menopausal status (collectively referred to as reproductive states) during time of injury on female post-concussion outcomes during the acute phase of recovery.

Methods: A total of 83 female participants (ages 17 - 71) recruited from a concussion clinic at a rehabilitation hospital were included in the analysis. Personal health information and Rivermead Post-Concussion Questionnaire scores were collected. Descriptive, bivariate regression and multivariable regression models were performed.

Results: The reproductive states were not associated with Rivermead Post-Concussion Questionnaire scores during the first week of recovery; however, females taking oral contraceptives had significantly higher Rivermead Post-Concussion Questionnaire scores two weeks post-injury. The other reproductive states were not related to Rivermead Post-Concussion Questionnaire scores up to 2 weeks post injury. Being on birth control was independently associated with more symptomatology. Participants with a prior head or neck injury and those with a concussion from a violence-related mechanism of injury were associated with higher week 1 Rivermead Post-Concussion Questionnaire scores. Having a higher education was related to lower week 1 Rivermead Post-Concussion Questionnaire scores. A prior head or neck injury was also associated with higher week 2 Rivermead Post-Concussion Questionnaire scores, while transportation as a mechanism of injury was related to lower week 2 Rivermead Post-Concussion Questionnaire scores.

Conclusion: Findings from this study and others strengthens the notion that sex differences should be considered when examining the severity and recovery from concussion, with a more individualized approach to rehabilitation rather than the one size fits all method. Health care professionals should acknowledge the sex differences that may exist in concussion recovery. More work is necessary to better understand these disparities and address them.
The Role of an Occupational Therapist in the Catastrophic Assessment under the Glasgow Outcome Scale (GOS) and the Glasgow Outcome Scale- Extended (GOS-E) Criterions

Galit Liffshiz

The Role of an Occupational Therapist in the Catastrophic Assessment under the Glasgow Outcome Scale (GOS) and Glasgow Outcome Scale- Extended (GOS-E) Criterions

The GOS and the GOS-E are widely used outcome measures after traumatic brain injury. However, it has been recognized as a global and relatively insensitive measure, precluding any description of the types of impairments that lead to the disability.

To date there is no standard format or a reliable written protocol when one is assessing and rating the GOS or GOS-E. Database on the issue will be reviewed.

The scales are a classification system, comprised of five-eight categories with corresponding scores to indicate the severity of disability after a traumatic brain injury.

A review of current literature referencing these scales will be presented to illustrate that presently, there is no standardized written protocol to conduct the assessment and rating of the GOS or the GOS-E, even though the Extended questionnaire is more detailed.

In the province of Ontario, Canada, the GOS is employed at six months post injury as a criterion for determining catastrophic injuries in the litigation of a motor vehicle claim for an accident that occurred prior to June 2016.

The GOS-E is employed at 1 month, 6 months and 12 months for determining catastrophic injuries in the litigation of motor vehicle claims for accident that occurred after June 1, 2016.

This determination significantly impacts the client’s medical and rehabilitation funding as well as their benefits for assistance with Activities of Daily Living (ADL).

The more severe disabilities are often cognitive impairments or personality changes affecting the client’s independence with their ADL’s. A health professional determines these deficits thorough questioning of both the clients, their family and care providers.

This presentation will provide an explanation of the role of an Occupational Therapist, introduction to Occupational Therapy assessment and observation tools as well as the Occupational Therapist’s ability to holistically analyze function within the client’s milieu. Occupational Therapists have the unique clinical expertise in determining the GOS or the GOS-E score.

A review of the literature, as well as clinical experience, outlines a comprehensive argument supporting Occupational Therapists are most suitably equipped to assess an individual’s severity of disability when determining the GOS rating.
This presentation will focus on GLA Rehab’s OTs’ clinical experience completing Catastrophic Assessment under the GOS and GOS-E.
A Case Study: The Positive Effect of Integrating A Hobby Into Life after Traumatic Brain Injury

Galit Liffshiz¹

¹Galit Liffshiz & Associates, Toronto, Canada

Objective: The presentation will explore the importance and benefits of integrating a pre-accident hobby into a meaningful activity after a brain injury.

Hobbies can enhance cognitive skills as they provide an isolated area of concentration. Hobbies help with developing memory skills because they involve repetition.

A hobby can provide a positive outlet for behavioural improvement and can be both beneficial for the person who suffered a brain injury and for family or caregivers. Hobbies are also important as it creates an opportunity to meet new people, build self-esteem, relieve stress, avoid boredom and enrich your perspective.

Method: Our client was 18 years old when he was involved in a motor vehicle accident, which resulted in a severe brain injury (GCS 3/15). He had just finished high school at the time of the accident and was interested in pursuing schooling at the local college.

He was experiencing severely impaired memory, decreased attention, executive function deficits, including issues with goal planning, initiation and problem solving, and slowed thought processing.

He could not be left alone as he displayed poor judgment, which placed his safety at risk.

He began community rehabilitation, including case management, occupational therapy, physical therapy, speech language pathology and psychology.

Along with his occupational therapist, they developed his hobby with music production and deejaying prior to the accident into his main productive occupation.

The OT educated the client on how to implement compensation strategies for his cognitive impairments related to Deejaying. This included technology devices for organization, memory and executive functioning, such as using high tech applications, special computers and voice recognition software.

In addition, the insurer paid for a sound proof room in his home to develop his Dj discs while still under the supervision of his family.

Results: Working with a rehab team for over 5 years, the client, was able to effectively develop a meaningful life, in which he is deejaying several times a week for different audiences in various venues within Ontario. He was motivated to gain his driver license and is driving independently for his deejaying jobs.

Conclusion: Our client now spends the majority of his time working on his music from his home and deejaying at different venues.

He finds this to be a meaningful and rewarding activity.
He is unable to make it as a full-time job but is enjoying part time vocational pursuits as a DJ and is able to develop friendships and relationships with other deejays and event promoters and has a fulfilling routine.

Hobbies can lead to a vocational and a-vocational routine after a severe brain injury.
Experiences on the Injured Self and the Rehabilitation Services – A Qualitative Study

Helene Søberg¹,², Unni Sveen¹,²
¹Oslo University Hospital, Oslo, Norway, ²Oslo Metropolitan University, Oslo, Norway

Objective: Sustaining a traumatic brain injury or multi-trauma is a dramatic event that requires rehabilitation efforts from the injured person in cooperation with rehabilitation services and professionals. The patients face an unknown situation, and the biographical reconstruction and rehabilitation process require user participation. There is a lack of knowledge about how patients with traumatic injuries experience their encounter with the health and rehabilitation professionals in specialized health care. Theories on biographical disruption and loss of self, liminality and biographical reconstruction are pertinent in understanding the patients’ rehabilitation process. The aim of this study was to explore how people with traumatic brain injury or multiple trauma experience their cooperation with and support from health and rehabilitation professionals and services.

Methods: The study had a qualitative design and was part of the “Transitions in rehabilitation” project at Oslo Metropolitan University. Fifteen patients with moderate to severe TBI or multi-trauma from Sunnaas Rehabilitation Hospital, and 9 patients with mild/moderate TBI with a protracted course of recovery from Oslo University Hospital, age 18-65, were included. They were 54% men, mean age was 42.5 (SD12.6) years. A semi-structured interview guide developed to explore the informants’ rehabilitation process guided the interviews. The interviews were transcribed verbatim and analyzed. Passages related to experiences with rehabilitation professionals and the recovery process were extracted and subject to further analysis.

Results: Topics that emerged related to the contact with health and rehabilitation professionals in the acute phase and primary rehabilitation concerned: Feelings of confusion, a need for safety and being taken care of. A lack of and need for experiencing control. Receiving the right information at the right time. The professionals were viewed as: advocate and mediator – supporting the reconstruction of self and reentry into community living; motivator – in regaining health, reconstruction and reorientation of self; organizer contributing to transforming chaos to restitution; a driving force in the rehabilitation effort. The professionals contributed to the fusion of the old and new self through formal and informal communication. The rehabilitation institution and program provided an arena for meeting other injured, resolving an existential loneliness.

Conclusion: The patients experienced the health and rehabilitation professionals in specialized health care mainly as supportive in the rehabilitation process and the biographical reconstruction. Feelings of confusion and lack of control were described and receiving timely information was important.

Keywords: brain injury, biographical disruption, rehabilitation process, health professionals
Destined for Life in a Nursing Home? Extended Long-Term Neurorehabilitation Promotes Independent Living in Severe Brain Injury

Stephan Bamborschke¹, Mareike Schrader¹, *Annette Sterr¹,²
¹Zentrum für Post-Akute Neurorehabilitation, Berlin, Germany, ²University of Surrey, Guildford, United Kingdom

Many advanced health care systems in Europe provide neurorehabilitation in specialised clinics. These are inpatient units where, depending on the severity of the brain damage, comprehensive treatment is given for 3-6 months. In Germany, this period is not long enough for about 30000 patients to recover sufficiently to return home or assisted living within the community. Life for these patients typically ends in nursing care, a situation where societal participation (Teilhabe) is extremely limited.

It is estimated that 5-10% of these patients can benefit from further extended inpatient rehabilitation. This is the target group of a specialised long-term neurological rehabilitation center in Berlin, Zentrum fuer Post-Akute Neurorehabilitation, P.A.N. The P.A.N. provides standard rehabilitation interventions embedded within a 24h group-based neuropedagogic setting designed to foster societal participation and independent living. Importantly, P.A.N. houses training apartments where patients can gradually learn to live independently and find their level of independence in a safe space. This therapeutic set up should result in a more effective transition from the inpatient rehabilitation setting to the destination after discharge. Here we report changes in ability, social participation, and living destination of patients discharged from the P.A.N. since 2015.

54 patients (37 male, 17 female) aged 44.8 ± 10.0 years were enrolled in the analysis. The group was mixed, comprising severe traumatic brain injury (20.4%), ischemic stroke (27.8%), intra cerebral (14.8%) and subarachnoid bleed (13.0%), and hypoxia (9.3%). evolution of functional recovery was assessed through the Fruehreha Barthel Index [1]. In 9 patients with orientation disorders, capacity for social participation was further assessed through the Mayo Portland Adaptability Index (MPAI);

All patients improved with the rehabilitation, indicated by an average rise of 19 points on the adapted Barthel Index [1] from P.A.N. admission (31.3 ± 49.3) to discharge (50.3 ± 52.7; p <.001). Average discharge was 15.6 months. 41/54 patients (76%) were moved on to assisted living arrangements within the community; 13/54 patients (24%) were not well enough to cope outside the institutional setting. Separate analysis of patients with primarily neurocognitive deficits revealed that 88.9% were discharged after 11.4 month into the community. MPAI in those with orientation disorders improved significantly (p<.0.017).

The P.A.N. concept of longterm neurorehabilitation effectively improves the overall outcome in the most severely affected patients. Critically, this outcome translates into real-world benefits of societal participation and independent living. The latter is likely to foster improved quality of life and wellbeing as well as physical and mental health on these individuals.

Differences in Neck Strength and Symmetry Dependent on Sex, Sport Risk, and Sport-Related Concussion History

Tara Porfido¹, Allison Brown¹, Nicola de Souza¹, Jennifer Buckman², Brian Fanning¹, Carrie Esopenko¹
¹Rutgers University, Newark, United States, ²Rutgers University, Piscataway, United States

Background: Sport-related concussion (SRC) is estimated to affect ~10,000 National Collegiate Athletic Association athletes each year (Kerr et al., 2015), with female collegiate athletes showing higher rates of SRC in sex-comparable sports (Covassin et al., 2016). Sex differences in neck strength is one potential mechanism underlying differences in SRC risk. SRC has been directly linked to lower neck strength in high school students (Collins et al., 2014) and lower neck strength has been associated with greater linear and rotational accelerations upon impact (Caccese et al., 2017). Relative to male athletes, female athletes show lower neck strength and more linear and rotational head acceleration upon impact (Tierney et al., 2005).

Objective: The aim of our study was to develop a comprehensive assessment of neck strength, and examine whether neck strength differs dependent on sex, sport risk (contact and non-contact sport athletes), and SRC history.

Method: High sport risk (n=29 contact sport; 52% female) and low sport risk athletes (n=56 limited/non-contact sports; 64% female) were assessed at the start of their athletic season. Isometric neck strength in six motions was collected using handheld dynamometry. Peak force values were averaged across three trials and used as measures of neck strength. Neck strength symmetry was evaluated using paired t-tests. An equal number of athletes in contact (n=8) and limited/non-contact (n=8) sports reported a history of SRC; thus, differences in neck strength in athletes with a history of SRC dependent on sport risk was examined.

Results: Relative to female athletes, male athletes demonstrated more strength across all motions assessed (p < 0.005). Males demonstrated greater flexion relative to extension strength (p=0.015) while females showed greater extension relative to flexion strength (p=0.001). Males also showed greater left relative to right SCM strength (p=0.003) and females showed greater right relative to left rotation strength (p=0.044). No significant differences in strength dependent on SRC history or sport risk were noted. In athletes with a history of SRC, however, contact sport athletes showed significant asymmetry in SCM strength (p<0.05) that was not observed in athletes participating in limited/non-contact sports.

Conclusion: Consistent with past work, sex differences in neck strength were noted across all measures. In addition, we noted sex differences in neck muscle symmetry. Although no symmetry differences were observed dependent on sport risk or SRC history, significant asymmetries in SCM strength were shown in athletes with a SRC history participating in contact sports. These results suggest that neck strength may be a critical factor in SRC, specifically for contact sport athletes. Future research should consider SCM asymmetries because they may strongly contribute to SRC risk and could be a focus for SRC prevention protocols.
Standardizing Concussion Recognition & Management in Canada: Updating the Concussion Awareness Training Tool for Medical Professionals

Pamela Fuselli\textsuperscript{1}, Shelina Babul\textsuperscript{2}, Stephanie Cowle\textsuperscript{1}, Kate Turcotte\textsuperscript{3}

\textsuperscript{1}Parachute, Toronto, Canada, \textsuperscript{2}BC Injury Research & Prevention Unit, BC Children's Hospital, University of British Columbia, Vancouver, Canada

The Concussion Awareness Training Tool (CATT) is a series of online educational modules and resources with the aim of standardizing concussion recognition, diagnosis, treatment, and management. CATT for medical professionals (CATT MP) launched in 2013, focusing on recognition and diagnosis, and demonstrating significant positive change in practices (p=0.001) and knowledge (p=0.039). In 2018, CATT was redeveloped by the BC Injury Research and Prevention Unit and Parachute as part of the Concussion Harmonization Project, supported by the Public Health Agency of Canada. This course targets primary care providers and the variations in practice identified in the literature. The course aligns with the best practice recommendations of the Canadian Guideline on Concussion in Sport, the International Consensus Statement on Concussion in Sport (Berlin 2016), and clinical practice guidelines and standards developed by the Ontario Neurotrauma Foundation.

The priority competencies identified for primary care providers to deliver best practice concussion care were: assessing a patient presenting with possible concussion (initial hours post-injury); managing care up to 2-4 weeks post-injury; and, identifying when referral to specialized care is required. Inconsistencies in primary practice identified in the literature include use of validated symptom scoring scales; use of diagnostic imaging; recommending and defining cognitive rest; and appropriate application of graduated return to school and sport progressions. Based on that scope, the new CATT MP includes four modules: A – Concussion: Definition and Epidemiology; B – Medical Assessment for Concussion, including adjunctive tests; C – Concussion Management and Medical Clearance, including what to inform the patient; and D – Persistent Concussion Symptoms and Management, including making referral decisions. Mobile-friendly versions of the SCAT5 and Child SCAT5 are included.

CATT increases knowledge and awareness of evidence-based concussion recognition, diagnosis, treatment and management to reduce related health problems and the risk of long-term brain damage. The CATT MP is part of the first national effort to harmonize concussion protocols in Canada. Ongoing collaboration among the health, education, and sport systems is necessary for concussion outcome optimization.
The Post-Concussion Symptom Scale May Exhibit A Ceiling Effect in Women with Post-Concussion Syndrome: A Case Series

Carrie Barrett¹, Donald Hoover¹
¹Western Michigan University, Kalamazoo, United States

Background: Post-Concussion Syndrome (PCS) is widely defined as the presentation of persistent signs and symptoms 1 month or more after a concussive event, and it is characterized as exhibiting 3 or more of the following signs or symptoms: dizziness, fatigue, irritability, poor concentration, memory limitations, headache, and insomnia. PCS can be life-altering and adversely affect independence in functional activities of daily living, work, and caregiver abilities. PCS is reported to affect more women than men. One of the outcome tools that has shown validity in individuals with PCS is the post-concussion symptoms scale (PCSS). PCSS is a self-reported scale and helps to establish a base of PCS for individuals in the outpatient setting. However, limited research exists on the efficacy of the PCSS populations of adults with PCS who are non-military, non-athletes. This case series describes 7 women who were diagnosed with PCS and the integration of the PCSS within their rehabilitation in an outpatient physical therapy setting.

Case Description: The PCSS was administered in the outpatient setting to 7 women patients diagnosed with PCS. At the time of initial evaluation, each had primary complaints of unstable gait, none were able to tolerate vestibulo-oculomotor testing at initial evaluation, and all had abnormal Modified Clinical Test of Sensory Interaction on Balance (mCTSIB) testing. During physical therapy, each received detailed screening of the neurologic system, as well as individualized treatment, including canalith repositioning techniques, therapeutic exercise, and oculomotor training, and cognitive behavior therapy, as individually indicated.

Outcomes: The initial PCSS scores for this group were suspected to have a ceiling effect, suggesting that this instrument may lack sensitivity and specificity for non-military, non-athlete samples such as the present one. Nonetheless, 6 of 7 women in this case series had improved scores on the PCSS over the course of her rehabilitation. Average improvements of 21.3 points from initial evaluation to discharge were recorded. Each patient in this case series noted having positive gains with gait stability, ranging from self-reported 30% to 100% improvement. Of the 3 who were not working at initial evaluation, all returned to work in a functional capacity; 2 returned fully, 1 returned with restriction due to awaiting a shoulder surgery.

Discussion: Outcome tools for adults with PCS who are neither military nor athletes need to be further investigated. The present case series suggests the PCSS lacks sensitivity and specificity for this population, prompting questions regarding issues such as minimal detectable difference and other variables helpful in clinical screening and decisions regarding discharge to previous activity levels. Future study on the PCSS or other instruments in non-military, non-athlete adults with PCS would be valuable, helping perhaps to both establish normative data and link clinically significant change to functional improvement.
Redesigning the Brain Injury Landscape in Ontario - HHS partners with CONNECT

John Zsofcsin1
1Hamilton Health Sciences, Hamilton, Canada

Hamilton Health Sciences is doing something different for people after Acquired Brain Injury (ABI) and stroke. Partnering with a private BC company CONNECT, a new resource opening in 2019 promises to help people redesign their lives – while redesigning the health system.

HHS would like to present a poster about this unique partnership and its intentions to transition people from hospital to home after ABI and stroke. A public/private partnership we feel will be replicated in other LHINs in Ontario and for other patient populations. After a successful RFP bid in 2016 CONNECT Hamilton will be opening in April/May 2019 and will focus on an alternative manner to support clients and their families.

Purpose and Culture:
This partnership has promoted respect for each other’s culture and strengths, breaks down silos in traditional medical models and changes the way we talk to and coach our clients to promote success.

Along with these significant outcomes, three other notable achievements of the partnership are:
1. The creation of the Life Redesign Model™:
   • A culture of personal accountability, support risk taking, social capital and meaningful community participation
   • Services planned around what the person wants more of in life. Participation in relevant life situations drives the residents’ goals
   • Leveraging neuroplasticity by pursuing resident goals in real-life, non-institutional settings
   • A “doing-with” coaching approach with blended job roles and a multi-professional coaching team

2. Leading Practice – Accreditation Canada
   The Life Redesign Model™ was deemed Leading Practice by Accreditation Canada in 2016 under client and family centred care for acquired brain injury services.

3. Proven Outcomes
   10 years into a partnership with Interior Health in British Columbia, CONNECT has:
   • Transitioned 165 individuals through with an average LOS is 278 Days
   • 75% of residents move out to a lower-cost environment for years to come;
   • Generating an estimated system savings of $85M and climbing, or an ROI of 553%.

Together CONNECT Lake Country and IH have filled a significant system gap for folks with ABI, providing an opportunity for people after ABI and stroke in BC to redesign their lives. The partnership has allowed many individuals to avoid long-term care and institutionalization, with 75% of people going home and to the community after CONNECT. Most importantly, the partnership has built a huge number of powerful individual stories that can inspire change and have positive influence for the individual and others.

Measuring Success: We want to share and develop this partnership as an example of what’s possible from Hospital to Community and will measure success through:
Goal-attainment scaling
Wait times
Occupancy Rates
Length of Stay
Quality of Life
Move-out destination
Once we can prove it’s working and successful, we want to share it!
Pupil Diameter and Behavioral Responsiveness in Disorders of Consciousness

Sepehr Mortaheb1,2, Estelle Bonin1,2, Steven Laureys1,2, Camille Chatelle1,2,3
1GIGA-Consciousness, University of Liege, Liege, Belgium, 2Coma Science Group, Neurology Department, University Hospital of Liege, Liege, Belgium, 3Laboratory for NeuroImaging of Coma and Consciousness, Massachusetts General Hospital, Boston, United States

The clinical diagnosis of consciousness is mainly based on bedside observation of the patient's responses using standardized neurobehavioral scales. By definition, it is common to observe vigilance fluctuation in patients in minimally conscious state (MCS) who would show reproducible but fluctuating signs of consciousness. As the probability to detect voluntary responses depends on the patient's level of vigilance at the time of assessment, multiple assessments are needed in order to detect signs of consciousness and avoid misdiagnosis. If this fluctuation is known in disorders of consciousness (DOC), it remains poorly understood and characterized. In this study, we investigated the relationship between pupil diameter (suggested as an objective physiological measure of alertness level in healthy subjects) and behavioral responsiveness in DOC patients. To this end, five patients with chronic DOC (1 unresponsive wakefulness syndrome [UWS; ie, reflexive responses], 2 MCS- [ie, signs of consciousness but no signs of language preservation, 2 MCS+ [ie, signs of language preservation]; 3 males; age=47±15.16 (median ± SD), median TSI=284 days) were enrolled. For each patient, four behavioral assessments were performed in a single day using the Coma Recovery Scale-Revised. Before each assessment, pupil response was recorded for 10 minutes during resting state. One of the patients (MCS-) was excluded from the analysis due to eye closure during whole recording period. Pupil diameter was recorded using Phasya Drowsimeter R100 glasses (eye images acquired at 120 Hz with a high-speed camera integrated into the glasses). Eye closure periods were marked manually. Several parameters were investigated: eye opening percentage (EOP), as well as median, variance, entropy, and Lempel-Ziv complexity of the pupil diameter. We here provide preliminary descriptive results for this small sample.

We observed lower EOP and median pupil diameter when the patients were unresponsive (i.e., diagnosis of UWS) vs. when they were responsive at bedside (i.e., MCS; median EOP=74.78% vs 99.6%, median pupil diameter=21 vs 28). Variance did not show any specific pattern; however, complexity measures of entropy and Lempel-Ziv were also lower in the UWS (median entropy=9.83 vs 10.58 and median Lempel-Ziv complexity=121 vs 328). Median pupil diameter also seemed to be more sensitive to behavioral changes across different assessments. These preliminary data suggest that higher responsiveness is related to higher median and complexity of the pupillometry signal and eye-opening percentage at rest, supporting that pupillometry markers could be used as potential predictor of behavioral responsiveness in DOC patients.
International validation of the Phone Outcome Questionnaire for patients with Disorders of Consciousness

Audrey Wolff1,2, Anna Estraneo3, Enrique Noé4, Rita Formisano5, Gianfranco Lamberti6, Orsola Masotta3, Daniela Lo Sapiò3, Joan Ferri4, Séverine Blainiaux1,2, Charlène Aubinet1,2, Helena Cassol1,2, Manon Carrière1,2, Leandro Sanz1,2, Alice Barra1,2, Jitka Annen1,2, Estelle Bonin1,2, Aurore Thibaut1,2, Charlotte Martial1,2, Steven Laureys1,2, Olivia Gossiers1,2

1GIGA-Consciousness, Université De Liège, Liège, Belgique, 2Coma Science Group, Neurology Department, University Hospital of Liège, Liège, Belgium, 3DOC Research Laboratory and Neurorehabilitation Unit for DOC patients, Maugeri Clinical Scientific Institutes, Telese Terme, Italy, 4Servicio de Neurorehabilitación de Hospitales Vithas, Valencia, Spain, 5Primario Unità Post-Coma Ospedale di Riabilitazione Fondazione Santa Lucia Via Ardeatina, Rome, Italy, 6Neurorehabilitation and Vegetative State Unit “E. Viglietta”, Pelvic Floor Dysfunction Rehabilitation Center, Cuneo, Italy

Background: Assessing the evolution of severely brain-injured patients with disorders of consciousness (DOC) with tools like the Glasgow Outcome Scale-Extended (GOS-E)1 remains a challenge. At the bedside, the most reliable diagnostic tool is the Coma Recovery Scale–Revised (CRS-R)2,3. It distinguishes between patients in an unresponsive wakefulness syndrome (UWS)4 patients in a minimally conscious state (MCS) and patients who have emerged from MCS (EMCS)5,6. The present international multi-centric study aims to validate a new phone outcome questionnaire (POQ) based on the CRS-R and compare it to the GOS-E. The POQ allows clinicians to probe the evolution of a patient’s state of consciousness based on caregivers’ feedback. This project is part of the IBIA-DOC-SIG and DOCMA consortium.

Methods: Five centres were involved in this study with at least two blinded examiners per centre. Examiner A conducted a phone interview with the patient’s main caregivers, asked for the caregivers’ and patients’ demographical data and administered the POQ, which evaluates the presence and frequency of purposeful behaviors based on CRS-R items, as well as the GOS-E. Examiner B performed 5 evaluations with the CRS-R7,8,9 within one week of the phone interview and the best CRS-R diagnosis was retained3. We measured diagnostic agreement between the CRS-R’s best clinical diagnosis, the POQ and the GOS-E.

Results: Seventy-four DOC patients (28 UWS, 37 MCS, 9 EMCS; 26 females; 48±17 years old; median time since injury: 10 months; 22 traumatic injury; 14 home, 52 rehabilitation centers, 7 nursing home, 1 other place) were enrolled (23 in ULiège, 24 in ICS Maugeri, 16 in NISA, 5 in Santa Lucia, 4 in Cuneo) and 74 caregivers (54 females; 50±14 years old) who frequently visited their relative were contacted by phone. We found 53/74 matches (72%) between the CRS-R and the POQ and 55/74 matches (74%) between the CRS-R and the GOS-E. We observed a 41/74 match (57%) between the CRS-R and the POQ, when we distinguish MCS- and MCS+ (i.e., absence or presence of language processing, respectively). In case of discrepancy, caregivers tended to observe more complex behaviors compared to clinicians who performed the CRS-R. Finally, we found a 68/74 match (92%) between the POQ’s and GOS-E’s diagnosis.

Conclusions: This study showed a good agreement between the POQ, GOS-E and the CRS-R when considering UWS, MCS and EMCS diagnosis. Further analysis will be done to better understand the discrepancy between families’ observations and repeated standardized assessments. In conclusion, the POQ can be recommended for the use of long-term longitudinal studies with DOC patients.
Dysphagia Rehabilitation Intervention Strategies in Moderate-Severe Acquired Brain Injury: A Scoping Review

Brooke Benton¹, Amanda McIntyre¹, Magdalena Mirkowski³, Pavlina Faltynek⁴, Robert Teasell¹, ², ³
¹Parkwood Institute Research, Lawson Health Research Institute, Parkwood Institute, London, Canada, ²Parkwood Institute, St. Joseph’s Health Care London, London, Canada, ³Schulich School of Medicine & Dentistry, University of Western Ontario, London, Canada

Objectives: To conduct a scoping review of all available literature on interventions for dysphagia rehabilitation among individuals with acquired brain injury (ABI), to answer the research question: What literature is available investigating dysphagia-specific interventions for moderate-severe non-stroke ABI?

Methods: A literature search was conducted using PubMed, MEDLINE, Embase, and CINAHL for studies published in English up to July 2018. Studies were included if: (1) a dysphagia rehabilitation intervention was provided to participants, (2) any of the participants had moderate to severe non-stroke ABI, and (3) there were ≥1 adult (≥18 years) participants. For each study meeting inclusion criteria, data on author(s), year, country of publication, study design, sample size, demographic information (age, gender, injury etiology), intervention type, comparators, and outcome measures were extracted. Levels of evidence were assigned to each study using the modified Sackett scale.

Results: Among the 16 studies which met our inclusion criteria, eight studies had a population of <50% ABI, three had >50% ABI, and five included an unspecified percentage of ABI. Eleven studies (68.75%) were published in the last six years (2012-2018), with the five remaining studies (31.25%) published more than ten years ago (1990-2007). Fourteen studies were published as journal articles, and two were conference abstracts. Four studies originated in the United States, three from Spain, two from each of the following countries, Canada, Korea, and Japan, and one each from South Africa, Germany, and Italy. Two randomized controlled trials (RCTs) provided level 1b evidence, six studies (3 RCTs, 3 prospective controlled trials) were level 2 evidence, six (3 post-test, 3 pre-post) were level 4 evidence, and two case studies provided level 5 evidence. Nine different interventions were investigated for dysphagia rehabilitation, with electrical stimulation, individualized management programs, and diet manipulation being the most common interventions. Eleven unique outcome measures were used overall, which crossed several domains and evaluated various outcomes including swallowing function, nutritional status, and aspiration.

Conclusions: The literature investigating dysphagia rehabilitation interventions for non-stroke ABI is limited, with wide variability in terms of intervention types, interventional study designs, study population injury etiology, and outcome assessment across studies. Although a growth in the number of dysphagia studies has been observed within recent years, there remains an important gap in the literature pertaining to dysphagia rehabilitation in non-stroke ABI populations.
Medication Management and Early Functional Outcomes of Pediatric Patients Diagnosed with Anti-NMDA Receptor Encephalitis during Inpatient Rehabilitation

Robyn Howarth1, Joshua Vova1, Gabrielle Alvarez1, Laura Blackwell1
1Children’s Healthcare of Atlanta, Atlanta, United States

Objective: Anti-NMDA receptor encephalitis is a recently described auto-immune disorder with a predictable clinical course. Early symptoms may include psychiatric symptoms and/or behavioral changes followed by seizures, movement disorder, and neurologic decline. Treatments include immunotherapies and various medications for symptom management. However, there is limited existing literature examining the medication management of pediatric patients, especially within an inpatient rehabilitation setting. The primary aim of the current study is to discuss the medication management of patients during admission to an inpatient rehabilitation unit. The second aim is to examine how the clinical presentation and medication management may relate to early functional outcomes.

Participants & Methods: Twenty-six pediatric patients were included with a confirmed diagnosis of anti-NMDA receptor encephalitis who required intensive inpatient neurorehabilitation following acute care hospitalization. Medications used for symptom management were grouped into six categories: agitation, cognition, sleep, psychiatric, anti-convulsant, and movement. Level of functioning (Functional Independence Measure for Children; WeeFIM) was assessed at admission and discharge. Patients were divided into two groups based on change in total WeeFIM score over the course of rehabilitation, including low responders (n=9) and high responders (n=17).

Results: On average, patients were 10.8 years of age (SD=5.2) at the time of symptom onset. During admission, a majority of patients received medications to treat agitation (96.3%), psychiatric symptoms (92.6%), seizures (63.0%), and insomnia (55.5%) compared to a smaller percentage of patients receiving medications to treat disordered movements (33.3%) and cognitive dysfunction (14.8%). From admission to discharge, three categories of medication decreased (agitation, sleep, anti-convulsants) whereas three categories of medication increased (cognition, psychiatric, movement).

With regard to early outcomes, one-way ANOVA revealed low responders (M=6.86) were younger than high responders (M=12.87). Hierarchical logistic regressions demonstrated that treatment for seizures [X2 (1) = 5.53, p < .05] and treatment for movement disorders [X2 (1) = 15.77, p < .01] was predictive of low functional gain above and beyond age. There was a trend for patients treated with two or more anti-psychotic medications to show higher functional gains during inpatient rehabilitation admission (p=.056). No differences were found to be associated with treatment for sleep or agitation.

Conclusions: Symptom management for pediatric patients with anti-NMDA receptor encephalitis often involves polypharmacy. Rehabilitation physicians are challenged to optimize symptom management, minimize side effects, and avoid interaction effects while also ensuring a patient can participate in intensive rehabilitation therapies. It is important for the approach to medication management to consider both brain injury and psychiatry perspectives. Current findings also suggest that younger age, treatment for seizures, and treatment for movement disorders may put patients at increased risk for worse functional outcomes following inpatient rehabilitation.
Predictors of Long-Term Outcomes after Inpatient Rehabilitation in Patients with Traumatic Brain Injury

Sareh Zarshenas1,2, Angela Colantonio1,2, Susan Horn3, Susan Jagla1,2, Nora Cullen1,2

1University of Toronto, Rehabilitation Sciences Institute, Toronto, Canada, 2University Health Network, Toronto Rehabilitation Institute, Toronto, Canada, 3University of Utah School of Medicine Department of Population Health Sciences, Salt Lake City, United States

Objective: To investigate the association of intervention activities during inpatient rehabilitation (IR) and post-discharge conditions with long-term outcomes.

Design: Secondary analysis of data set.

Participants: A total of 85 patients with TBI consecutively admitted to IR in one Canadian Institute during 4 years and had data available from admission to about 1 year post-injury. Main outcome measures included Functional Independence Measure-Rasch cognitive and motor scores.

Intervention: Not applicable.

Results: Having fewer post-discharge health conditions was associated with better long-term cognitive and motor scores.

Also, more therapy time in complex occupational therapy activities was significant predictors of better long-term motor function.

Conclusion: Results of this study underlines the importance of making patients and families aware of residual health conditions following discharge from IR. Also, this study provides valuable information for clinicians and patients about long-term benefits of IR activities.
Botulinum Toxin A in Upper Limb Spasticity Management: Changing Clinical Practice. Data from the Upper Limb International Spasticity (ULIS) Programme

Lynne Turner-Stokes1, Stephen Ashford1, Klemens Fheodoroff2, Jorge Jacinto3, Allison Brashear4, Pascal Maisonobe5, Andreas Lysandropoulos6

1King’s College London School of Medicine, Palliative Care, Policy and Rehabilitation and Regional Rehabilitation Unit, Northwick Park Hospital, London, United Kingdom, 2Department of Neurorehabilitation, Gaißal-Klinik, Hermagor, Austria, 3Centro de Medicina de Reabilitação de Alcoitão, Serviço de Reabilitação de Adultos, Estoril, Portugal, 4Wake Forest School of Medicine, Department of Neurology, Winston-Salem, United States, 5Biometry, Ipsen Pharma, Boulogne-Billancourt, France, 6Global Medical Affairs, Ipsen Pharma, Boulogne-Billancourt, France

Background: The Upper Limb International Spasticity (ULIS) programme is a series of observational cohort studies across >30 countries. The program evaluates treatment of ULS with botulinum toxin A (BoNT-A) and concomitant therapies in real-life clinical practice. Primary outcomes focus on the achievement of person-centered goals to capture the diversity of patients’ priorities across the wide spectrum of spasticity-related problems presenting for treatment.

Systematic evaluation of individual goal achievement over the last 10 years has led to important changes in clinical practice.

Aim of the Study: This analysis explores changes in goal setting and achievement between the second and third stages of the program to describe these emerging changes in our approach to spasticity management.


Throughout the program we have progressively refined the approach to outcome measurement. The Upper Limb Spasticity Index (ULSI) now uses a structured approach to goal attainment scaling (GAS), recorded alongside standardized outcome measures and critical confounders. The Upper Limb Spasticity Therapy Recording Schedule (ULSTR) provides detail on concomitant therapies and self-directed exercise.

Results: Between ULIS-II and III, the overall rate of goal achievement fell from 79.6 to 69.4%, reflecting tighter definition of goals. Nevertheless, overall GAS T scores were 52.0 (SD 10.1) for ULIS-II and 49.9 (SD 7.9) for ULIS-III, indicating that goals were achieved at least as expected.

Between ULIS-II and -III, the frequency of primary goals set for pain increased from 13.4 to 25.3%; for reduction of involuntary movement from 9.0 to 13.3% and for passive function from 28.9 to 30.7%. Correspondingly, goal setting for active function decreased from 22.8 to 15.0% and for range of movement from 23.0 to 13.9%.

Patterns of injection have also changed between ULIS-II and -III. In particular, the frequency of injection around the shoulder increased from 32 to 39.4% (the majority of those being targeted on pain reduction) possibly because clinicians have increasingly become aware of the benefits of BoNT-A in management of spasticity-related shoulder pain.
Conclusion: Developed over a decade, the ULIS program provides a uniquely rich dataset to describe the evolution of clinical practice in spasticity management as clinicians start to appreciate which goals are more likely to be achieved for which patients.

Breaking data from this initial cycle of ULIS-III provide preliminary insights into these developments, which will be expanded as the longitudinal data from repeated cycles become available. Full data are expected by 2020.
Risk Factors of Obstructive Sleep Apnea among Individuals with Moderate to Severe Traumatic Brain Injury

Kimberley Monden¹, David Mellick¹, Kathleen Bell², Jennifer Bogner³, Jesse Fann⁴, Jeanne Hoffman⁴, Marc Silva⁵, Risa Nakase-Richardson⁵
¹Craig Hospital, Englewood, United States, ²UT Southwestern Medical Center, Dallas, United States, ³The Ohio State University, Columbus, United States, ⁴University of Washington Medical Center, Seattle, Australia, ⁵James A. Haley Veteran’s Hospital, Tampa, United States

Objective: Twenty-five percent of people with traumatic brain injury (TBI) have been found to have obstructive sleep apnea (OSA) (Mathias & Alvaro, 2012) – rates that are much higher than in the general population. Sleep disturbances have the potential to negatively impact inpatient rehabilitation, recovery, and outcomes. Therefore, identification of persons at risk for OSA is imperative to address the impact of sleep early after TBI. Prior research has not provided information about the potential impact of TBI severity on the presence or absence of OSA. The purpose of the present study is to examine the relationship between TBI severity and presence of OSA during inpatient rehabilitation.

Design: Cross-sectional analysis of an ongoing, three-year multicenter prospective observational cohort study comparing methods to screen for and diagnose OSA.

Setting: Six inpatient rehabilitation centers across the United States.

Main Outcome Measure(s) and Analysis: The primary outcome (OSA) was assessed with Level 1 polysomnography and characterized using the American Academy of Sleep Medicine (AASM) Obstructive Apnea-Hypopnea Index. Participants were classified as either having a diagnosis of OSA or not having a diagnosis of OSA. A binomial logistic regression was performed to ascertain the effects of age, body mass index (BMI), neck circumference, and TBI severity on the likelihood that participants were diagnosed with OSA.

Results/Conclusions: The sample consisted of 233 participants who were primarily male (83%) with an average age of 43 years (SD=18). The most common causes of injury were motor vehicle collisions (42%) and falls (32%). 67% of participants met AASM criteria for diagnosis of OSA. BMI ranged from 14 to 50 (M = 25.99, SD = 5.15). The average number of days in post-traumatic amnesia was 35.87 (SD = 48.55) and ranged from 0 to 323 days. The logistic regression model was statistically significant, χ² 46.27, p < .0001. The model explained 41% of the variance (Nagelkerke R²) in OSA and correctly classified 77.6% of the cases. Sensitivity was 85.9%, specificity 59.5%, positive predictive value was 82.3%, and negative predictive value was 65.8%. Of the four predictor variables, only age was statistically significant. Increasing age was associated with an increased likelihood of being diagnosed with OSA (OR = 1.10, p < .0001). Severity of TBI was not found to be a statistically significant predictor of OSA diagnosis (p = .17).

When considering age, BMI, neck circumference, and severity of TBI, the model correctly classified the presence or absence of OSA in 78% of participants. In this sample, age was the only significant predictor of OSA. Contrary to the general population, BMI, and neck circumference did not significantly increase the odds of being diagnosed with OSA.
Participants’ Satisfaction with Compensatory Cognitive Training (CCT) as Part of a Vocational Rehabilitation Program

Emilie Howe1,2, Silje Fure3, Anne-Margrethe Linnestad3,4, Helene Ugelstad5, Øystein Spjelkavik3, Heidi Enehaug3, Cecilie Røe1,2, Torgeir Hellstrøm1, Elizabeth Twamley6,7, Marianne Løvstad4,8, Nada Andelic1,2

1Department of Physical Medicine and Rehabilitation, Oslo University Hospital, Oslo, Norway, 2Faculty of Medicine, University of Oslo, Oslo, Norway, 3Oslo Metropolitan University, Oslo, Norway, 4Sunnnaas Rehabilitation Hospital, Nesoddtangen, Norway, 5Department of Vocational Rehabilitation, Norwegian Labour and Welfare Administration, Oslo, Norway, 6Center of Excellence for Stress and Mental Health, VA San Diego Healthcare System, San Diego, United States, 7Department of Psychiatry, UC San Diego, San Diego, United States, 8Department of Psychology, University of Oslo, Oslo, Norway

Background: Compensatory Cognitive Training (CCT) is a group-based manualized cognitive training intervention developed in the United States (1). CCT targets post-concussive and cognitive (learning and memory, prospective memory, attention and concentration, cognitive flexibility and problem-solving, planning and goal-setting) symptom management following traumatic brain injury (TBI), and has previously been delivered to veterans with mild TBI (2). As part of an ongoing randomized controlled trial aimed at exploring the effect of a combined cognitive and vocational intervention, CCT was adapted to a Norwegian setting.

Aims: Assess satisfaction with CCT in a civilian TBI-sample and compare satisfaction ratings to a previous pilot study (1).

Methods: Thirty-eight individuals with mild-to-moderate TBI in the South-Eastern region of Norway received the CCT-intervention over a period of 10 weeks. Satisfaction with the intervention was assessed with the CCT Feedback Form consisting of 9 items rated on a 5-point scale with regard to perceived helpfulness (1 = not helpful, 5 = extremely helpful). Participants also provided qualitative feedback on what topic or strategy they found most and least helpful, suggestions on how to improve the program, and whether they would recommend the program to others with similar problems. Descriptive statistics were applied.

Results: Average age was 40 years (range 25-58) and years of education was 16 (range 12-22), with 53% being male. The participants rated information about TBI and post concussive symptoms, strategies for fatigue, prospective memory, attention and concentration, and learning and memory above 3.5 (i.e. towards very helpful), and strategies for headache, problem solving and cognitive flexibility, and information about additional services available above 3 (i.e. moderately helpful). Information regarding TBI and post concussive symptoms received the highest mean rating (4.1), while sleep strategies received the lowest mean rating (2.9). The total mean score of all categories was 3.5. With the exception of sleep strategies, these results are comparable to Twamley’s pilot study (1). In the qualitative feedback section, the participants reported the most helpful strategies to be those concerning memory, fatigue, attention and concentration. With regards to the least helpful strategies, strategies related to organization, problem-solving and cognitive flexibility were most frequently mentioned. The most frequent suggestion on how to improve CCT was to increase program duration. Finally, 87% of the participants responded that they would recommend CCT to others with similar problems (8% = “I don’t know”, 5% = “No”).

Conclusion: The participants rated most topics in the CCT-intervention CCT as helpful. Based on the feedback, minor adjustments concerning duration and sleep strategies could be considered. As the main study is ongoing, the results are preliminary, and final results will be presented at the congress.
Admission Levels of Tau, Aβ40 and Aβ42 in Predicting Outcome of Mild TBI

Iftakher Hossain1,2,3, Mehrbod Mohammadian2,3, Riikka Takala2,4, Olli Tenovuo2,3, Leire Azurmendi6, Henna Ala-Seppälä2,3, Mark van Gils6, Peter Hutchinson7, Ari Katila2,4, Henna-Riikka Maanpää1,2,3, David Menon8, Virginia Newcombe8, Jussi Tallus2,3,9, Kevin Hrusovsky10, David Wilson10, Kaj Blennow11,12, Jessica Gill13, Henrik Zetterberg11,12,14,15, Jean-Charles Sanchez5, Jussi Posti1,2,3

1Division of Clinical Neurosciences, Department of Neurosurgery, Turku University Hospital, Turku, Finland, 2Turku Brain Injury Centre, Turku University Hospital, Turku, Finland, 3Department of Neurology, University of Turku, Turku, Finland, 4Perioperative Services, Intensive Care Medicine and Pain Management, Turku University Hospital and University of Turku, Turku, Finland, 5Department of Human Protein Sciences, Faculty of Medicine, University of Geneva, Geneva, Switzerland, 6Department of Clinical Neurosciences, Neurosurgery Unit, University of Cambridge, Addenbrooke’s Hospital, Cambridge, United Kingdom, 7VTT Technical Research Centre of Finland Ltd., Tampere, Finland, 8Division of Anaesthesia, University of Cambridge, Addenbrooke’s Hospital, Cambridge, United Kingdom, 9Department of Radiology, Turku University Hospital, Turku, Finland, 10Quanterix Corporation, Lexington, United States, 11Institute of Neuroscience and Physiology, Department of Psychiatry and Neurochemistry, Sahlgrenska Academy at the University of Gothenburg, Mölndal, Gothenburg, Sweden, 12Clinical Neurochemistry Laboratory, Sahlgrenska University Hospital, Mölndal, Gothenburg, Sweden, 13National Institute of Nursing Research, National Institutes of Health, Bethesda, United States, 14Department of Molecular Neuroscience, UCL Institute of Neurology, Queen Square, London, United Kingdom, 15UK Dementia Research Institute at UCL, University College London, London, United Kingdom

Objectives: To investigate if admission levels of tau and β-amyloid isoforms 1-40 (Aβ40) and 1-42 (Aβ42) correlate with outcome in patients with mild traumatic brain injury (mTBI).

Methods: Patients with mTBI (n = 105, [Glasgow Coma Scale (GCS) ≥ 13]) were included in this study. Blood samples were drawn within 24 hrs of admission for analysis of tau, Aβ40 and Aβ42 using ultrasensitive single molecule array (Simoa) technology. Patients were divided into computed tomography (CT)-positive and CT-negative groups. The outcome was assessed 6-12 months after the injury using the Extended Glasgow Outcome Scale (GOSE). Outcomes were defined as complete (GOSE 8) or incomplete (GOSE < 8) recovery. Panels of biomarkers were generated to assess their predictive values for different outcomes and to compare how combination of biomarkers perform compared to single biomarkers.

Results: The admission levels of tau, Aβ40 and Aβ42 were not significantly different between patients with complete and incomplete recovery. The levels of tau, Aβ40 and Aβ42 could poorly predict complete recovery, with the area under the receiver operating characteristic curve 0.557, 0.525 and 0.543, respectively. There was a significant negative correlation between the levels of tau and GOSE score (Spearman ρ = -0.231, p = 0.018). In a multivariate logistic regression model including age, GCS, duration of posttraumatic amnesia, injury severity score, time from injury to sampling and CT findings, none of the biomarkers could improve prediction of complete recovery, independently or together with the other two biomarkers. For CT-positive and CT-negative subgroups, the levels of tau, Aβ40 and Aβ42 did not differ between the outcome groups, and the levels of Aβ40 and Aβ42 did not correlate significantly with the outcome. In the CT-positive subgroup, the levels of tau significantly correlated with GOSE score (Spearman ρ = -0.288, p = 0.035). Panels of biomarkers had a better sensitivity of 90.8% (95% CI, 83.1-96.9) and a specificity of 57.1% ((95% CI, 40-74.3) for predicting complete recovery compared to a single biomarker performance.
Conclusion: The early levels of tau are significantly correlated with the outcome in patients with mTBI. Neither tau, Aβ40 or Aβ42 alone nor in different combinations could predict full recovery in patients with mTBI.
Traumatic Brain Injury Induces Cell Death and Alters IGF Signaling in Human Primary Dopaminergic Neuronal Precursor Cells

Syed Ali¹, Susan Lantz¹, Elvis Cuevas¹, Syed Imam¹, Hector Rosas-Hernandez¹
¹National Center for Toxicological Research, Jefferson, United States

Traumatic brain injury (TBI) is one of the major causes of disability in the United States. TBI is caused when an external mechanical force induces damage to the brain due to impact, penetration, rapid acceleration/deceleration or blast waves, resulting in deformation throughout the brain tissue. Although one of the consequences of TBI is neuronal cell death, different molecular mechanisms are triggered as response of the initial trauma that can affect the outcome of recovery, including insulin-like growth factor-1 (IGF-1) signaling. IGF-1 is a polypeptide hormone with a wide variety of functions in the brain including: proliferation, survival, axon myelination and neurite outgrowth. Although IGF-1 is synthetized mainly in the liver by influence of growth hormone (GH), IGF-1 can also be locally produced in the brain by a GH-independent mechanism. Serum levels of IGF-1 are decreased after brain injury probably due to pituitary dysfunction, whereas brain levels of IGF-1 increase after TBI. Exogenous administration of IGF-1 has proven to be neuroprotective after TBI. Therefore, this study evaluated changes in the neuronal levels of IGF-1 and related proteins after TBI in vitro. Human primary dopaminergic neuronal precursor cells (HPDNPC) were differentiated for 7 days before being submitted to mild (10% stretch) or severe (50% stretch) TBI in vitro using a commercially available system. Subsequent analyses were performed 1 and 7 days after injury. Release of lactate dehydrogenase (LDH) was measured as an index of cell death and levels of IGF-1, IGF-2, insulin and IGF binding proteins (IGFBPs) were measured in cell lysates using an IGF signaling array. LDH release increased only at 50% stretch 1-day post-injury and values returned to control levels after 7 days. 50% stretch decreased while 10% stretch increased IGF-1 levels 1-day post injury; however, the levels of this hormone were decreased at both conditions after 7 days. IGF-2 decreased 1 day after injury but increased after 7 days under both conditions. IGFBPs remained practically unchanged, except for IGFBP-2, which levels increased after 10% and 50% stretch both 1- and 7-days post injury. On the other hand, insulin levels decreased 1-day post injury under both conditions, whereas 10% decreased and 50% increased its levels 7 days after injury. These data suggest that IGF signaling is altered by both mild and severe TBI and may trigger different mechanisms inside the neuron independent of cell death since the proteins involved in IGF signaling were differently expressed even in conditions where no cell death was observed. Further investigation is required to analyze which neuronal functions are altered by IGF signaling after TBI and if manipulation of this pathway may confer neuroprotection after brain injury. Supported by NCTR protocol E7584.11.
Multidisciplinary Neurobehavioural Assessment and Treatment of Somatoform and Cogniform Disorder Following Mild Traumatic Brain Injury: Review and Case Study

John Davis, Fran Richardson, Scott McCullagh, Zhihui Deng, Flor Muniz-Rodriguez

1 Hamilton Health Sciences, Hamilton, Canada

We describe a case of mild traumatic brain injury with somatoform and cogniform symptoms which had successful and durable outcome following specialized neurobehavioural rehabilitation in an inpatient setting. Treating individuals following traumatic brain injury requires careful assessment and formulation of complex, interacting factors related, for example, to the person’s physical, mental, and social condition, as well as their health history before and after injury. In many cases, somatic and cognitive symptoms are not easily explained by the injury itself, are out of proportion to the immediate effects of trauma, and difficult to account for by the patient's current physical condition. Such symptoms may be characterized as somatoform and diagnosed as a somatic symptom disorder if a medical explanation cannot be found for the symptom and it occurs with a distinctive pattern of affect, thinking, and behaviour. Analogously, cognitive symptoms, for example of pronounced memory deficit, may be characterized as cogniform if results of neuropsychological assessment show levels of performance or patterns that cannot be explained by a neuropsychological formulation. Although somatoform and cogniform symptoms are not easily explained, they can cause disproportionate suffering among patients, loss of function at home and community, and frustration among health care professionals. This presentation reviews a model for understanding, assessing, and treating somatoform and cogniform symptoms in the context of a biopsychosocial approach to formulation. The application of this model in an inpatient neurobehavioural rehabilitation service will then be illustrated with the case of a patient who presented somatoform and cogniform symptoms and benefited from treatment to the degree that he resumed his independent social life and work.
Using Novel Virtual Reality-based Neuropsychological Tests to Measure Performance in a Mild Traumatic Brain Injury (mTBI) Patient with and without Levoamphetamine/Dextroamphetamine (Adderall)

Bill Rosen¹², Gabriel Rau¹, Thomas Rau¹
¹Neural Injury Center, University of Montana, Missoula, United States, ²Bill S Rosen, MD, PC, Missoula, United States

Objective: Stimulants are commonly used in the treatment of mTBI. Many patients report immediate improvements in cognitive and/or behavioral functioning with the ingestion of stimulants. However, these benefits are largely subjective, as there is a paucity of objective data that supports their validity. The purpose of this case study was to objectively assess stimulant use in a mTBI patient, who continues to experience self-reported cognitive impairments.

Methods: In previous research, we developed a novel virtual reality (VR) testing suite for mTBI subjects, in which neurological and cognitive performance is evaluated. Speed and accuracy data is collected for an ascending battery of seven distinct tests that assess visual and auditory performance, visual-spatial accuracy, visual-motor coordination, working memory, and executive function. Currently, we have collected data on over 100 brain injured patients and over 50 age matched healthy peers. We have observed significant differences between brain injured subjects suffering from persistent cognitive issues and non-injured controls. Using our VR application, we tested a 45-year-old female who had suffered a mTBI 3.5 years previously and reports persistent cognitive issues, additionally, her exam reveals residual neurologic impairments. With regular Adderall use, she expressed a marked improvement in cognitive function. For this case study, her initial test was performed 30 minutes after having consumed her usual 20 mg dose of Adderall. Her second test was performed 2 weeks later, after having abstained from Adderall for 24 hours prior to testing. There were no other changes in her treatment and the testing was done at the same time of day in each case.

Results: While using Adderall, the test subject performed significantly better on visual reaction time, visual accuracy and on auditory reaction time tests. On visual-spatial testing, visual-motor coordination, memory, and impulse control tests, the subject experienced a reduction in performance while on Adderall.

Conclusions: This case study suggests that Adderall did provide the subject with a benefit, by improving auditory and visual reaction time responses. However, the subject’s performance was significantly decreased on tests that required memory and executive function. This observation, while only a single data point, does suggest that Adderall in mTBI subjects may improve performance in certain areas while compromising performance in other areas. Further investigation is warranted.
Brain Damage Biomarkers Associated with Diffuse Axonal Injury in Patients with Traumatic Brain Injury

**Alejandro Bustamante**, Deborah Pareto, Laura González-García, Natalia Gill, Monica Buxeda, Elsa González-Pérez, Elisa Cuadrado-Godía, Manuel Quintana, Jean-Charles Sanchez, Alex Rovira, Joan Montaner

1Vall d’Hebron Institute of Research (VHIRr), Barcelona, Spain, 2MRI unit, Institut de Diagnostic per la Imatge (IDI), Hospital Universitari Vall d’Hebron, Barcelona, Spain, 3Department of Clinical Biochemistry, Hospital Universitario Virgen del Rocio, Seville, Spain, 4Department of Neurosurgery, Hospital Universitari Mutua de Terrassa, Terrassa, Spain, 5Department of Neurosurgery, Hospital Universitari Son Espases, Mallorca, Spain, 6Department of Neurology, Hospital del Mar, Barcelona, Spain, 7Emergency Department, Hospital Universitario la Paz, Madrid, Spain, 8Department of Human Protein Sciences, University of Geneva, Geneva, Switzerland

Background: Although just 8-10% of mild traumatic brain injuries (mTBI) have visible lesions on computer tomography (CT) scans, 30% of patients with mTBI experience some degree of neurologic or cognitive sequels. Detection of diffuse axonal injury (DAI) with magnetic resonance imaging (MRI) sequences such as susceptibility weighted imaging (SWI) and diffusion tensor imaging (DTI) have demonstrated higher sensitivity than CT for the prediction of clinical outcome after mTBI. The objective of the present study was to investigate the clinical value of blood biomarkers for prediction of MRI lesions in patients with mTBI.

Methods: The study included 20 patients with mTBI, defined as a non-penetrating head trauma with a Glasgow Coma Scale (GCS)>13, with one or more of the following: loss of consciousness <30 minutes, post-traumatic amnesia <24 hours, persistent vomits, severe headache or equilibrium disorders. All of them underwent a CT scan within the first 24 hours after TBI. Blood samples were collected within six hours after trauma, to analyze serum levels of CCL23, S100b, VCAM, GSTP-1, IL-10 and H-FABP by different immunoassays. A MRI including DTI and SWI was performed within 7 days after trauma. A positive MRI (MRI+) was considered if any of the following were present: any hemorrhage or cortical contusion, diffuse axonal injury (DAI-defined as four or more non-hemorrhagic white matter lesions), or any damage at the corpus callosum. Fractional anisotropy (FA) was evaluated at pre-specified regions of interest (ROI) and corrected by the mean FA between all ROIs in each patient. Outcome was evaluated at three months with the Glasgow Outcome Scale (GOS). Patients were divided into three groups: CT+, CT-MRI+ and MRI- (all CT+ patients were MRI+).

Results: From the included 20 patients (mean age 50.7±22.7, 50% female), six were CT+, four CT-MRI+ and 10 MRI-. Corrected mean FA and FA in the splenium of corpus callosum were correlated with 3-month GOS. Serum IL-10 and H-FABP levels were elevated in CT+ patients (p=0.017 and 0.036, respectively), but no differences were found between CT+ and CT-MRI+ patients. S100b was positively correlated with corrected FA in the splenium of corpus callosum (R=-0.518 and -0.736, p=0.102 and 0.010 for left and right sides, respectively). High S100b levels were found in patients with hemorrhages (p=0.064), microbleeds on SWI (p=0.014) and cortical contusions (p=0.011). There were no significant associations between biomarkers and 3-month GOS.

Conclusions: The present pilot study investigated the use of serum biomarkers to predict MRI findings of DAI. Despite a small sample size, our study showed that H-FABP and IL-10 might have potential to serve as a clinical screening tool, predicting severe lesions on CT scan as previously described. In addition, S100B might be a predictor for the presence of DAI in MRI.
Influence of Body-Oriented Therapy on Executive Abilities in Preschool Children with ADD

Sergey Kiselev
Ural Federal University, Ekaterinburg, Russian Federation

Objectives: It is known that children with ADD have deficit of executive abilities. We have revealed that body-oriented therapy can impact executive abilities in 6-7 years age children with ADHD (Kiselelev & Parshakova, 2018). The goal of this study was to reveal effect of body-oriented therapy on executive abilities in 5 years of age children with ADD. We compared the efficacy of two methods of treatment (body-oriented therapy for children vs. conventional motor exercises) in a randomized controlled pilot study.

Methods: 14 children with ADD between 5 years of age were included and randomly assigned to treatment conditions according to a 2×2 cross-over design. The body-oriented therapy included the exercises from yoga and breathing techniques.

To assess the executive functions and attention in children we used 4 subtests from NEPSY (Tower, Auditory Attention and Response Set, Visual Attention, Statue). Effects of treatment were analyzed by means of an ANOVA for repeated measurements.

Results: The ANOVA has revealed (p<.05) that for 3 subtests (Auditory Attention and Response Set, Visual Attention, Statue) the body-oriented therapy was superior to the conventional motor training, with effect sizes in the medium-to-high range (0.44-0.82).

Conclusions: The findings from this pilot study suggest that body-oriented therapy has a specific effect on executive functions in 5 years age children with ADD. It influences predominantly the selective and sustained attention, inhibition, monitoring, and selfregulation but it has no effect on planning and nonverbal problem solving. However, it is necessary to do further research into the impact of body-oriented therapies on the prevention and treatment of ADD in children.

The research was supported by Act 211 Government of the Russian Federation, agreement 02.A03.21.0006.
A Descriptive Summary of the Medical Profiles of Former Professional Rugby League Players

Andrew Gardner¹,², Douglas Terry³,⁴,⁵,⁶, Christopher Levi¹,², Grant Iverson³,⁴,⁵,⁶
¹Priority Research Centre for Stroke and Brain Injury, School of Medicine and Public Health, University of Newcastle, Callaghan, Australia, ²Hunter New England Local Health District, Sports Concussion Program, Waratah, Australia, ³Department of Physical Medicine and Rehabilitation, Harvard Medical School, Boston, United States, ⁴Spaulding Rehabilitation Hospital, Boston, United States, ⁵MassGeneral Hospital for Children Sports Concussion Program, Boston, United States, ⁶Red Sox Foundation and Massachusetts General Hospital Home Base Program, Boston, United States

Background and Objectives: A career in contact and collision sports is physically, psychologically, and emotionally demanding. This study describes the prevalence of various health problems in retired professional rugby league athletes.

Methods: 86 former Australian professional rugby league players (age: M=52.7, SD=13.3) and 36 community-based controls with no history of collision sport participation or neurotrauma (age: M=51.9, SD=14.8) completed a clinical interview with a clinical neuropsychologist during which they were asked if they had ever been diagnosed with or treated for a variety of health conditions. The prevalence of these health conditions was compared across groups using chi-squared tests.

Results: The retired athletes and community controls were similar in age (U=1,489.5, p=.74) and years of education (retired players: M=11.8, SD=2.6, controls: M=12.8, SD=2.69, U=1,269.5, p=.11). Almost half (48.8%) of retired players reported a history of arthritis, which was a greater proportion than controls (16.7%; χ²=11.00, p=.001). A sizable minority of both groups reported a history of headaches (retired players: 23.3%, controls: 22.2%, χ²=0.02, p=.90). A greater portion of retired players reported a history of migraines (10.5%), diabetes (11.6%), and hypertension (11.6%) compared to controls (migraines: 2.8%, diabetes: 0%, hypertension: 8.2%), but these differences were not statistically significant (migraines: χ²=1.99, p=.16; diabetes: χ²=2.64, p=.10; hypertension: χ²=0.29, p=.59). A small portion of the retired player group reported various other health conditions (cancer: 5.8%, stroke: 3.5%, other heart condition: 4.7%, myocardial infarction: 2.3%, COPD: 2.4%; thyroid disease: 2.3%, peptic ulcer: 2.3%, peripheral vascular disease: 2.3%, epilepsy: 2.3%). The prevalence of these conditions did not differ across groups (ps>.05).

Conclusions: Approximately half of the retired professional rugby league players reported suffering from arthritis, which was the most commonly reported health problem among the sample. This finding is consistent with the physical demands and types of injuries that are commonly sustained during a professional rugby league career. A smaller proportion of retired players reported a number of other medical conditions, though these conditions were not reported at a significantly higher rate than the control group.
A Descriptive Summary of the Mental Health Profiles of Former Professional Rugby League Players

Andrew Gardner1,2,3, Douglas Terry3,4,5,6, Frances Kay-Lambkin1, Peter Schofield1,2, Christopher Levi1,2, Peter Stanwell1, Grant Iverson3,4,5,6

1Priority Research Centre for Stroke and Brain Injury, School of Medicine and Public Health, University of Newcastle, Callaghan, Australia, 2Hunter New England Local Health District, Sports Concussion Program, Waratah, Australia, 3Department of Physical Medicine and Rehabilitation, Harvard Medical School, Boston, United States, 4Spaulding Rehabilitation Hospital, Boston, United States, 5MassGeneral Hospital for Children Sports Concussion Program, Boston, United States, 6Red Sox Foundation and Massachusetts General Hospital Home Base Program, Boston, United States

Background and Objectives: Former collision sport athletes may be at risk for mental health problems due to a variety of factors such as lifestyle changes upon retirement, co-occurring physical health conditions, and potentially repetitive neurotrauma. We describe the mental health profiles of retired professional rugby league players.

Methods: 86 former Australian professional rugby league players and 36 community-based controls with no history of collision sport participation or neurotrauma completed a clinical interview about their mental health with a clinical neuropsychologist. Participants also completed the Depression, Anxiety and Stress Scale-21 (DASS21). Chi-Squared analyses were conducted to examine the prevalence of self-reported mental health history and current mental health symptoms on the three DASS21 scores (Depression, Anxiety, and Stress) between groups.

Results: Groups were similar on age (retired players: M=52.7, SD=13.3, range 30-89; controls: M=51.9, SD=14.8, range=31-82, U=1489.5, p=.74) and education (retired players: M=11.8, SD=2.6, controls: M=12.8, SD=2.69, U=1269.5, p=.11). Compared to controls, a higher portion of retired players reported a clinical history of psychiatric illness (i.e., anxiety or psychotic symptoms; 17.4% vs. 2.8%, χ²=4.79, p=.03). A greater portion of retired players reported a history of depression, but the results were not statistically significant (23.3% vs. 13.9%, χ²=1.37, p=.24). At the time of the evaluation, retired players were more likely to be experiencing mild or greater levels of depression (31.8% vs. 2.8%, χ²=11.95, p=.001), anxiety (18.8% vs. 2.8%, χ²=5.39, p=.02), and stress (28.2% vs. 0%, χ²=12.68, p<.001) compared to controls. Cohen’s d effect size analysis of raw scores showed medium-to-large effect size differences between the groups (DASS21 Depression: d=0.66; Anxiety: d=0.54; Stress: d=0.70). 41.2% of retired players had at least one DASS21 subscale elevation, compared to only 5.6% of controls (χ²=15.11, p<.001).

Conclusions: A substantial minority of retired professional rugby league players reported a history of mental health problems. Furthermore, the retired players more commonly reported current issues with depression, anxiety, and stress compared with community controls. This finding is consistent with previous research examining mental health difficulties in former collegiate athletes and retired National Football League (NFL) players. These results highlight the importance of evaluating past and current history of mental health concerns in retired professional athletes as part of routine medical evaluation. Further, it may be important to account for mental health symptoms when comparing retired players to controls on other outcome measures.
A Descriptive Summary of the Recreational Drug and Alcohol Uses/Abuse of Former Professional Rugby League Players

Andrew Gardner1,2,3, Douglas Terry3,4,5,6, Frances Kay-Lambkin1, Grant Iverson3,4,5,6

1Priority Research Centre for Stroke and Brain Injury, School of Medicine and Public Health, University Of Newcastle, Callaghan, Australia, 2Hunter New England Local Health District, Sports Concussion Program, Waratah, Australia, 3Department of Physical Medicine and Rehabilitation, Harvard Medical School, Boston, United States, 4Spaulding Rehabilitation Hospital, Boston, United States, 5MassGeneral Hospital for Children Sports Concussion Program, Boston, United States, 6Red Sox Foundation and Massachusetts General Hospital Home Base Program, Boston, United States

Background and Objectives: The level and duration of recreational drug use and alcohol consumption may have adverse effects on various aspects of an individual’s life. Former professional athletes may be at a greater risk of using substances due to a variety of factors, such as pain management, self-medication of mental health difficulties, or other lifestyle factors. We describe the self-reported past and present use of illicit substances and alcohol in retired professional rugby league players.

Methods: 86 former Australian professional rugby league players and 36 community-based controls with no history of collision sport participation or neurotrauma completed a clinical interview with a clinical neuropsychologist during which they were asked about their previous and current substance use across several drug categories. Participants also completed the Alcohol Use Disorder Identification Test (AUDIT). The prevalence of lifetime and recent (i.e., past 6 months) substance use was compared across groups using chi-squared tests. The total AUDIT score was compared across groups using a Mann-Whitney U Test because the data were non-normally distributed.

Results: The retired athletes and controls had similar ages (retired players: M=52.7, SD=13.3, range 30-89; controls: M=51.9, SD=14.8, range=31-82, U=1,489.5, p=.74) and years of education (retired players: M=11.8, SD=2.6, controls: M=12.8, SD=2.69, U=1269.5, p=.11). Retired players had higher scores on the AUDIT (U=887.5, p<.001). This effect was in the medium-to-large range (Cohen’s d=0.70). Similar portions of the sample reported a lifetime history of cannabis use (retired players: 38.4%, controls: 41.7%, χ2=0.12, p=.73). Very few participants reported using cannabis in the past 6 months (retired players: 3.5%, controls: 0%, χ2=1.29, p=.26). A greater portion of retired players reported a lifetime history of using any illicit drugs compared to controls (24.4% vs. 5.6%, χ2=5.90, p=.02). Over the past 6 months, 6 players reported using illicit substances (n=1 opiates, n=1 amphetamines, n=3 cocaine only, n=1 cocaine and hallucinogens; 7.0%) compared to no controls (0%; χ2=2.64, p=.10)

Conclusions: More retired professional rugby league players reported a lifetime history of illicit substances use compared to control participants, though the prevalence of lifetime cannabis use was similar across groups. At present, retired players reported more alcohol use compared to community controls, and 7% of retired players reported recent use of illicit substances. It may be important to screen for alcohol/substance use disorders in this population as part of routine clinical care. Further, drug/alcohol abuse may serve as a potential confound in studies comparing former professional athletes to controls using other outcome measures.

Carmen Martino1, Shelley Gardiner2, Catherine Wiseman-Hakes3

1Private Practice, Oakville, Canada, 2Private Practice, Aurora, Canada, 3Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada

Background and Rationale: Concussion/mild Traumatic Brain Injury (mTBI) is a commonly occurring injury and data from the Ontario Neurotrauma Foundation indicate that, in the province of Ontario, Canada, almost 150,000 people are diagnosed every year with a concussion, by a family or emergency department doctor or pediatrician. While the majority of individuals recover without complications, approximately twenty percent will go on to experience persistent and potentially debilitating symptoms that negatively impact returning to functional activities, including school, work, and recreation. Impairments in aspects of communication, that may include difficulties following complex conversations, finding words, formulating sentences, reading, writing, and social communication have been reported clinically among those with persistent symptoms. These difficulties are not routinely evaluated and the emerging evidence regarding assessment and treatment of communication and cognitive-communication issues following mTBI/concussion has not been well established.

Objectives: The purpose of this review was to synthesize and chart the literature regarding assessment and management of communication and cognitive-communication issues following mTBI/concussion. Gaps in the literature and future research directions were also identified.

Methods: This scoping review was conducted according to the framework proposed by Arksey and O’Malley (2005). Searches were conducted in Medline, Embase, CENTRAL, PubMed, CINAHL, and SpeechBite databases for studies published in English between 1995 and August 2016. An additional search was conducted in April 2018 to capture current literature. The search was focused on literature examining communication and cognitive-communication impairments in adults and children who have sustained an mTBI or concussion. Inclusion/exclusion criteria were applied to select the relevant papers. Two levels of screening were conducted (title and abstract, full text reading), by two independent reviewers and conflicts resolved by consensus.

Results: A total of 1081 articles were identified following the database searches. Of these, 44 studies met inclusion criteria. These were charted and categorized into distinct areas based on the communication and cognitive-communication impairments or management programs identified:

- Auditory comprehension, reading comprehension, pragmatic and social communication, discourse, and fluency,
- Development of protocols and/or programs for return-to-learn.

Conclusions: Results of this scoping review suggest that adults and children who have sustained an mTBI/concussion, regardless of mechanism of injury, may present with ongoing communication and/or cognitive-communication impairments. These persisting impairments can benefit from assessment and management. Gaps in the literature were identified regarding studies specific to mTBI or concussion, as the majority of studies combined participants of all severity levels. An additional gap in the literature was
identified related to the impact of communication and cognitive-communication impairments on return-to-work. These gaps may suggest directions for future research.
Associated Factors with Discharge Location from Acute Care after Traumatic Brain Injury: A Systematic Review

Sareh Zarshenas¹, Angela Colantonio¹,², Nora Cullen¹,²
¹University of Toronto, Rehabilitation Sciences Institute, Toronto, Canada, ²University Health Network, Toronto Rehabilitation Institute, Toronto, Canada

Introduction: With the increasing rate of survival after Traumatic Brain injury (TBI), more attention has been given to discharge destinations from acute care as an important measure of clinical improvement and pathway of care. Several studies were carried out on patients with brain injury in the context of acute care with the focus on the determinants of discharge to various discharge destinations. However, their results were not consistent.

Objective: to appraise and systematically review studies on clinical and non-clinical predictors of discharge to rehabilitation facilities versus home from acute care in patients with TBI.

Methods: The search was conducted using seven main databases up to November 2016 based on predefined protocol and inclusion criteria. A systematic review and in-depth quality synthesis were conducted on eligible articles using the quality in prognostic studies tool.

Results: Included studies demonstrated that a large proportion of patients with TBI were discharged home than other settings. The main predictors of discharge to rehabilitation facilities included age, race/ethnicity, accessibility to insurance coverage, severity of the injury and acute care length of stay.

Discussion: The results of this review provide evidence that may guide health care providers in making more informed and timely discharge decisions to the next level of care for patients with TBI. These findings also suggest the need for further studies with a stronger methodology to distinguish the predictors of discharge to specific rehabilitation facilities.
Concussion Assessment Tools: A Scoping Review

Ali Mojdeh¹,², Tiffany Toong², Elaine Biddiss¹,², Shannon Scratch¹,²
¹University of Toronto, Toronto, Canada, ²Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada

Introduction: The rate of adults or children seeking care following a concussion, ranges from 100 to 300 per 100,000 and concussion includes 70 to 90% of all treated traumatic brain injuries. According to concussion guidelines and consensus statements, a multi domain assessment approach is needed for management of concussion symptoms. Thus, a challenge in concussion management is determining when a person is ready to return-to-activity, as premature return-to-activity can put an individual at an increased risk of repeat concussion. At present there is no standard clinical practice for return-to-activity decision making.

Objective: The objectives of this scoping review are to: (1) identify and describe clinical tools used to assess readiness to return-to-activity following concussion; and, (2) to explore how/if these clinical tools are used to conduct multi-domain assessments in return-to-activity decision making.

Methods: A search of four databases was conducted to identify peer-reviewed, English language papers published from 2008-2018 that describe assessment tools used in return-to-activity clinical decision making following concussion. Two reviewers independently screened and extracted data describing the assessment tool (domain, psychometric properties), the clinical population tested (age), return-to-activity analysis (implemented or not), and the protocol by which the tool was administered (computer, video, self-report, etc.).

Results: Seventy-four articles were included in the review. Among those, 47 examined adults (8 on active duty service members), 37 targeted children, and 10 targeted both. All 74 articles used an objective measurement tool for their study and only 17, used some type of subjective (e.g. self-report) measure. The three most commonly used tools were: Immediate Post-concussion Assessment and Cognitive Testing (ImPACT) (23%), Sport Concussion Assessment Tool 2 or 3 (17.5%), and the Balance Error Scoring System (BESS) (17.5%). More than 90% of the articles, used single-domain tools for assessment and only 7 studies (9%) used multiple domain measures. Of the studies, 64 relied solely on single task assessment and 8 (11%), proposed and used multitask (2 or more tasks at the same time) assessments. Twenty studies (27%) suggested that their method could potentially be used for return-to-activity decision making but the measures were not formally used for this in any identified study.

Conclusion: There are many assessment tools available for return-to-activity decision-making post-concussion that address a single domain of function. Very few protocols are proposed for using these tools to assess multiple domains that may be impacted. Assessment tools and protocols that consider function in multitask paradigms are even less common. Future research is needed to improve and standardize return-to-activity decision-making following concussion that consider multiple domains and multitask demands representative of real-life activities such as sports, driving, and work.

Keywords: Concussion, mTBI, return to activity, assessment tools, clinical decision making
Test-Retest Reliability of the Acquired Brain Injury Challenge Assessment (ABI-CA) Concussion Module as a Baseline Testing Tool in Typically Developing Youth Athletes

Christopher Gupta¹, Katherine Wilson¹, Michelle Tanel¹, James Murphy¹, Virginia Wright², Nick Reed³
¹Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, ²Department of Physical Therapy, University of Toronto, Toronto, Canada, ³Department of Occupational Therapy, University of Toronto, Toronto, Canada

Background/Rationale: Concussion is a common injury in youth athletes. In concussion assessment, a multimodal approach is recommended because it evaluates performance across multiple domains (cognition, balance, gross motor abilities) that may be negatively influenced by a concussion. The Acquired Brain Injury- Challenge Assessment (ABI-CA) Concussion Module is a gross motor function assessment used in populations with acquired brain injury including concussion and may be useful in a concussion baseline testing protocol. However, the test-retest reliability of this tool in healthy children and across a clinically relevant time frame has yet to be explored.

Research Questions:
1) What is the long-term test-retest reliability of the ABI-CA Concussion Module in healthy children?
2) How do sex, age, change in height and time between assessments influence test-retest reliability?

Methods & Analyses: Sixty-seven healthy, athletic children (age 9-12 years) and adolescents (age 13-18 years) completed the 6-motor task of the ABI-CA Concussion Module at two time points between 0.5 to 24 months apart. Reliability of performance was analyzed using Intra-Class Correlations (ICC), Paired Sample t-tests, Regression Based Models (RBM) and Reliable Change Indices (RCI). Analyses were stratified by age, gender, change in height, and time between assessments.

Results: Within 1 year of reassessment, ICC’s ranged from 0.38 to 0.83. The most reliable tasks were Ins and Outs (0.73), Standing Long Jump (0.81), and Backwards Tandem Walking (0.83). RCI’s at 95% confidence interval showed minimal improvements or declines in performance. All tasks showed unstable reliability beyond when testing points were separated by 12 months or more (ICC<0.70). RBM results showed almost every task to be reliable when re-assessed less than 1 year later, or when assessed in participants with lesser changes in height. Age effects varied depending on the task, however indicated that the ABI-CA may be slightly more reliable when used with adolescents than with children. Gender influenced reliability, however the influence of gender on reliability varied across tasks. Lastly, participants who demonstrated minimal changes in height across the retest time interval had more reliable scores on the ABI-CA.

Conclusions: Four tasks of the six tasks of the ABI-CA Concussion Module are reliable within one year of the initial assessment, and are more reliable with lesser changes in height, indicating that growth attenuates reliability. Age and sex influenced the reliability on certain tasks as well, however no trend was seen regarding the ABI-CA Concussion Module as a whole.
Baseline Concussion Symptom Score Differences Comparing Collision, Contact, and Noncontact Sports and Comparison of Between Sexes

Aleah Gillenkirk¹, Michael Popovich¹, Matthew Lorincz¹, Andrew Sas¹
¹University of Michigan, Ann Arbor, United States

Objective: To determine if baseline concussion symptoms scores in athletes prior to the start of their season vary by sport or level of competition.

Background: Concussion is a clinical diagnosis that includes an appropriate clinical scenario, reporting of symptoms through a post-concussion symptom score list, and an objective neurologic exam. Symptom reporting is considered when determining if an athlete has recovered from their concussion. Without a baseline symptom assessment, the origin of post-concussion symptoms can be confused for baseline symptoms of an individual. Recent studies have shown that athletes at baseline can report symptoms at a rate high enough to meet criteria for post-concussion syndrome without any history of concussion. Females and male athletes with pre-existing conditions include migraines, learning disabilities, attention deficit hyperactivity disorder, sleep disorders, and psychiatric conditions have documented higher symptom reporting. But to date there has not been a clear consideration of how these symptoms compare across different sports or level of sport played.

Methods: We performed retrospective chart review of baseline pre-participation sport exams from 2016 from high school and college athletes. 240 collegiate athletes and 363 high school athlete charts were reviewed for age, sex, sport played, past medical history, number of past concussions and baseline concussion symptom checklist. Baseline concussion symptom checklist scores of symptoms that are reported on the SCAT3 assessment were reviewed recording number of symptoms reported by an athlete and severity score of the symptoms reported. Comparisons were made on number of symptoms and severity of symptoms reported between groups comparing level of sport, sport played, and sex.

Results: Female athletes in all sports compared reported more baseline symptoms and more severe symptoms compared to their male counterparts. Athletes of the same sex, male or female who participated in collision or contact sports reported less baseline symptoms than athletes who participated in noncontact sports. Male and female athletes who compete at a higher level of competition in collegiate sports report less symptoms that athletes in the same sport at a less competitive high school level.

Conclusions: Baseline symptom reporting varies by sex, amount of contact, and eliteness of the athletes. This result leads to questions about why certain athlete populations report less symptoms. Symptom reporting could be due to underlying physical traits in different sports, or player psychology differences between sports. The psychology of athlete baseline pain reporting and level of eliteness should be explored to gain understanding on how athletes choose to report baseline symptoms.
Ready to Be Steady: Virtual Reality and Balance after Traumatic Brain Injury

Candace Tefertiller1, Kaitlyn Hays1, Jessica Ketchum1, Audrey Natale1, Denise O’Dell1,2, Mitch Seveigny1, Cynthia Harrison-Felix1

1Craig Hospital, Englewood, United States, 2Regis University, Denver, United States

Purpose: To evaluate the use of the virtual reality (VR) training (Xbox Kinect™) in comparison to a traditional home exercise program (HEP) to address balance deficits in individuals with chronic traumatic brain injury (TBI).

Subjects: 64 community dwelling ambulatory individuals previously diagnosed with a TBI with remaining balance deficits (39 males, 24 females, mean age 48), at least 1-year post-TBI.

Methods: Individuals were enrolled and randomized (1:1) into either a VR home-based exercise program using the Xbox Kinect or a traditional written HEP to address residual balance impairment. Subjects completed 12 weeks of training (recommended to complete 3-5 times/week) in their home environment with evaluations at baseline, 6 weeks, 12 weeks and a 24 week follow up assessment. The community balance and mobility (CB&M) scale was the primary outcome used in this trial with secondary outcomes including the Balance Evaluation Systems Test (BESTest) and the Activities Balance Confidence (ABC).

Results: There was no significant differences between the two groups at baseline for all outcome measures. For the primary analysis, there was no significant difference in CB&M scores over time between the two groups (p = 0.9983). However, both groups demonstrated statistically significant improvements in the CB&M from baseline to 24 weeks with the mean VR group increase = 8.60, p < 0.0001 and mean HEP group increase = 8.73, p < 0.0001. Both groups exceeded the minimal detectable change for this measure of 7.5. There was no significant difference in ABC score change over time between the two groups (p = 0.4343) with both groups demonstrating nominal non-significant increases from baseline to 24 weeks. There was also no significant difference noted in BESTest scores over time between the two groups (p = 0.8822) while both groups also demonstrated statistically significant improvements from baseline to 24-week evaluation 5.89 (VR) and 6.80 (HEP) increase, p<0.001

Conclusions: Significant balance improvements were noted in individuals with chronic TBI in response to home-based balance training programs which included VR as well as a traditional written HEP. There were no significant differences in outcomes between these two types of training interventions demonstrating that both approaches may be beneficial to address balance deficits in home environment even in chronic TBI. Interventions for both groups were designed by a skilled physical therapist to address each subject’s specific balance deficits which may be an important factor in these results.

Clinical Relevance: Individuals with TBI may benefit from home-based balance training structured by a physical therapist and may be able to demonstrate clinically meaningful improvements even years after injury. Commercially available VR systems have become more affordable and may give clinicians and patients an alternative to traditional written HEPs facilitating continued balance training in the home environment.
Mindfulness-Based Cognitive Therapy for Clients with Acquired Brain Injury in an Outpatient Rehabilitation Setting

Sucheta Heble1,2, Sareh Zarshenas1,2, Martin Vera3, Evangeline Zhang1, Nora Cullen1,2,3
1Toronto Rehab-UHN, Toronto, Canada, 2University of Toronto, Toronto, Canada, 3West Park, Toronto, Canada

Background: Mindfulness-based cognitive therapy (MBCT) group intervention has been considered an effective therapeutic intervention for individuals recovering from depression and anxiety among many clinical populations, including those with acquired brain injury (ABI). A previous randomized control trial demonstrated that MBCT was an effective intervention for individuals with traumatic brain injury (TBI) and depression (Bédard, et al, 2013). This follow-up pilot study explores the efficacy of implementing a MBCT group program within an existing outpatient rehabilitation program for adult clients with ABI and depression and/or anxiety.

Objectives: To investigate the efficacy of MBCT on adult participants with ABI in reducing symptoms of depression and/or anxiety following group intervention; and to compare MBCT intervention efficacy between patients with TBI and those with non-TBI.

Methods: ABI outpatient participants were recruited and enrolled in three separate MBCT group sessions, for ninety-minute sessions, in nine weekly group sessions. Groups were co-facilitated by two MBCT-trained outpatient clinicians. Participants completed three outcome measures (Beck Depression Inventory-II, Patient Health Questionnaire-9 and Symptom Checklist-90-Revised) at pre-intervention, post-intervention and at three-month follow-up.

Results: Seventeen participants with ABI completed the group sessions and completed post-intervention and follow-up outcome measures. Results revealed a statistically significant reduction in participants’ severity of depressive symptoms, as measured by the BDI-II, post-intervention and maintained at three-month follow-up. Frequency of depressive symptoms, as measured by the PHQ-9, was also decreased post-intervention and considered statistically significant. Participant symptoms of anxiety, as measured by the anxiety SCL-90-R subscale also revealed statistically significant reduction of anxiety post-intervention. A large effect size was seen for the BDI-II looking at severity of depression symptoms and the PHQ-9 looking at frequency of depression symptoms. Furthermore, our study demonstrated that participants with ABI and depression and/or anxiety reported improved sense of well-being and statistically significant reduction in symptoms of distress post-intervention. These findings were measured by the composite subscales of the SCL-90-R tool including Global Severity Index, Positive Symptom Index and Positive Symptom Distress Index. No significant differences were found between TBI and non-TBI participants.

Conclusion: Based on the results of this pilot study, MBCT group programs appear to be an important adjunct to regular outpatient therapies for individuals with ABI to assist with improved mood from symptoms of depression and/or anxiety. Participants may continue to demonstrate changes in the months following their injuries or illnesses and may find the mindfulness practices beneficial in assisting not only with improvement of mood but assisting with overall acceptance of current challenges and help promote readiness for change.
Preschool Children with ADD Have a Deficit of Visual Memory in Delayed Recall Condition

Sergey Kiselev¹
¹Ural Federal University, Ekaterinburg, Russian Federation

Objectives: It was shown that children with ADHD have a deficit in working memory (Martinussen et al., 2012). In our previous research we have revealed that ADHD children have a deficit in visual and verbal memory in delayed recall condition in comparison to immediate condition (Kiselev & Lvova, 2014; Kiselev & Lvova, 2016; Kiselev, 2018). The goal of this research was to examine the hypothesis that preschool children with attention deficit disorder (ADD) have a deficit in visual memory in delayed recall condition.

Methods: The experimental group included 14 children with ADD at age of 5 years. The control group included 14 typically developing children. The children from experimental and control group were matched for IQ, gender and age.

Children from both groups were assessed with visual memory subtest from Luria’s neuropsychological assessment battery. This subtest is designed to assess the ability to perform visual memory for objects in immediate and delayed recall conditions. Two-way ANOVA was used to reveal group differences in reproducing the objects in two conditions.

Results: We have not revealed significant differences between children from experimental and control group in the reproducing the objects in immediate condition. However, the interaction of condition type and group was significant (p≤0,05). Children with ADD were less successful in reproducing the objects in delayed condition.

Conclusions: This research has revealed that preschool children with ADD have specific (not global) deficit in visual memory in delayed recall condition. In view of our previously received results in children with ADHD and ADD, we can propose that deficit in memory in delayed recall condition can be one of the key symptoms in these disorders.

The research was supported by Act 211 Government of the Russian Federation, agreement 02.A03.21.0006.
Transcranial Direct Current Stimulation (tDCS) in Post-Stroke Patients with Chronic Aphasia: Preliminary Findings from A Double-Blind Randomized Controlled Study

Emily Rosario¹, Henry Millan¹, Sharon Lee¹, Melissa Howard¹, Aaron Rothbart¹, Caroline Schnakers¹
¹Casa Colina Hospital and Centers for Healthcare, Pomona, United States

Objectives: Approximately one million people in the United States are living with aphasia, a language impairment estimated to affect up to 40% of stroke patients. There is growing evidence that transcranial direct current stimulation (tDCS) might be a good treatment option for these patients. Our study therefore aims to collect evidence on the efficacy of tDCS using a double-blind randomized controlled design in a large sample of post-stroke patients diagnosed with chronic aphasia.

Methods: In our on-going protocol, patients (18 years old or older) with chronic aphasia due to ischemic or hemorrhagic stroke are randomly assigned either to the tDCS group or to the sham (placebo) group. Everyone except the principal investigator is blinded to group assignment. Both groups receive five consecutive days consisting of approximately 20 minutes of tDCS or sham across each session. Behavioral, EEG and DTI MRI data acquisition are performed within a week before/after the tDCS/sham intervention. Behavioral measures are performed again 3 months following tDCS/sham treatment to assess long-term benefits. Behavioral and performance assessments were conducted by a trained speech pathologist. Outcome measures include the Western Aphasia Battery-Revised (WAB-R), Communication Outcomes after Stroke (COAST), and Stroke and Aphasia Quality of Life Scale-39 (SAQOL-39). For the purpose of this preliminary analysis, we focused on pre-post behavioral data in both groups (tDCS vs. sham) using an ANOVA with repeated measures.

Results: In this preliminary sample, we had 26 post-stroke patients with chronic aphasia (20 males; age: 58±12y; 0.8-18years post-injury; 17 ischemic stroke; 19 non-fluent aphasia). Fourteen patients were in the tDCS group. Using t-tests and chi-square tests, we determined that the groups (tDCS vs. sham) did not differ according to age, time post-injury, gender, type of stroke, or type and severity of aphasia. Preliminary results demonstrate a significant increase on the auditory-verbal comprehension subscore of the WAB-R in the tDCS group vs. sham group (F=6.82; p=0.02), while an increase on the total score of the COAST was observed in both groups (F=10.67; p<.01). No significant changes were observed on the total score of the SAQOL-39.

Conclusion: Our findings suggest an improvement in language functions, particularly among receptive language skills, in response to treatment (vs. placebo). Interestingly, improvements in communication were subjectively perceived by patients in both groups. Our preliminary findings did not reveal significant changes in quality of life.
What Does a Standardised Test of Accelerated Long-Term Forgetting Tell Us About How Memory Works?

Sara Ramos\textsuperscript{1}, Harriet Paul\textsuperscript{1}, Michael Oddy\textsuperscript{1}

\textsuperscript{1}The Disabilities Trust, Brain Injury Rehabilitation Trust, Horsham, United Kingdom

Accelerated long-term forgetting has been described as “abnormal forgetting over hours to weeks despite normal acquisition or initial consolidation” (Elliot et al., 2014). Despite being a thoroughly researched phenomenon, commonly observed in clinical settings, there is currently no standardised test to assess it. Furthermore, there is discussion as to whether this seemingly faster forgetting actually reflects subtle acquisition deficits that are not detected by existing memory tests (Cassel & Kopelman, 2018). The aim of this study was to explore the relationships between demographic variables, such as age and intellectual function (IQ), and performance in a series of verbal memory tasks repeated after a long-delay (one week). We hypothesised that if the “acquisition deficit hypothesis” holds, the patterns of performance on immediate, short-delay and long-delay tasks of the same type should be comparable, as should the relationships between performance in each of these tasks and variables with known links to cognitive reserve and decline. As part of a larger study revising the BIRT Memory and Information Processing Battery (BMIPB), 386 participants completed a story recall and a list learning task. These tasks involved recalling the information presented immediately, after a short delay (30 to 40 minutes) and again after a delay of approximately one week. Demographic information, including gender, age, mood, alcohol consumption and IQ was also gathered, as was performance on a short-term memory task (reliable digit span). We explored differences in patterns of performance across the various tasks and investigated the relationships between the scores on the various memory tasks and the five demographic variables. We did not find significant differences between the pattern of performance in the immediate recall, short delay and long delay tasks. Participants’ standardised scores were comparable in the immediate, short delay and long delay tasks, suggesting that they were performing at a consistent level regardless of the task. We also found associations between performance on the immediate, short delay and long delay recall tests of the same type, suggesting that immediate, short delay and long delay tests of a particular kind (e.g. story versus list recall) tap the same mechanisms. Performance on all tests was only weakly correlated with demographic variables, and the patterns of association were comparable for immediate, short and long delay tests of the same type. These results do not support the suggestion that poor performance in memory tests administered at long delays rely on a different cognitive mechanism than those administered immediately or after a short delay. Long delay memory tests appear to be a more sensitive measure of memory acquisition. We discuss the implications of these findings for future research and for clinical practice in the assessment and rehabilitation of people with memory problems.
Mild TBI During the War is Associated with Further Microstructural Alterations in the Cortical Gray and White Matter in 1991 Gulf War Veterans with Gulf War Illness

Bang-Bon Koo1, Chia Hsin (Jasmine) Cheng1, Deborah Little2, Lea Steele2, Timothy Heeren3, Kimberly Sullivan3

1Boston University School of Medicine, Boston, United States, 2Baylor College of Medicine, Houston, United States, 3Boston University School of Public Health, Boston, United States

Introduction: Gulf War illness (GWI) is characterized by a combination of symptoms that most commonly include widespread pain, fatigue, neuropsychological impairment and gastrointestinal problems that are associated with past exposure to neurotoxicants (e.g., organophosphates). Past work from our group has shown that nearly half of all GWI cases reported a history of mild Traumatic Brain Injury (mTBI) during the war. Further, self-report of past mTBI was associated with GWI symptom severity. Our hypothesis is that veterans with GWI and a history of mTBI during the war have greater neuroinflammation and neurodegeneration on brain imaging. Here, we applied multimodal neuroimaging on 73 GW veterans to study whether veterans with GWI and mTBI history resulted in more detrimental impacts on the brain than GWI alone or in healthy GW veteran controls.

Methods: Three groups of veterans’ data were included: veterans with GWI with no history of self-reported mTBI (n=20), veterans with GWI but without mTBI (n=38), and GW veterans who did not meet the Kansas criteria for GWI and without mTBI (controls; n=15). Both T1-weighted structural and multi-shell (b=1000~3000) diffusion MRI scans took place on 3T Philips scanner. Brain morphometry was performed on T1-weighted scans. Diffusion MRI was used to assess both major white matter (WM) tract integrity and microstructure in the gray matter (GM). We applied multi-dimensional diffusion mapping to measure intracellular volume fraction (ICVF), orientation dispersion along with diffusion tensor indices. Seventy-eight GM regions and 18 major WM bundles were defined from in-house developed processing pipeline. All imaging dependent variables were examined between GWI cases +/- mTBI and healthy controls. All analyses controlled for age, gender, and multiple comparisons.

Results: GWI cases showed significantly lower ICVF in 9 major WM bundles- the anterior callosal, bilateral anterior thalamic radiation, bilateral inferior longitudinal fasciculus, bilateral uncinate fasciculus, the left cingulate angular bundle, and the right corticospinal tract compared with controls. In those tracts, GWI+mTBI group had slightly higher group difference patterns than GWI-mTBI. GM microstructural patterns (lower ICVF) in the GWI+mTBI group were found in the hippocampus and medial/inferior temporal, medial prefrontal and medial parietal regions. GW veterans without mTBI did not show statistically significant differences in these regions.

Discussion: Our results show that the group with GWI+mTBI showed further changes in GM in addition to the WM alterations. Since the intracellular compartment refers to the tissue water diffusivity in neurites, the lowered ICVF in GM may reflect microscale changes in extra-neurites such as arborization of dendrites or gliosis. Change in GM tissue microstructure may fingerprint the chronic impact of neuroinflammation and highlighting the regions vulnerable to further tissue damage in later life. These differences in the GM tissue microstructure and WM tracts should be further validated and compared in longitudinal studies.
Can Cluster Analysis Help Us Better Plan, Communicate, and Deliver Brain Injury Rehabilitation?

Sara Ramos¹, Sue Copstick¹
¹The Disabilities Trust, Brain Injury Rehabilitation Trust, Horsham, United Kingdom

Objectives: It is recognised that the clinical presentation of people in the post-acute phase of recovery after acquired brain injury is very heterogeneous (Arnould et al., 2016; Turner-Stokes, 2008). Classifications on the basis of medical diagnosis of the brain injury do not fully address the problem, as there is heterogeneity even within the same diagnosis (e. g. Saatman et al., 2008). In addition, medical diagnoses do not provide a clear understanding of the impairments, rehabilitation needs and “rehabilitation potential” of patients in the post-acute stage of recovery, which has led to the suggestion that various profiles of symptoms should be considered in order to match interventions and service levels to needs (Arnould et al. 2016; Arnould et al., 2015). The aim of this study was to explore whether a data-driven approach (cluster analysis) could be used to derive clinically meaningful subgroups of patients based on profiles of rehabilitation need.

Methods: Global outcome data gathered across all rehabilitation centres of the Brain Injury Rehabilitation Trust (BIRT) between 01 January 2016 and 30 June 2017 were used in the analyses. Data from a total of 300 cases were extracted. Scores on groups of items of the Mayo-Portland Adaptability Inventory (MPAI-4) were entered in an iterative series of cluster analyses. Logistic regression was then used to identify areas of functioning that were the best predictors of cluster classification, and the outcomes on discharge within each cluster category were also investigated.

Results: The cluster analyses identified three profiles distinguishing individuals on the basis of their rehabilitation needs on admission. These groupings did not overlap with medical diagnoses or other demographic characteristics. Global cognitive and behavioural impairment alone did not reliably distinguish between these three profiles, as problems in these areas were prevalent in all three groups. We also found that all three groups benefited from rehabilitation, but the extent and nature of improvement differed. Results of the logistic regression analyses identified specific areas of function that distinguished between the groups and were thus shown to be related with outcome on discharge.

Conclusions: Determining the rehabilitation needs, key areas for targeting treatment, and likely outcomes of post-acute brain injury rehabilitation is challenging and using medical diagnoses as the basis for such predictions is uncertain, as it may result in underestimation of the level and complexity of need. Using a data-driven approach, the present study led to the development of a framework for classifying rehabilitation needs and predicting specific areas of outcome on discharge. We describe how these findings can be applied to communicating with stakeholders and we suggest areas for further development in service delivery planning.
Examining Associations Between Repetitive Head Trauma and Indicators of Accelerated Aging in Professional Rugby League Players

Magdalena Wojtowicz¹, John Anderson⁵, Peter Stanwell², Christopher Levi², Grant Iverson³, Andrew Gardner²

¹York University, Toronto, Canada, ²University of Newcastle, Australia, ³Harvard Medical School, Boston, United States, ⁴Massachusetts General Hospital, Boston, United States, ⁵Center for Addictions and Mental Health, Toronto, Canada

Objective: Recent studies examining retired athletes have revealed altered neural structure and functioning, and differences in white matter microstructure, compared to healthy controls. Several studies examining cortical and subcortical changes in former athletes with exposure to repetitive head trauma report an age by concussion exposure interaction, raising the question of possible accelerated aging in those with a history of participation in contact and collision sports. The purpose of the present study was to examine whether there is evidence of accelerated aging in white matter of professional rugby players with extensive history of repetitive head trauma using diffusion tensor imaging (DTI).

Method: Participants included 54 active and retired professional rugby league players between the ages of 24-89 (M=46.66, SD=15.59) and 49 age-matched healthy male controls (M=48.53, SD=15.60) with no reported prior history of concussion. Participants completed psychiatric and neuropsychological testing and underwent structural and DTI neuroimaging. Neuroimaging data were analyzed using FMRIB Software Library (FSL).

Results: Professional rugby league players reported sustaining a median 15-lifetime concussions (range 1-150). Compared to controls, athletes had lower FA in the body and genu of the corpus callosum, the fornix, and bilaterally in the posterior limb of the internal capsule (ps<.05). Athletes also had higher RD and MD values in some of these same regions. This pattern of findings remained even when controlling for age, education, and alcohol use in the past year (i.e., Alcohol Use Disorders Identification Test scores). When examining the associations with age, relative to athletes, control subjects had a greater difference in FA values with age than athletes did. In contrast, athletes had greater changes in AD, RD, and MD than controls with increasing age. Within-group correlation analyses revealed that controls generally showed greater FA within the subcortical and corticospinal regions with age and lower FA in the bilateral cingulum bundles. There were no significant correlations with age in athletes.

Conclusions: Professional rugby players with an extensive history of repetitive head trauma had alterations in the white matter microstructure that suggest possible demyelination and axonal degeneration, compared with healthy controls with no history of repetitive neurotrauma. Differential effects of age on white matter microstructure between athletes and controls were observed. These findings suggest that athletes with an extensive history of head trauma may have altered patterns of white matter microstructure with age.
Determinants of Readmissions Among Individuals with Hypoxic Ischemic Brain Injury: A Population-Based Perspective

**Vincy Chan**, David Stock, Binu Jacob, Nora Cullen, Angela Colantonio

1Toronto Rehabilitation Institute - UHN, Toronto, Canada, 2Department of Clinical Health and Epidemiology - Dalhousie University, Halifax, Canada, 3West Park Healthcare Centre, Toronto, Canada, 4University of Toronto, Toronto, Canada, 5Institute for Clinical and Evaluative Sciences, Toronto, Canada

**Background**: Readmissions to acute care is a significant policy concern that is associated with indicators of suboptimal care and health system inefficiencies. It is costly to the health system, negatively affects patient outcomes, and unfortunately, is common among the brain injured population.

**Objective**: The goal of this study was to identify independent determinants of readmissions following survival of hypoxic ischemic brain injury.

**Methods**: A retrospective cohort study was conducted using population-based health administrative data from the province of Ontario in Canada. Survivors of hypoxic ischemic brain injury aged 20 years and older discharged from acute care between fiscal years 2002/03 and 2010/11 were identified using International Classification of Diseases Version 10 codes. Multivariable negative binomial regression was used to identify independent determinants of (1) number of readmissions and (2) cumulative duration of hospital stay(s) within one year of index acute care discharge.

**Results**: Between fiscal years 2002/03 and 2010/11, there were 2,880 patients with a hypoxic ischemic brain injury-related acute care visit. Of the 593 who survived their index acute care episode, 39.3% were readmitted to acute care within one-year of acute care discharge, some more than once (average number of readmissions=1.79±1.31), resulting in 417 total readmissions and 4,758 inpatient hospital days (average length of readmission stay=20.42±39.21 days). The number of readmissions was associated with age [35-49 years vs. 65-79 years; rate ratio (RR)=0.57; 95% confidence interval (CI)=0.38-0.85 and ≥80 years vs. 65-79 years; RR=0.58; 95% CI=0.34-0.97] and higher comorbidity score (Johns Hopkins Aggregated Diagnosis Group score >30 vs. <10; RR=1.60; 95% CI=1.11-2.31). Duration of cumulative readmission stay was associated with increased index acute care length of stay (31-90 days vs. ≥90 days; RR=4.17; 95% CI=1.38-12.64), prior use of healthcare services (minimal vs. very high; RR=0.15; 95% CI=0.05-0.49), and discharge disposition (home vs. continuing/long-term care; RR=0.44; 95% CI=0.21-0.91).

**Conclusion**: Findings from this study indicate a high readmission rate in the first year after the index acute care admission for survivors of hypoxic ischemic brain injury. This suggests care gaps and system inefficiencies and encourages bolstered discharge and homecare planning and support to address the specific needs of those with hypoxic ischemic brain injury.
A Panel of Blood Biomarkers to Differentiate Between Ischemic and Hemorrhagic Stroke Within the Therapeutic Window for Intravenous Thrombolysis

Alejandro Bustamante¹, Anna Penalba¹, Victor Llombart¹, Emilio Pecharroman¹, Oriol Ventura¹, Alba Simats¹, Luz María Cruz², Marc Ribó³, Teresa García-Berrocoso¹, Joan Montaner¹  
¹Neurovascular Research Laboratory, Vall d’Hebron Institute of Research (VHIR), Barcelona, Spain, ²Biochemistry Department, Hospital Universitary Vall d’Hebron, Barcelona, Spain, ³Stroke Unit, Hospital Universitary Vall d’Hebron, Barcelona, Spain

Introduction: Pre-hospital differentiation between ischemic strokes (IS) and intracerebral hemorrhage (ICH) using blood biomarkers would allow early initiation of intravenous thrombolysis without the need of neuroimaging techniques. The combination of glial fibrillary acid protein (GFAP) and retinol binding protein-4 (RBP-4) has been proposed to differentiate both subtypes. In this study, we aimed to evaluate whether the addition of a third biomarker (X-marker) might improve the accurate classification of IS patients.

Methods: From December-2013 to July-2014, patients with suspected stroke admitted within 4.5 hours after onset were enrolled. Blood samples were collected at admission. Biomarkers were measured by ELISA. Stroke subtype was confirmed by neuroimaging. Biomarkers were dichotomized by cut-offs, selected as having the highest sensitivity with 100% specificity for IS in order to minimize any mistake by giving tPA to an ICH patient.

Results: After exclusion of stroke-mimics, 190 patients (155 IS and 35 ICH) were enrolled. ICH patients had higher GFAP levels and lower RBP-4 and X-marker than IS. The combination of RBP-4>52µg/mL and GFAP>0.18ng/mL resulted in an accurate diagnosis of 6.5% of IS and 34.3% of ICH. The addition of the X-marker kept 100% specificity and improved sensitivity for IS up to 20% (31/155) by using RBP4 > 52µg/mL and the X-marker cutoff > 4076.5 pg/mL.

Conclusions: The present study confirms RBP-4, GFAP and X-marker as useful biomarkers for IS and ICH differentiation. This panel might allow a safe pre-hospital treatment in selected cases if fast point-of-care devices are developed.
Experiences of Sleep on Social and Occupational Engagement after Traumatic Brain Injury

Rachael Mumbower¹, Karen Heaton²
¹University of Alabama, Capstone College Of Nursing, Tuscaloosa, United States, ²University of Alabama at Birmingham, School of Nursing, Birmingham, United States

Objective: Over half of individuals with traumatic brain injury (TBI) experience sleep disturbances. In addition to cognitive and physical sequelae, sleep disturbances may also impair social and occupational engagement after TBI. Social and occupational engagement are highly related; both are goals of rehabilitation following TBI and social engagement is considered a benefit of occupational engagement. Sleep disturbances or disorders may have a dangerous impact on survivors of TBI returning to work. Feelings of isolation have been noted in general after TBI but only a few studies have referenced isolation in the context of sleep. The study aimed to describe the self-reported impact of sleep disturbances following TBI on occupational and social engagement. Specifically, the study addressed the following research questions: 1) How do survivors of a moderate-severe TBI describe their social engagement in relation to their sleep experiences? and 2) How do survivors of a moderate-severe TBI describe their occupational engagement in relation to their sleep experience? These questions were secondary interests in a larger study developing a broad description of sleep experiences following TBI.

Methods: A qualitative descriptive design using a semi-structured interview guide facilitated data collection from community dwelling adult survivors of TBI (N = 16). Inclusion criteria: 1) moderate-severe TBI; 2) ability to provide consent and independently communicate; 3) ages 18 to 50; and 4) one to four years postinjury. Exclusion criteria: 1) history of sleep disturbance or disorder prior to TBI; 2) non-English speaking; and/or 3) pregnant. Current and past employment status was not used in sample criteria because employment status is not necessarily stable over the course of recovery following TBI and those not working, not attempting to work, or unemployed prior to TBI still provide relevant descriptions of sleep in relation to their occupational or social engagement. Survivors described a broad spectrum of employment status, from applying for disability to full-time work. Average age was 23.4 years (SD = 9.9) with average length of years post-injury 2.6 years (SD = .89).

Results: Thematic analysis yielded three key themes describing sleep experiences in the context of: 1) relationships, 2) work, and 3) mood. Participants described sleep experiences and daytime fatigue as impactful to social and occupational engagement. Mood was described in connection with poor quality sleep.

Conclusions: These findings strengthen a reported connection between survivor descriptions of sleep disturbances and fatigue following TBI to the similarly common reports of difficulty engaging in work and maintaining social interaction. With a growing focus on the issue of sleep disturbances and disorders following TBI, researchers should further investigate the impact of sleep on occupational and social engagement and consider a more extensive investigation of experiences in a larger, more diverse sample.
Cognitive and Mental Health Outcomes in Acquired Dystonia after Pediatric Basal Ganglia Stroke

Justine Ledochowski1,2, Kyla McDonald1,2, Tricia Williams2, Nomazulu Dlamini2, Robyn Westmacott2
1 York University, Toronto, Canada, 2 The Hospital for Sick Children, Toronto, Canada

Pediatric arterial ischemic stroke involving the basal ganglia and/or thalamus is one of the most common causes of dystonia in children. Dystonia is a movement disorder in which excessive, involuntary muscle contractions result in twisting or repetitive movements, and abnormal posturing. The basal ganglia have been implicated in mood and cognitive functioning and difficulties in these domains have been noted in adults with dystonia, yet little is currently known about these outcomes in children with dystonia following stroke.

The objective of this study was to determine whether children with acquired dystonia experience additional cognitive and mental health difficulties compared to children with similar patterns of brain injury but no dystonia. Eligible children were identified through the Children’s Stroke Outcome Registry at The Hospital for Sick Children. Children were considered for participation if they had a history of arterial ischemic stroke diagnosed from birth to 16 years of age, with a single unilateral infarct involving the basal ganglia or thalamus.

Participants were 98 children, 27 with dystonia (Mean age= 12.08, SD=3.16), 72 basal ganglia and/or thalamic stroke only (Mean age= 11.28, SD=3.60). Intellectual outcomes were measured using the Wechsler Intelligence Scale for Children IV/Wechsler Adult Intelligence Scale IV, academic skills were assessed with the Wechsler Individual Achievement Test II/Woodcock Johnson Test of Achievement Test III, executive functioning was assessed with the Delis-Kaplan Executive Function System Color-Word Test, and mental health outcomes were measured using the Behavior Assessment System for Children 2. Independent samples t-tests and Mann-Whitney U tests were used to examine differences between dystonia and no-dystonia groups. Children with dystonia showed poorer performance on tasks of verbal (p=.002) and non-verbal reasoning (p < .001), working memory (p=.008), processing speed (p=.04), academic skills (p < .001-.009), inhibitory control (p=.001), mental flexibility (p=.009) and higher levels of anxiety (p=.019) and depression (p=.021). Effect sizes were in the medium to large range for cognitive outcomes (d=.49-.96) and small range for mental health outcomes (r=.27).

Results support the presence of additional cognitive and mental health difficulties in children with acquired dystonia after stroke relative to those with similar patterns of stroke, but no dystonia. These findings suggest maladaptive reorganization after stroke may contribute to motor, cognitive, and mental health outcomes after pediatric basal ganglia stroke.
Evaluating Changes in Brain Structure Associated with Persistent Post-Traumatic Headache Symptoms in a Group of Patients with Mild Traumatic Brain Injury

Diana Sibai1,2, Scott Holmes1,2, Jaymin Upadhyay1,2, David Borsook1,2
1Boston Children’s Hospital, Boston, United States, 2Harvard Medical School, Boston, United States

Background: Post-traumatic headache (PTH) is a common symptom experienced by adolescents and adults who have sustained a mild traumatic brain injury (mTBI). To date, the pathogenesis embedded within the central nervous system (CNS) that underlies PTH in mTBI remains largely unknown. Neuroimaging studies have shown promise in terms of detecting changes in CNS structure between mTBI and control groups, reporting changes in regions such as the insula and temporal and cingulate cortices. The purpose of this study is to assess if changes in brain structure coincide with the persistence of headache symptoms by looking at two patient cohorts. It was predicted that unique changes in brain structure will appear in persons with and without post-traumatic headache relative to healthy controls.

Methods: Patients diagnosed with mTBI (n=23,12-21 years old) were evaluated at 3-months post-concussion and separated into those recovered from headaches (R-PTH; n=10) and those with persistent headache (P-PTH; n=13). Patients were compared against a healthy control dataset (n=11). Participants completed the ImPACT concussion test and mTBI patients additionally completed a concussion questionnaire evaluating headache characteristics. Cortical thickness was evaluated using FreeSurfer at the p<0.01 level. White matter integrity and connectivity was evaluated using fractional anisotropy (FA) extracted from FSL’s TBSS tool. Comparisons were performed between healthy controls and mTBI patients, as well as between R-PTH and P-PTH groups.

Results: Participants from the P-PTH group reported that their headaches impacted daily life to a moderate degree compared to the R-PTH group who reported no impact on daily. ImPACT data showed the P-PTH group reported higher mean concussion symptoms (26) compared to R-PTH (3) (t=-2.57, p=0.021). Relative to controls, cortical thickness in mTBI patients was significantly greater in the right superior frontal gyrus and inferior parietal lobule. In mTBI participants the right paracentral lobule exhibited both an increase and decrease in cortical thickness relative to controls. In the left hemisphere, controls had greater cortical thickness in the insula. The P-PTH group showed greater cortical thickness in the superior parietal and pericalcarine cortex, and less thickness in the entorhinal when compared to R-PTH within the right hemisphere. In the left hemisphere, R-PTH showed greater cortical thickness in the precentral gyrus, superior parietal, and cingulate. DTI findings from the R-PTH group showed a trend suggesting a decrease in FA relative to controls in the anterior region of the corpus callosum.

Conclusion: The current findings indicate the presence of structural brain changes in patients with mTBI and headache regardless of symptom resolution. Unique group differences in cortical thickness suggest that the persistent of mTBI-related headache symptoms may have a distinct neurophysiological basis in regions involved in sensory integration and pain processing. Future research is targeted at understanding later time points and monitoring symptom resolution.
The Effect of Injury Severity on Cognition Affect and Quality of Life Following Traumatic Brain Injury: A Longitudinal Study

Ofer Keren1,2, B. Bodini1,3, S. Shlomo1, M. Sapir1, G. Tsarfaty1,2, M. Gallucci3, E. Tchvaloon1, Z. Zibly1,2, Abigail Livny1

1Sheba Medical Center, Ramat Gan, Israel, 2Tel Aviv University, Tel Aviv, Israel, 3Università degli Studi Milano Bicocca, Milan, Italy

Background: Traumatic brain injury represents a major health challenge. Not only is it estimated to be a leading cause of death; but, in case of survival, quality of life, affect and cognitive abilities may drastically be affected. The goal of our research is to examine how injury severity modulates the cognitive, affective and quality of life changes over time, from acute to chronic stages of recovery. Furthermore, we aim to explore predicting factors in the acute stage which may predict quality of life in the chronic stage (a year post-injury).

Methods: Seventy-two participants were recruited: 21 mild TBI (mTBI; GCS>13), 24 moderate-severe TBI (msTBI; GCS<13) and 25 healthy controls (HC). Research visits occurred in 2 time-points: acute (T1), and chronic phase (T2). In each visit participants were submitted a cognitive battery (CANTAB) including 3 domains: attention, memory and executive function and answered questionnaires concerning quality of life and affect.

In order to examine the effect of injury severity, and time since injury on cognition we ran a mixed model ANOVA. In order to explore possible predictors of quality of life in chronic phase, we ran multiple regression analyses, while controlling for quality of life in the acute phase. In all analyses we controlled for years of education.

Results: We found in both attention and executive function, group, time, and interaction effects. Accordingly, at T1, msTBI and mTBI differed from HC. At T2, in attention msTBI differed from both mTBI and HC, whereas, in executive function msTBI differed only from HC. Finally, in memory, we found group and time effects, while quality of life and affect, only produced a group effect by which both TBI groups differed from HC. In addition, the cognition level at T1 predicted improvement in quality of life at T2 in TBI patients, and not in HC. Furthermore, memory ability exhibited the higher variance across all cognitive domains while predicting improvement of quality of life.

Conclusions: Our preliminary results show a different recovery pattern between groups in attention and executive functions, accordingly the msTBI group demonstrated a decrease in performance which remained impaired in the chronic phase. In contrast, both TBI groups exhibited the same pattern of performance in memory, affect and quality of life over time.

In addition, our results indicate that the acute level of cognition is an important predictor of improvement in quality of life following injury. In particular, memory ability was found as the most prominent predictor among the other cognitive indicators. Therefore, our results emphasize the importance of memory rehabilitation for improving quality of life post TBI, and should be designated to all TBI patients, with no regard to the level of injury severity.
Characteristics of Service Members with Concussion Referred to Physical Therapy Who Seek to Return to Active Military Duty

Karen McCulloch, Amy Cecchini, Julianna Prim

1Division of Physical Therapy, Department of Allied Health Sciences, School of Medicine UNC-Chapel Hill, Chapel Hill, United States, 2Geneva Foundation at Intrepid Spirit Center Fort Bragg, Fayetteville, United States

Individuals who sustain concussion in military service are commonly managed by primary care acutely, only seeking additional levels of care if symptoms are persistent. Concussion complaints have been described in clusters of signs and symptoms, yet the presentations seen for physical therapy in military treatment facilities are not well studied.

Study Aim: The purpose of this abstract is to describe the characteristics of individuals referred for physical therapy with the intent to return to active duty, who were participating in an observational study of a performance-based test of tactical agility.

Subjects: Our current sample of 13 will be expanded prior to presentation to include a larger n. Participants were on average 29.5 years (SD 7.3), all male, having served in the military on average for 7.8 years (SD 6.1) and completed a mean number of deployments of 2.8 (SD 2.8). Self-reported number of prior concussions ranged from 2-40 (median 6). Referral to therapy occurred on average 7.5 months post-injury (range 3-16 months), with all participants reporting multiple symptoms and complaints. Self-reported Neurobehavioral Symptom Inventory scores were 35.9 (SD 13.8), with stress related responses on the PCL-5 averaging 22.8 (SD 18.5) and 23% of the sample reporting scores above the 33 red flag level. Self-reported pain on the Defense and Veterans Pain Rating Scale was 4.5/10 on average (SD 2.1). A very high level of headache complaint was reported with the Headache Impact Test-6. All of the participants reported a level of sleep dysfunction on the Pittsburgh Quality Sleep Index that was indicative of poor sleep quality (average 14.1, SD 2.7), consistent with prior studies of primary care patients. Dizziness Handicap Inventory subscale scores were on average as follows: a-function: 10/28 (SD 7.8), b-physical: 9.4/28 (SD 4.4), c-emotion: 6.9/36 (SD 6.4). Dynamic visual acuity testing demonstrated an average of 2.7 lines lost during head movement (range 1-5 lines). Sensory Organization Test (SOT) composite scores were on average 72.8 (SD 12.4). The Head Shake SOT was performed to challenge balance to a greater degree, but 46% of participants could not tolerate this test because of dizziness.

Summary: This group of military service members demonstrated multiple somatic, vestibular and balance related complaints that may respond to physical therapy. The chronicity of service member complaints, on average more than 6 months, was notable. It is possible intervention sooner after injury could reduce problems that were prevalent including chronic pain, sleep dysfunction and lack of ability to return to duty. Service members may manage their symptoms without seeking additional care as a result of military cultural norms and an expectation of resilience.
Developing the Concussion Challenge Assessment: Towards Evaluating Gross Motor Performance Following Concussion in Children and Youth

Michelle Tanel1, Christopher Gupta1, Katherine Wilson1, James Murphy1, Virginia Wright1,3, Nick Reed1,2,4

1Bloorview Research Institute, Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, 2Rehabilitation Sciences Institute, Faculty of Medicine, University of Toronto, Toronto, Canada, 3Department of Physical Therapy, Faculty of Medicine, University of Toronto, Toronto, Canada, 4Department of Occupational Science and Occupational Therapy, Faculty of Medicine, University of Toronto, Toronto, Canada

Background/Rationale: Concussions are one of the most common injuries in youth athletes. A multimodal approach to concussion assessment is recommended as it evaluates many factors that may be impacted following a concussion. Gross motor performance is one such factor that may be impacted following a concussion; however, there is a dearth of validated clinical assessment tools that evaluate gross motor performance in a concussion population. The development of a tool to evaluate gross motor performance specific to youth with concussion would provide valuable information to assist with return to sport clinical decision-making. The aim of the present research is to develop and conduct initial validation of the Concussion Challenge Assessment (CCA), a gross motor clinical assessment for paediatric concussion populations.

Research Question/Objective: (1) Refine the Acquired Brain Injury Challenge Assessment (ABI-CA) to a subset of tasks relevant to a paediatric concussion population to create the CCA, (2) Revise the item specific response options for the CCA to generate empirically based options specific to the youth athlete population, and (3) Evaluate the performance of items in the CCA including task difficulty and stratification of response options.

Methods: This research was conducted in three phases. The first phase involved an expert panel of clinicians and researchers to evaluate the tasks of the existing ABI-CA and determined which tasks were relevant for the paediatric concussion population and should be included in the newly created CCA. The second phase involved administering the CCA to a convenience sample of 854 healthy youth aged 9-17 years. Response options specific to the youth concussion population were generated using the same method as in the development of the ABI-CA. The third phase involved an analysis of the response options for each task while considering the difficulty of each task. Generating response options specific for age and gender was considered.

Results: In phase one, the original ABI-CA was reduced from 20 tasks to 6 tasks, creating the CCA. Phase two resulted in the generation of 4-point response scales for each item with cut points established specific to the youth concussion population. In phase three, the evaluation of the difficulty of the tasks led to the generation of 5-point response scales for each task. In this phase, response options were generated specific to age (9-12 years and 13-17 years) and gender (male and female).

Conclusion: Gross motor performance is essential in the participation of many meaningful activities for youth. A clinical assessment tool capable of evaluating gross motor performance following a concussion can assist in the determination of when a youth is able to safely return to activity. This will help to reduce the risk of youth returning to activity prematurely, reducing the risk of further injury or prolonged recovery.
In Search of Biomarkers for Late Recovery of Patients with Traumatic Brain Injury: A Multimodal Approach

Caroline Schnakers¹, James Divine¹, Micah Johnson², David Patterson¹, Gary Jensen¹, Emily Rosario¹
¹Casa Colina Hospital And Centers For Healthcare, Pomona, United States, ²University of California, Los Angeles, Los Angeles, United States

Research Objective: To provide a preliminary database of neural profiles that can be related to cognitive and functional outcome measures in chronic patients with moderate to severe traumatic brain injury (TBI).

Design: Prospective longitudinal study. Setting: Casa Colina Hospital and Centers for Healthcare Research Institute (Pomona, CA).

Participants: Six TBI patients (5 males; age range: 21-44 years old; 12-21months post-injury) were included in this study.

Interventions: N/A. Main Outcome Measures. The following data were collected at monthly intervals over 6 months: a) Blood sample to detect changes in molecular blood-based biomarkers such as neuron-specific enolase (NSE), glial fibrillary acid protein (GFAP), S-100β protein, myelin basic protein (MBP), cleaved tau protein (C-tau), spectrin breakdown products (SBDPs), ubiquitin C-terminal hydrolase-L1 (UCH-L1). Blood-based biomarkers are determined using ELISA. b) Magnetic Resonance Imaging (MRI) recordings were performed on a Siemens Magnetom Verio 3T to assess structural changes. MRI data are analyzed in collaboration with the UCLA Department of Psychology, using FMRIB Software Library (FSL). c) Electrophysiological recordings of 2 types were performed, using a B-Alert wireless system, to assess changes in electrical activity and processing: 5 minutes resting state and P300 auditory oddball (listening versus counting). EEG/ERPs analyses are performed using EEGLAB. d) Neuropsychological assessments were performed by trained clinicians to assess cognition and functional recovery.

Results: Significant correlations between functional abilities, neuroimaging and blood-based biomarkers were observed. Results also suggest both transient and enduring changes in neural activity over the 6-month study period of recovery.

Conclusion: Our preliminary findings will help characterize the diverse range of brain activity patterns that occur as a result of chronic TBI and potentially lead to the development of adapted and tailored treatment plans for these patients.
Deficit of Attention and Executive Abilities in Children Born with Hypoxic-Ischaemic Encephalopathy

Sergey Kiselev¹, Nadia Anochina¹
¹Ural Federal University, Ekaterinburg, Russian Federation

Background: There are evidences that children, born with Hypoxic-ischaemic Encephalopathy (HIE), have a delay in the development of neurocognitive functions. The goal of this research was to examine the hypothesis that children, born with HIE, have a deficit in attention and executive abilities.

Participants and Methods: The experimental group included 19 children aged 5-6 years (mean age = 5.7). They were born full-term with perinatal Hypoxic-ischaemic Encephalopathy. The control group included 19 typically developing children. The children from experimental and control group were matched for gender and age.

Children from both groups were assessed with 4 subtests from NEPSY (Tower, Auditory Attention and Response Set, Visual Attention, Statue) which are designed to assess the attention and executive abilities in children.

Results: One-way ANOVA has revealed group differences (p<.05) in subtests from NEPSY. Children from control group have shown better results in performing these 4 subtests in comparison to children from experimental group.

Conclusion: In view of the obtained results it can be assumed that the Hypoxic-ischaemic Encephalopathy has a negative effect on development of attention and executive abilities in children aged 5-6 years.

Funding: The research was supported by Act 211 Government of the Russian Federation, agreement no. 02.A03.21.0006.
Summary of Controlled Intervenotional Studies from the Evidence-Based Review of Acquired Brain Injury

Pavlina Faltynek\textsuperscript{1,2}, Brooke Benton\textsuperscript{1,2}, Amanda McIntyre\textsuperscript{1,2,3}, Robert Teasell\textsuperscript{1,2,3}

\textsuperscript{1}Lawson Health Research Institute, Parkwood Institute, London, Canada, \textsuperscript{2}St. Joseph’s Health Care, Parkwood Institute, London, Canada, \textsuperscript{3}Schulich School of Medicine and Dentistry, University of Western Ontario, London, Canada

Objectives: To compare controlled interventional studies evaluating acquired brain injury rehabilitation research literature with respect to their number, sample size, and methodological quality, and year of publication.

Data Sources: A literature search was conducted using PubMed, PsycINFO, CINAHL, and EMBASE for all articles evaluating any rehabilitative intervention for ABI, published in English up to December 2017.

Study Selection: Studies were included if: (1) they were categorized controlled interventional rehabilitation studies, (2) participants had a moderate or severe ABI and comprised more than 50% of the study population, (3) participants were adults (≥18 years), and (4) the study sample had a minimum of three participants.

Data Extraction: For each article meeting inclusion, data on author, country of investigation, journal, study design, sample size, and year of publication was extracted. Methodological quality was assessed using the Physiotherapy Evidence Database (PEDro) tool.

Data Synthesis: A total of 341 studies met inclusion criteria and were published between 1975 and 2017; 61.2% were randomized controlled trials (RCTs), 16.4% were prospective controlled trials (PCTs), 8.7% were cohort studies, and 13.5% were case control studies. Studies examining cognitive interventions made up the largest proportion of total studies (N=102), followed by psychosocial (N=84) and medical complication interventions (N=84). Sensory and motor studies (N=43) along with principles and models of care (N=41) had the least number of published studies; 13 studies overlapped more than one category. Studies examining principles and models of care had the highest mean sample size (mean=331), median sample size (median=108), and PEDro scores (mean=6.75). In contrast, sensory and motor studies had the lowest sample size (mean=40, median=22) and PEDro scores (mean=5.7). Studies assessing psychosocial and cognitive interventions have consistently been published over time; however, studies related to medical complications have seen the greatest increase in publication the last decade.

Conclusions: As the number of studies ≥ level 3 evidence are published, a greater proportion of those are becoming RCTs over time. While studies examining cognitive deficits have been the focus of ABI published work, other categories of rehabilitation are beginning to increase in publication such as medical complications, and principles and models of care, although these trends are not necessarily reflective sample size and methodological quality.
Traumatic Brain Injury and the Microbiome: A Review

David Sudderth¹
¹David B. Sudderth, MD, Fort Myers, United States

Over the last few years the intimate and bidirectional relationship between the brain and the gastrointestinal tract has been an area of intense interest and has been referred to as the gut-brain axis. Indeed, many of the major brain diseases have been postulated as being related to disturbances in the gut and its contents, the microbiome. Autism, major depression, idiopathic Parkinson’s disease, chronic pain, anxiety and even Alzheimer’s disease may have connections to the G-I tract which is often referred to as our “second brain.”

Recent TBI studies have documented abrupt changes in the gastrointestinal permeability and microbiome after a brain trauma. These changes are thought to initiate and maintain inflammatory processes in the CNS as well as other organs. Manipulating the microbiome has already been determined to improve clinical state in 3 TBI studies. In this review, various mechanisms will be considered by which the post-TBI brain may be affected by the microbiome including inflammatory, endocrine and metabolic pathways.
Impact of Family History of Neurodegenerative Disease on Concussion Recovery Profiles: Data from the NCAA-DoD CARE Consortium

Adam Harrison¹, Andrew Lapointe², Thomas McAllister⁴, Michael McCrea³, Steven Broglio², Robert Davis Moore¹
¹University of South Carolina, Columbia, United States, ²University of Michigan, Ann Arbor, United States, ³Medical College of Wisconsin, Milwaukee, United States, ⁴Indiana School of Medicine, Indianapolis, United States

Introduction: It has been suggested that a family history of neurodegenerative disease may predispose an athlete to abnormal recovery following concussion. However, no one has longitudinally assessed outcomes in athletes with and without a family history of neurodegenerative disease. Accordingly, the aim of our study was to longitudinally examine the influence of family history of neurodegenerative disease on clinical symptoms, neurological function, and cognition, following a concussion.

Methods: During the 2014-2017 academic years, data were collected from 29 NCAA universities and military service academies as part of the Concussion Assessment, Research, and Education (CARE) Consortium. Baseline assessments were completed prior to the beginning of the sport season for all athletes. Athletes were re-assessed 24-48 hours post-concussion, and again when they were granted unrestricted return-to-play. Symptom profiles were measured using the Sport Concussion Assessment Tool (SCAT) symptom checklist, neurological function was measured using the Standardized Assessment of Concussion (SAC), and cognition was measured using the ImPACT test. Athletes who sustained a concussion were separated into those with (n = 70) and without (n = 140) a family history of neurodegenerative disease (Parkinson’s, Alzheimer’s, Non-Alzheimer’s Dementia, or Mild Cognitive Impairment). Athletes without a family history of neurodegenerative disease were double matched based on age, sex, body mass index, sport played, and concussion history.

Results: No group differences were observed at any timepoint for any measure of the SCAT or SAC (p’s > .05). In contrast, athletes with a family history of neurodegenerative disease exhibited significantly poorer visual working memory at baseline than athletes without a family history of neurodegenerative disease (p < .05). Following concussion, athletes with a family history of neurodegenerative disease exhibited greater decreases from baseline in visual working memory (24-48 hours post-injury) than athletes without a family history of neurodegenerative disease (p < .05).

Conclusions: These results suggest that a family history of neurodegenerative disease is associated with poorer visual working memory at baseline and more severe acute memory deficits following a concussion.
The Persistent Influence of Concussion on Cardio-Autonomic Function During Cognitive Task Performance Before and After Exercise

Adam Harrison¹, Brett Gunn¹, Robert Davis Moore¹
¹University of South Carolina, Columbia, United States

Introduction: In an average day of a student-athlete, they must endure the cognitive demand of classes, physical stress of practice, and then end the day studying and doing homework for the next day. Cardio-autonomic regulation is an integral process linking the neurological and cardiological systems, that responds and adapts to these changing environmental stressors to maintain overall effective functioning. The adaptation of the cardio-autonomic system to environmental stressors is often impaired in people who have experienced a concussion. The aim of the current study was to assess cardio-autonomic function in a group of athletes with and without a history of sports-related concussion (SRC) in an experimental paradigm designed to mimic an average day of a student-athlete.

Methods: Heart-rate variability (HRV) was assessed in a group of adolescent athletes with a history of diagnosed concussion (n= 16) and healthy matched controls (n=19) 1.) at rest; 2.) during a switch task paradigm; and 3.) during a switch task paradigm following a 20-minute bout of aerobic exercise at ~70% of their theoretical max heart rate.

Results: No group differences were observed at rest or during the pre-exercise cognitive task (p’s > 0.05). However, following a single bout of sub-maximal aerobic exercise, individuals with a history of SRC demonstrated significantly greater HRV during the cognitive task (p < 0.05).

Conclusions: These results demonstrate that following an SRC, individuals may appear normal when assessed while at rest. However, underlying deficits in neurological function may appear when tested following bouts of mental and physical workloads.
A Population-Based Perspective of Comorbid Neck Injuries in Concussion-Related Emergency Department Visits

*Mitchell Sutton*¹,², Vincy Chan¹, Tatyana Mollayeva¹, Zheng Hu², Michael Escobar², Angela Colantonio¹,²,³

¹Toronto Rehabilitation Institute - UHN, Toronto, Canada, ²University of Toronto, Toronto, Canada, ³Institute for Clinical and Evaluative Sciences, Toronto, Canada

Background: The cervical spine region can be especially vulnerable to concurrent injuries in concussion due to its proximity to the head. Evidence also supports that females have weaker and anatomically distinct necks than males, suggesting that the relationship between neck injuries and concussions may be sex-dependent.

Objective: The goal of this study was to identify sex differences in the rate of comorbid neck injuries across the lifespan among patients with a concussion-related emergency department (ED) visit in the province of Ontario in Canada, by cause of injury (motor vehicle collision and sports).

Methods: A retrospective cohort study was conducted on patients with a first concussion-related ED visit in Ontario, Canada. These patients were identified using International Classification of Diseases Version 10 codes in the National Ambulatory Care Reporting System, a population-based dataset that captures all ED and ambulatory care in Ontario. Age-dependent odds ratio of comorbid neck injury for sex were estimated using polynomial multivariable logistic regression models, adjusting for sociodemographic and clinical characteristics.

Results: There were 90,1754 concussion-related ED visits between fiscal years 2002/03 and 2011/12, of whom 53% were males. The rate of comorbid neck injuries per 100,000 concussion-related ED visits was higher among females (4,333 vs. 2,995 per 100,000). Females had significantly higher odds of sustaining a comorbid neck injury between the ages of five to 49 years for all concussion-related ED visits, 15 to 49 years for motor vehicle collision-related ED visits, and 10 to 39 years for sports-related ED visits, holding all other covariates in the model constant.

Conclusion: These results support the consideration of increased awareness of comorbid neck injuries, particularly for females, to allow for early intervention and appropriate care. Future studies on concussions should also consider both linear and non-linear sex and age interactions, as this study found that the increased risk of comorbid neck injuries in females with a concussion-related ED visit was age-dependent, with the interaction between sex and age following a non-linear trend.
Intravenous Ketamine for Treatment of Major Depressive Disorder in a Patient with a History of Repetitive Traumatic Brain Injuries

John Dougherty III
Actify Neurotherapies, Bryn Mawr, United States

Background: Depression is the most common psychiatric disorder that occurs following a TBI. To date, there are limited studies demonstrating the effectiveness of current treatments to treat this disorder and even less for those with repetitive or rTBIs. Ketamine has been demonstrated to be effective in treating depression and helping with damaged connections within the brain. It can be hypothesized that Ketamine may help with both of areas that many TBI patients face after injury. The aim of this report is to describe the successful treatment of a patient with a history of rTBIs who struggled with depression for the past several years.

Case Report: A 51-year-old Caucasian male patient presented to the Actify Neurotherapies Treatment Center for treatment of his Major Depressive Disorder. He had been depressed for five years but refused oral med treatment due to fears over side effects. He presented with anergia, amotivation, feelings of sadness, anhedonia, impaired concentration and guilt/worthlessness. Previous neuropsychological records revealed some cognitive impairment likely attributed to his multiple head injuries including being hit over the head in an alley leading to amnesia for one month along with permanent anosmia. After completing a course of Ketamine treatments, his symptoms either completely resolved or vastly improved as measured by the Levine Treatment Resistant Depression Scale.

Conclusion: This case appears to be the first published report of a patient with multiple TBIs/rTBIs and Major depressive disorder successfully treated with intravenous ketamine. Overall, this illustrates the potential that Ketamine may play in the treatment of psychiatric sequelae in individuals with a history of rTBIs. Ketamine has been demonstrated to increase BDNF and increase synaptogenesis which should encourage further research for brain injured individuals. Ketamine is also believed to potentially have neuroprotective effects as well which need to be further studied. Those with a history of one TBI are also at increased risk of having further rTBIs and therefore further increasing the chances of a depressive disorder. If one might be able to treat the individual before the repetitive event occurs, it may lead to quicker resolution of symptoms and may even decrease the chances of a subsequent event from occurring. Further studies are necessary to validate and replicate the symptom resolution of the above case but indicates that this treatment may be a potential viable rapid treatment option for those struggling without relief in sight.
Compensatory Brain Activation While Completing Tasks With Varying Cognitive Loads In Youth Who Have Sustained A Concussion

Karolina Urban\textsuperscript{1,2}, Larissa Schudlo\textsuperscript{1,4}, Nick Reed\textsuperscript{1,2,3}, Tom Chau\textsuperscript{1,4}

\textsuperscript{1}Bloorview Research Institute, Holland Bloorview Kids Rehab Hospital, Toronto, Canada, \textsuperscript{2}Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada, \textsuperscript{3}Department of Occupational Science and Occupational Therapy, University of Toronto, Toronto, Canada, \textsuperscript{4}Institute of Biomaterials and Biomedical Engineering, University of Toronto, Toronto, Canada

Introduction: Return to play protocols following sports related concussions often rely on subjective symptom reporting and are often limited to simple tasks with low ecological validity. Yet participation in everyday activities relies on the integration of multiple sources of information while deciding a course of action. Brain regions involved in coordinating information such as the dorsal lateral prefrontal cortices (DLPFC) and parietal lobes are particularly vulnerable to injury. Concussions, caused by biomechanical forces, are often characterized as a functional injury that can impact brain efficiency and communication. Therefore, it is important to evaluate brain function in the context of more ecologically valid protocols.

Method: Control youth (n=14; age 15.8±1.7; Female n=10) and those who sustained a concussion (n=5; age 15.8±1.3; Female n=4) completed a dual task paradigm consisting of: single stroop, postural sway and dual task (i.e. single tasks completed concurrently). Brain activation was measured in the frontal and posterior cortices (located via the 10-20 EEG coordinate system) using a Hitachi ETG-4000 functional near infrared spectroscopy (fNIRS) system. Data preprocessing and analysis was completed using the NIRS Brain AnalyzIR (NITRC) open source Matlab based toolbox (MathWorks, Natick MA USA). We used an auto-regressive whitening and iterative weighted robust regression algorithm general linear model approach (AR-IRLS GLM) and compared brain activation patterns between groups for each condition with T-statistics and false discovery rate to control for type 1 errors.

Results: There was no difference task accuracy and reaction time between control and concussion group in all task conditions. During single task, the concussion group had great activation in the right prefrontal regions including the DLPFC, superior frontal gyrus, and posterior regions including superior marginal (SMG) and superior parietal cortices. During dual task, the concussion group elicited greater activation in the left DLPFC, bilateral SMG, and left inferior parietal cortices than in the control group.

Conclusion: Despite similar performance during single and dual task, the concussion group had hyperactivity in brain regions during single task that were not activated in the control group until dual task. Furthermore, the concussion group continued to have enhanced activation during dual task suggesting a pattern of increased recruitment to account for the functional injury. Our results indicate that despite similar performance on tasks there is underlying functional changes that need to be better understood prior to return to play.
A Promising Tool Based on Serious Gaming to Assist in the Management of Concussions in Sports

Carolane Croteau¹, Cindy Chamberland¹, Pierre Frémont¹, Sébastien Tremblay¹
¹Université Laval, Québec, Canada

Sports participation have deep positive impacts on individuals, communities and societies, including improvements in academic performance, lower risk of cardiovascular diseases and lower absenteeism. However, the benefits related to sports are overshadowed by insufficient safety precautions and prevention practices which, in turn, can lead to negative socio-economic impacts. There are between 1.6 and 3 million sport-related concussions reported each year in the United States alone. Concussions are associated with higher healthcare expenditures, lost work days for parents providing care, the inability to return to school or work, and deteriorated family dynamics and social outlooks. In 43.4% of concussion cases, the management protocol is not completely followed either by the health professionals or the athletes. This calls for alternative assessment and monitoring methods that are more engaging, closer to the athlete’s reality and that could empower by bringing self-awareness to the athletes and assistance to their entourage. To this end, we have developed a serious game (Simulation ENgageante Immersive et cognitive; SENIC) taking the form of a tablet application in which the athlete can watch a series of video sequences of his/her sport and must detect as quickly as possible a stimulus associated with an imminent potential danger or gameplay situations that require fast decision making by touching the screen at the location of the danger.

The objectives of the present study were to examine whether SENIC is associated with greater task engagement by the athletes than other more traditional tools and whether SENIC could be used on the side field to provide a quick assessment. A series of tests were conducted in which Université Laval’s Rouge et Or soccer team players were asked to perform SENIC several times during their season. Results showed that SENIC is found to be more playful and engaging than the ImPACT test by all participants. Moreover, task performance (number of false alarms, % of detection, detection time) was similar whether SENIC was performed before or after a game practice, indicating that task performance is not influenced by physiological activation, making its administration possible during a practice or a match. A small learning effect was found over the first three sessions, but task performance tended to stabilize afterwards. Taken together, our study suggests that SENIC could be used to compare the athlete’s performance at a specific point in time relative to previous test performance. SENIC has the potential to help better identify the cognitive impairment related to a concussion, and also to contribute to the decision of the athlete and his/her entourage to return to play by providing a dashboard of historical data.
Integrating Brain Injury, Mental Health, and Addictions Research Program

Vincent Chan1,2, Robert Balogh2, Alisa Grigorovich1,3, Halina (Lin) Haag4, Bonnie Kirsh3, Pia Kontos1,3, Robert Mann3,5, Flora Matheson3,6, Emily Nalder3, Richard Riopelle7, Catherine Wiseman-Hakes3, Angela Colantonio1,3,8

1Toronto Rehabilitation Institute - UHN, Toronto, Canada, 2University of Ontario Institute of Technology, Oshawa, Canada, 3University of Toronto, Toronto, Canada, 4Wilfrid Laurier University, Waterloo, Canada, 5Centre for Addiction and Mental Health, Toronto, Canada, 6St. Michael's Hospital, Toronto, Canada, 7Ontario Neurotrauma Foundation, Toronto, Canada, 8Institute for Clinical and Evaluative Sciences, Toronto, Canada

Background: Approaches to serving individuals with traumatic brain injury (TBI) and mental health and/or addictions (MHA) are reported to be very fragmented, even though TBI and MHA are provincial priorities. This is an important gap to address, as more than one in five people who receive MHA services have a history of TBI; this number rises to one in three among those with concurrent disorders, homelessness, and legal involvement.

Objective: The goal of this Research Program is to develop an integrated approach to TBI and MHA by engaging persons with lived experience, front-line staff, health service providers, and decision-makers in research and knowledge transfer (KT) activities.

Methods: Four inter-related aims are conducted to (a) understand the impact of a concurrent TBI on system level outcomes among individuals with a MHA; (b) determine the barriers and facilitators to accessing health services, the extent to which individuals with a self-reported TBI and MHA use health services, and the types of services used; (c) identify the critical characteristics of housing support services for individuals with a concurrent TBI and MHA; and (d) identify gaps in knowledge and practice regarding individuals who intersect with the criminal justice system, and women survivors of intimate partner violence (IPV) with a TBI and MHA. Innovative KT methods such as research informed animated videos will be used.

Results: Persons with lived experience, front-line staff, service providers, and decision-makers across the care continuum and TBI and MHA sectors were invited to form a Program Advisory Committee that guides and participates in the research process and co-creates KT materials. The integration of sex and gender in the Research Program is ongoing; every effort is made to recruit persons of different genders to ensure that all perspectives are taken into account, and all quantitative data analyses to date are stratified by sex. The anticipated outcomes of this research program are: (a) policy-relevant data for decision-makers to direct resources to meet health services needs at the health system level and to provide equitable access to healthcare; (b) design of appropriate housing models for individuals with MHA and TBI at risk of homelessness; and (c) create gender-sensitive education and KT materials to illustrate best practices for effective communication and interaction with individuals who intersect with the criminal justice system and women survivors of IPV.

Conclusion: This research program will spearhead an integrated approach to addressing major research and KT gaps identified by stakeholders and inform ways to improve timely and equitable access, integration, and coordination of care.
Creation of Dance Therapy for children with Cerebral Visual Impairment: Results of a Scoping Review

Frédérique Poncet1,2,3, Arthi Rajadurai1, Geylimar Sanchez2, Danièle Jean1,3, Chloé Proulx-Goulet1,4, Sylvie Fortin5, Bonnie Swaine1,6

1Centre For Interdisciplinary Research In Rehabilitation Of Greater Montréal (cri), Montréal, Canada, 2Laboratory for Adult Development and Cognitive Aging, Concordia University, Montréal, Canada, 3CISSS Montérégie Centre_Institut Nazareth et Louis Braille, Longueuil, Canada, 4CIUSSS Centre Sud de l’Île de Montréal, Montréal, Canada, 5Dpt. Danse, Université du Québec à Montréal, Montréal, Canada, 6École de Réadaptation, Université de Montréal, Montréal, Canada

Dance Therapy (DT) seems to show promising effects on physical and cognitive function in children. However, there is no consensus on the parameters of DT (e.g. duration and frequency of sessions), and there are no studies on the effects of DT in children with cerebral visual impairment (CVI). The Institut Nazareth et Louis Braille, a Rehabilitation Center, is interested in exploring the effects of DT in children with CVI who may also have cognitive (e.g. executive dysfunction) or motor impairments. Because the literature is poor, it is challenging to propose innovative, global therapeutic interventions to enable these children to improve their activities and participation. DT is an innovative group intervention that could broaden the child’s motor experiences, help them explore the surrounding space, and interact with others. With the goal of creating a DT intervention for children with CVI, this study aimed to systematically map the current state of the literature describing different group physical activity interventions and their outcomes for children with CVI.

Methods: Our scoping review follows a 6-step framework (Levac, 2010; Arskey and O’Maley, 2005). The electronic search strategy conducted included 11 electronic databases such as MEDLINE, Embase, and CINAHL, and resulted in 1535 references. Documents reporting any type of physical or leisure group activity for individuals with CVI or children with low vision were included. The Template for Intervention Description and Replication (TIDieR) checklist was used to extract data from articles. An expert stakeholder group from the rehabilitation center will validate and enhance the results thereby establishing the consultation phase of the review.

Results: Data from 12 studies were extracted and analyzed. The results indicate a large variability of interventions that include different physical activities: balance function (n=1), physical/performance education (n=5, e.g. endurance, cardio respiratory), specific group sports (n=6, e.g. judo, goalball), social/mental wellbeing (n=2), and orientation and mobility (n=1). We found no literature on DT for these children. The duration of the interventions is also very variable. In addition to the week-long summer camps (n=3), the interventions ranged from 2 hours (e.g. horseback riding) to 10 months (e.g. 90 minutes once a week of physical activities).

Conclusion: This information will inform the development of a DT intervention for these children and its future implementation and evaluation, including the identification of appropriate assessment tools.
Can Deficit in Executive Abilities Influence the Development of Grammar Understanding in Children?

Sergey Kiselev

Ural Federal University, Ekaterinburg, Russian Federation

Background: Children with specific language impairment (SLI) have difficulties producing and understanding language (Bishop, 1997). Particularly, these children have problem with grammar understanding. The goal of this research was to examine the hypothesis that Russian-speaking children at the age of 5 with deficit in executive abilities have a risk for emerging weakness in grammar understanding at the age of 8.

Participants and Methods: 95 children at the age of 5 were assessed using 5 subtests from NEPSY (Tower, Auditory Attention and Response Set, Visual Attention, Statue, Design Fluency), which are designed to assess executive abilities in children.

We have revealed 22 children with deficit in executive abilities. These children were included in the experimental group. The control group included 22 children with no deficit in executive abilities.

In the framework of longitudinal research children at the age of 8 from both groups were assessed by Grammar Understanding Test from Luria's neuropsychological assessment technique.

Results: One-way ANOVAs has revealed significant differences (p<.05) between groups for scores in the Grammar Understanding Test. Children from an experimental group had low level of grammar understanding.

Conclusion: This research has shown that deficit of executive abilities can explain the delay in the development of grammar understanding in children. The received results provided insight into cognitive mechanisms in typically developing and the underlying nature of specific language impairments (SLI), helping to elucidate the nature of impaired mechanism in grammatical-SLI. It can be assumed that deficit in executive abilities is one of the risk factors for emerging weakness in grammar understanding in children.

The research was supported by Act 211 Government of the Russian Federation, agreement 02.A03.21.0006.
Rehabilitation Without Communication: Reducing Challenging Behaviours and Enhancing Client Outcomes with Functional Communication

Stacie Dertinger
1Head Injury Rehabilitation Ontario, formerly Brain Injury Services, Hamilton, Canada

Rehabilitation in the absence of vocal communication is a multifaceted obstacle course for individuals with an acquired brain injury (ABI) and health professionals. A communication hypothesis assumes that some problem behaviour "may be viewed as a non-verbal means of communication" (Carr & Durrand, 1985, p. 111). According to this hypothesis, though they differ in form, problem behaviour and verbal communicative acts can share the same function; therefore, by strengthening communicative behaviour one would expect to see a weakening in problem behaviour.

An interactive exploration of three case studies will be presented demonstrating individualized techniques to assess the function of challenging behaviour, teach functionally equivalent alternative communication, and enhance conversation through teaching the Picture Exchange Communication System (PECS).

The three case studies will address how each individual faced with unique rehabilitation needs, varied from low to high functioning cognitive levels, and experienced moderate to severe challenging behaviour that required individualized behavioural support programs. Case studies will include a review of behavioural data demonstrating a reduction in challenging behaviour and a reduction of more intrusive intervention components including psychotropic medication when the team focused on enhancing communication strategies.

Using neuropsychological assessment results to guide program design will be discussed as will the need for prolonged learning timelines for post-acute clients. The challenges in developing therapeutic rapport with individuals with limited communication will also be addressed. This presentation will focus on the need for trans-disciplinary collaboration between psychiatry, speech and language pathology, behaviour analysis and frontline rehabilitation team to ensure maximum client benefits.

This presentation will demonstrate a variety of techniques that break down barriers, acknowledge and reveal an individual's competence, and assist to reduce challenging communicative behaviours. Delegates will gain an improved understanding of the tools and skills that are necessary for individuals with ABI to gain control of their non-verbal voice through effective and persistent trans-disciplinary rehabilitation.

Pituitary Stalk Transection Syndrome Secondary to Severe Traumatic Brain Injury in Lactant: A Case Report

Eliane Huard, Paulo Oliveira
1Sarah Network of Rehabilitation Hospitals, Brasilia, Brazil

Introduction: Hypo-pituitarism results from impaired production of one or more of anterior pituitary trophic hormones. Patients with hypo-pituitarism may have isolated pituitary hormone deficiency (IPHD) or multiple pituitary hormone deficiency (MPHD) and may present with varied clinical manifestations like growth failure, central hypothyroidism, or underdeveloped secondary sexual characters. A rare cause of hypo-pituitarism is pituitary stalk transection syndrome. The MRI features of this condition in children and its association with hormonal deficiencies has been reported earlier. Reports on adults with this disorder are scarce, with only one small case series published in the recent literature.

Aim: The aim of this study was to describe the clinico-radiological phenotype of pituitary transection syndrome in a 5 years old girl victim of traumatic brain injury in lactance.

Materials and Methods: We studied the hormonal deficiency pattern and MRI findings of 1 patient with pituitary stalk transection syndrome who presented to our department with a previous history of severe traumatic brain injury when she was 3 months old.

MRI Technique Three-millimeter contiguous sagittal and coronal plain through the sella were obtained using a 3.0-T superconducting MRI unit.

Observations and Results: The child presented with MPHD, with mycrocefphaly, short stature, and behavioural problems. The MRI features in our case are small anterior pituitary gland, absent or ectopic high signal intensity of posterior pituitary, and absence or hypoplasia of pituitary stalk, besides encephalomalacy on left cerebral hemisphere.

Discussion: Structural pituitary abnormalities have been reported in 50%–70% of patients with pituitary hormone deficiency. These abnormalities are more prevalent in MPHD. In both adults and children, ectopic posterior pituitary bright spot (EPPBS) at the median eminence was a universal finding in all patients.

Conclusion: This entity should be considered in the differential diagnosis in patients with hypo-pituitarism. The presence of MRI features suggestive of pituitary stalk transection syndrome should prompt a full pituitary hormonal evaluation. It is important to closely follow up these patients in the long-term so that their natural history of progressive radiological and hormonal deterioration can be ascertained, and these patients can be managed better. As patients progress from IPHD to MPHD, with subsequent hormone deficiencies appearing as they age from childhood to adulthood, the stalk and adenohypophysis become smaller, indicating that the term ‘pituitary stalk hypoplasia’ or ‘thin stalk syndrome’ is more appropriate than pituitary stalk transection syndrome.
Detection of Cerebral Necrosis in Ischemic Stroke Using a New Infarct-Avid Agent 18F-Fluorodeoxyglucaric Acid (FGA) in a Mouse Model of Stroke

Alexander Mdzinarishvili1, Hailey Houson1, Evgeny Sidorov1, Vibhudutta Awasthi1

1University of Oklahoma Health Sciences Center, Oklahoma City, United States

Stroke is a leading cause of disability worldwide. More than 80% of brain strokes are ischemic, caused by interruption of blood supply to the brain from thrombotic or embolic cerebrovascular occlusion. Ischemic stroke is a time-sensitive event requiring immediate recognition and intervention to salvage viable tissue which is threatened by hypoperfusion. Mortality and morbidity associated with stroke can be significantly reduced if location and extent of injury are divulged early after symptoms emerge. Given the dynamic evolution of ischemic penumbra into infarct, accurate and rapid delineation of these regions is critical for clinical decision making and intervention to salvage metabolically viable tissue. We describe a new positron emission tomography (PET) infarct-avid agent 2-deoxy-2-(18F)fluoro-D-glucaric acid (FGA) for determining necrotic areas in ischemic stroke in a mouse model. We hypothesized that FGA accumulation will be inversely correlated with cerebral perfusion in a mouse model of transient middle cerebral artery occlusion (tMCAO). The radiopharmaceutical, FGA, was synthesized by controlled, rapid, and quantitative oxidation of clinical doses of 18F-fluorodeoxyglucose (FDG) in a one-step reaction using a premade kit formulation. Brain stroke was induced in the left cerebral hemisphere of CD-1 mice by occluding the middle cerebral artery for 1 h, and then allowing reperfusion. One day post ictus, perfusion SPECT was performed with 99mTc-hexamethylpropyleneamine oxime (HMPAO), followed by ex vivo PET acquisition with FGA. Plasma and brain tissue homogenates were assayed for markers of inflammation and neurotrophins.

We found that FGA/PET images clearly showed 375% more accumulation of FGA in ipsilateral hemisphere than in the contralateral hemisphere. HMPAO/SPECT images for perfusion showed that ipsilateral HMPAO accumulation was reduced to 55% of normal levels; there was significant negative correlation between ipsilateral accumulation of FGA and HMAPO (p < 0.05). The FGA accumulation in stroke also correlated with tissue IL-6 levels in the ipsilateral hemisphere. There was no change in IL-6 or TNFα in the plasma of mice with stroke. Overall, the results showed that accumulation of FGA correlates well with the perfusion defect and inflammatory injury caused by ischemic stroke. As a new PET agent, FGA has the potential to image infarcted core in stroke injury with high sensitivity, resolution, and specificity.
Assessing Autobiographical Memory in Patients with Disorders of Consciousness

Jonathan Erez\(^1\), Marie-Ève Gagnon\(^2\), Adrian Owen\(^1\)

\(^1\)Brain and Mind Institute, Western University, London, Canada, \(^2\)Universite du quebec a Trois-Rivières, Trois-Rivières, Canada

Assessing cognitive function in patients with disorders of consciousness (DOC) is a challenging task. Past research has shown that some DOC patients have residual brain activity, respond to sensory stimulation, can pay attention and follow commands. However, little is known about other dimensions of their conscious experience. For example, it is unclear whether they can form novel autobiographical memories. Previous fMRI studies of autobiographical memory in neurologically normal participants revealed a consistent pattern of activity across a network of frontal, parietal, and medial temporal lobe regions when viewing personal photographs as opposed to viewing photographs from somebody else’s life. The fact that there is a neural signature that is associated with remembering a personally experienced event can be used to examine whether severely brain-injured patients, who may be conscious but are unable to speak, move, or exhibit any other willful behaviour, have a conscious experience similar to those of healthy individuals. In order to reduce the demands on patients in the scanner, in this study we opted for a simplistic experimental design that would allow us to investigate this question in the absence of complex task instructions. Our goal was to capture real-world experiences in a naturalistic setting and play it back to participants in an fMRI scanner, hoping to evoke a similar neural signature. Twelve healthy participants were recruited and asked to sit in a wheelchair while a researcher wheeled them around a local mall. Importantly, a small wearable camera was mounted on each participant, in order to capture autobiographical videos from this visit. One week later, we scanned the participants while they viewed a series of videos from different categories. Some of the videos were autobiographical (taken from their own experiences at the mall a week prior to scanning), other videos were of other people’s experiences at the same location, and some videos were recordings of other people’s experiences in a different location altogether. Participants were asked to simply view the videos and no overt behavioural response was required. A cross-validate, leave-one-subject-out machine learning model was trained on the fMRI data from all participants. The model was able to successfully classify the video categories above chance in all participants, including that of one DOC patient, implying that there was a shared mechanism differentiating autobiographical videos from non-autobiographical ones. The model feature weights revealed that regions in the fronto-parietal network, medial temporal lobe and ventral visual stream were critical in differentiating between autobiographical memories and non-autobiographical ones. This study uses a novel paradigm that allows researchers to investigate autobiographical memories in patients with brain injuries that are unable to respond to experimental stimuli overtly and was successfully applied in one DOC patient.
Individuals who sustain a concussion in military service may demonstrate subtle impairments in motor function that are important for combat related activities. A tactical agility test, based on test items in the Assessment of Military Multitasking Performance, was designed to challenge these abilities in a portable clinical test that could be administered in typical therapy space. In this abstract we report on preliminary findings comparing the first 10 individuals with concussion to the first 10 control group subjects in our ongoing POWAR-TOTAL project. The task begins with the service member prone, holding a simulated weapon. A rapid transition to standing is followed by a short distance run, transition to a combat roll, transition back to standing and back pedaling to the start position. Rolls are completed in both directions over trials. Movement is measured with the use of tri-axial accelerometry and gyroscopes in cell phones attached at the lumbar area and on the head of each subject.

Subjects: Healthy controls (n=10) included 7 men, were on average 23.6 years (SD 4.8), with 2.9 years (SD 3.7) in service and only 1 had deployed. Healthy controls reported an average of 6.2 hours (SD 1.1) of sleep per night. Individuals with concussion (n=10) were all men, on average older 30.4 years (SD 7.6), with 9.3 years (SD 9.3) in service and 3.3 deployments (SD 3.0). Those with concussion reported an average of 4.9 hours (SD 1.0) of sleep per night.

Methods: Accelerometry and gyroscope data are displayed with each of 3 axes labelled as red, green and blue in RGB color display. This allows us to identify stepping cycles (via accelerometer readings) and combat rolls (via gyroscopic readings) and illustrates high frequency oscillatory patterns of running as well as low frequency oscillatory patterns of turning. Using a network of Radial Basis Function units, we can identify individual running steps and turns in order to time precise segments of the task in a portable test.

Results: Healthy control and individuals with concussion differed significantly (at alpha=.05) in the time of an agility trial, with slowdowns in performance observed in all phases of the task (forward running, clockwise roll, running backward, counter-clockwise roll) but the slowing was more prominent in the second half of the task.

Conclusion: Differences in movement observed in our preliminary analysis could have multiple causes. The injured group was older, had more time in service, self-reported a history of more concussions and less sleep, all of which could contribute slower movement. Reduced speed in the latter half of the task could reflect a fatigue effect in the concussion group. As the project continues, our healthy control recruitment will target older participants to provide more valid comparisons.
Using of Accelerometer in Neurorehabilitation of Upper Limb Paresis

Petra Sladkova¹, Olga Svestkova¹
¹Charles University, Prague, Czech Republic

Introduction: The movement ability of the upper limb is essential for an individual’s self-sufficiency, for an independent life in a family setting. The using of accelerometer is possibility for objective functional assessment in motor neurorehabilitation.

Purpose: The main aim of the study was to demonstrate that the monitoring of motor functions in patients after acquired brain injury leads to improved motivation, thereby improving motor functions.

Methods: The basic principle is measuring of static and dynamic acceleration. Sensors can be used objectively to quantify amount of movement paretic and healthy upper limb activity.

A study was conducted among 60 selected patients after brain damage with central hemiparesis who participated in the 4-week stay in a rehabilitation day care centre. Two groups of patients were studied, one group with an accelerometer (30 patients - Group A) and one group without an accelerometer (30 patients - Group B). The parameter studied with the accelerometer was daylong physical activity of the upper limbs, paretic limb and non-paretic limb.

We used 3 different types of sensors: left sensor is on the left wrist, right sensor is on the right wrist and body sensor on the left hip.

Results: Using of sensor - accelerometer in the experimental group (group A) significantly improved upper limb movement activity, can objectively detected the positive changes in movement spastic pattern. The accelerometer has the role of virtual therapist for the idea of permanent monitoring by the therapist. The patients were more motivated for active cooperation during the whole rehabilitation process.

Conclusion: Sensor – accelerometer can improve motivation (virtual therapists) of patients and also improve movement pattern and functioning of upper extremity. Activities of daily living of the patients with brain damage were also improved.
Dysregulation in Neurovascular Coupling Persists During Sub-Acute Phase Following a Sports-Related Concussion

Sushmita Purkayastha1, Sydney Lyng1, Emma Brown1, Tonia Sabo2, Kathleen Bell3

1Applied Physiology & Wellness, Southern Methodist University, Dallas, United States, 2Department of Pediatrics, University of Texas Southwestern Medical Center, Dallas, United States, 3Department of Physical Medicine and Rehabilitation, University of Texas Southwestern Medical Center, Dallas, United States

Objectives: Despite alterations in cerebral blood flow (CBF) reported following mild traumatic brain injury; the underpinning pathophysiology is still poorly understood. Neurovascular coupling (NVC), an important factor in CBF regulation is a tight temporal relationship between neuronal activity and cerebral blood flow. The present prospective cohort study examined NVC on days 3, 21, and 90 in athletes following a sports-related concussion in comparison to healthy non-injured controls.

Materials and Methods: Twenty-nine NCAA Division I and recreational athletes (20±1 years) with a physician diagnosed sports-related concussion were enrolled in the study. Data was collected on Day-3 (N=29), Day-21 (N=26), and Day-90 (N=21) following a concussion. Thirty-two non-injured healthy control (20±1 years) athletes were also enrolled in a cross-sectional design. Symptom number and symptom severity was measured using the Sports Concussion Assessment Tool (SCAT-3). Subjects performed 0-Back (control task) and 2-Back (cognitive task), a measure of working memory and executive function, for 3-minutes each in an upright position. Continuous beat-to-beat blood flow velocity was recorded from the middle cerebral artery (MCAV) during the tasks, utilizing bilateral 2 MHz transcranial Doppler ultrasonography secured with an adjusted silicon headband.

Neurovascular coupling (NVC) was estimated as the percentage change in MCAV between the 2-Back (MCAV2Bk) and 0-Back (MCAV0Bk) tasks for each subject, that is, NVC (%)=[(MCAV2Bk - MCAV0Bk)/ MCAV0Bk] X 100. A non-parametric Wilcoxon rank sum test was utilized to compare NVC means between the controls and athletes with concussion at the three time points.

Results: Percent correct responses for concussed subjects compared to controls on the 2-Back task were lower on Day-3 (82±13 vs. 90±5; P=0.02), Day-21 (89±12; P=0.012) and Day-90 (90±5; P=0.018). Compared to the non-injured controls (2.73±3.7), NVC was impaired on Day-3 (0.36±3.62 P=0.03), Day-21 (0.18 ±3.31 P=0.01) and persisted at least till Day-90 (-0.5±2.9 P=0.003) following concussion. No difference in NVC was observed between the three points post-concussion. As anticipated, compared to the controls, concussed athletes exhibited higher symptom number (12.2±6.8 vs. 2.4±3.4; p<0.001) and severity (4±6 vs.28±23) on Day-3 with resolution of symptoms by Day-21.

Conclusion: Dysregulation in NVC was observed during the acute phase and appeared to worsen during sub-acute phases following a concussion suggesting persistent physiological impairment despite symptom resolution. Future studies with longer follow-up periods and larger populations are necessary to track the physiological recovery trajectory and examine if there is an association between dysregulation of NVC and higher risk of secondary injuries post-concussion. These findings may have implications for medical management after concussion.
Long-Term Reproductive Health Outcomes in Women with Persistent Symptoms Following Mild Traumatic Brain Injury

Melissa Biscardi¹, Nora Cullen¹, Gillian Einstein¹, Angela Colantonio¹
¹University of Toronto, Toronto, Canada

Background: Traumatic brain injury (TBI) is a major public health concern with neuroendocrine disturbances occurring more than previously thought. Disruptions in gonadotropins are one of the most common neuroendocrine disturbances in both the acute and chronic stages. While women consist of up to 40% of TBI cases, research on the long-term effects unique to women are virtually non-existent. This study examined the long-term reproductive health outcomes in women living with mild TBI.

Methods: A convenience sample of 10 women was consecutively recruited from the largest adult TBI rehabilitation program in Canada. Eligible participants were premenopausal women who sustained a mild TBI one or more years ago and who were suffering from persistent symptoms. Participants attended the research clinic and completed a structured questionnaire on menstrual cycle metrics, the Menopause Rating Scale (MRS), Symptom Checklist-90r (SCL-90r), the Repeatable Battery for the Assessment of Neurological Status (RBANS) and provided a serum sample for Anti-Mullerian Hormone (AMH).

Main findings: Of the 10 participants, 50% experienced clinically low levels of AMH for their age. New menstrual cycle variability was reported by 50% of participants. All participants experienced higher levels of distress in comparison to norms for the population as measured by the SCL-90r. Participants experienced higher menopausal symptoms as measured by the MRS when compared to the general population. Spearman correlation found a statistically significant correlation between distress and menopause symptoms. Interestingly, those participants with lowest AMH scored lowest on the RBANS and were in the lowest 6th percentile or less as compared to women of the same age.

Conclusion: These findings suggest monitoring of reproductive health in the long-term post TBI is needed. Future research should be sufficiently powered to expand and validate these findings in population-based samples with a greater range of injury severity.
The Noble Gas Xenon Prevents Injury Development Following Blast-Traumatic Brain Injury In Vitro

Rita Campos-Pires¹,²,³, Amina Yonis¹, Ashni Pau¹, Warren Macdonald²,⁴, Katie Harris¹, Christopher Edge⁵,⁶, Nicholas Franks⁵, Robert Dickinson¹,²

¹Anaesthetics, Pain Medicine and Intensive Care Section, Department of Surgery & Cancer, Imperial College London, London, United Kingdom, ²Royal British Legion Centre for Blast Injury Studies, Department of Bioengineering, Imperial College London, London, United Kingdom, ³Charing Cross Hospital, London, United Kingdom, ⁴Department of Bioengineering, Imperial College London, London, United Kingdom, ⁵Department of Life Sciences, Imperial College London, London, United Kingdom, ⁶Royal Berkshire Hospital, Reading, United Kingdom

Background: Blast traumatic brain injury is a ‘signature injury’ of recent military operations and is recognized as having a unique pathophysiology. The prevalence of blast injury in recent conflicts has prompted greater research into blast TBI. Despite increased research, there are currently no clinically effective treatments to limit the development of ongoing brain injury following blast. Preventing the neurological and cognitive impairments experienced by those exposed to blast represents an unmet need. Xenon is a noble gas shown to be neuroprotective in models of blunt traumatic brain injury [1-3]. In order to evaluate the efficacy of xenon as a potential neuroprotectant in blast TBI we developed a novel in vitro model of blast-induced TBI [4].

Methods: Organotypic hippocampal slice cultures (OHSCs) were prepared from day 5-7 C57BL/6N mouse pups [2]. Under aseptic conditions, individual tissue culture inserts were sealed in sterile polyethylene sample bags pre-filled with warmed (37°C) experimental medium bubbled with 95%O2: 5%CO2. A shock-tube was used to generate Friedlander-type blast waves that model real-life free-field explosions. The sample bag was clamped in a vertical position in front of the shock-tube with the inserts positioned perpendicular to the axis of the shock tube with the OHSCs facing the shock tube and OHSCs were exposed to a single shockwave [4]. Sham slices were treated identically, but the shock tube was not fired. Following blast TBI the inserts were carefully transferred to six-well culture plates and placed in a small custom-made hyperbaric chamber. One hour after blast, xenon (50% atm) or control gas (helium) was applied as described previously [2], and injury was quantified by measuring propidium iodide fluorescence at 24 hours, 48 hours and 72 hours.

Results: Xenon had a protective effect against blast trauma at all time-points measured. Injury in the xenon-treated slices was reduced by 47 ± 12 % (p<0.01) at 24 hours after blast; 48 hours after blast injury was reduced by 31 ± 7 % (p<0.05); 72 hours after blast, the injury was reduced by 39 ± 7% (p<0.001). Injury in the xenon-treated blast-injured slices at 24 hours and 72 hours was not significantly different to uninjured sham slices.

Conclusion: Treatment with xenon, starting 1 hour after trauma, limits injury progression following blast-induced traumatic brain injury in vitro. These findings support the idea that xenon could be used as a novel treatment for blast-induced TBI.

Mood Alterations Caused by Concussion in University Athletes

William Sauvé1,2, R. Davis Moore3, Dave Ellemberg1,2
1Department of kinesiology, University of Montreal, Montreal, Canada, 2Centre for Research in Neuropsychology and Cognition, University of Montreal, Montréal, Canada, 3Exercise Science Arnold School of Public Health, University of Montreal, Montréal, Canada

Mood is helpful in everyday life. It is used to signal states of the self, direct attention by influencing our information search; take broader and more flexible approaches to problems and ready behavioral responses. However, if mood is not well regulated, it can lead to maladaptive behaviors particularly when they are of the wrong type, intensity, or duration for a given context. Indeed, mood disorders such as depression are now estimated by the World Health Organisation to be the greatest cause of disability worldwide. Accumulating research into affective dysregulation suggest that the prefrontal cortex plays a role in the regulation of mood. One common injury of the prefrontal cortex is concussion, which account for 70 to 90% of all brain injuries. Recent research on possible affective alterations caused by concussion suggests an association between disturbances in mood states and sport-related brain injuries. To date, although accumulating research details the affective outcomes following a concussion, most of the relevant evidence comes from cross sectional studies. This means that confounding factors such as time since injury or other variables may interfere in the relationship between concussion and alterations in mood states. Accordingly, the purpose of this paper is to fill an important knowledge gap regarding the mood health of athletes following a concussion. Specifically, by using standard questionnaires in psychological research and clinical practice, we assessed the mood state of asymptomatic athletes before and after a concussion. Twenty-one collegiate athletes (age = 20.81 ± 1.72) completed the Beck’s Depression Inventory-II (BDI-II) and the Profile of Mood States (POMS) at baseline, 170.93 ± 188.83 days prior to a concussion and 7.70 ± 8.06 days following concussion. Athletes actively participating in hockey, soccer, football, and rugby were recruited directly from university sports teams via the university sports medicine clinic. The attending sports-medicine physician diagnosed all concussions within 24 hours of injury. On the POMS subscales, athletes reported lower tension (p = 0.003) one week following the injury (5.43 ± 3.68) compared to preinjury scores (7.67 ± 4.39). Although the present findings suggest a concussion does not cause mood alterations so important as to change a patient’s diagnostic label, results from this study suggest that concussions could be associated with subtle mood alterations. Further, these alterations are selective to tension symptoms. The implications of the current findings are much broader, as they suggest that removal from play or pressure from coaches and teammates are likely not the only underlying factors that trigger mood changes in athletes, as has been previously suggested.
Evaluating Headache Symptoms in Persons with a Mild Traumatic Brain Injury: The Neuronal Correlates of Self-Reported Symptoms as Features in Machine Learning Analyses

Scott Holmes\textsuperscript{1,2}, Diana Sibai\textsuperscript{1,2}, Jaymin Upadhyay\textsuperscript{1,2}, David Borsook\textsuperscript{1,2}

\textsuperscript{1}Harvard Medical School, Boston, United States, \textsuperscript{2}Boston Children’s Hospital, Boston, United States

Background: Patient reported symptoms in persons with a mild traumatic brain injury (mTBI) are highly subjective and relied upon for diagnostic purposes. Headache and associated pain are frequently reported symptoms following an mTBI and can lead to decreased quality of life. Current research efforts are focused on developing more objective criteria for evaluating persons with an mTBI. Use of supervised machine learning algorithms has demonstrated the capacity to delineate groups using structural and functional brain imaging data. However, the capacity to develop accurate classifiers requires ecologically valid features for analysis. The aim of this investigation was to evaluate the neural correlates of self-reported headache symptoms and determine their capacity to delineate patients with mTBI relative to healthy controls.

Methods: A group of patients diagnosed with an mTBI and post-traumatic headache (n=25) were recruited alongside a group of healthy controls (n=11). All participants with an mTBI completed the Rivermead post-concussion scale. Headache scores and total scores were extracted from the Rivermead scale. Cortical thickness was evaluated using Freesurfer and was extracted for 68 brain regions (Whole-brain). Correlation of grey matter thickness was performed with the qdec program from Freesurfer. Regions showing positive and negative correlation with the headache sub-scale of the Rivermead test were extracted and entered as features (Restricted) into machine learning classifiers (k-nearest neighbor (KNN), support vector machine, and Tree algorithms) using Matlab. The Restricted model was evaluated relative to the Whole brain model for accuracy.

Results: Participants with an mTBI had a mean of 29.8 (SD=15.6; range:0-65) on the Rivermead symptom scale and a mean of 2.08 (SD=1.35; range:0-5) on the headache sub-scale. A total of 32 clusters were found to correlate with headache symptoms in the mTBI group (p<0.01). Negative correlations were observed in the right inferior and middle temporal area, precentral, and superior parietal area as well as the left fusiform, middle temporal, parahippocampal and lateral occipital cortex. Positive correlations were observed in the right pericalcarine and left lingual gyrus. A total of 24 non-redundant features were submitted to machine learning analysis. Of the models tested, KNN produced the highest accuracy with the Restricted set, delineating mTBI from healthy controls with an accuracy of 67%. This was comparable to use of the Whole brain set that had a maximum accuracy of 70.3% using the KNN method. All other models produced lower accuracy.

Discussion: Brain regions found to significantly correlate with headache symptom reporting were distributed throughout the cortex. Positive correlations were found in regions that have previously been observed in migraine patients suggesting a shared neurological focus. Machine learning classifiers based on the restricted features accurately predicted mTBI status similar to the whole-brain approach which suggests that selected features may be highly representative of this cohort.
Xenon Treatment Prevents Late Onset Cognitive Impairment and Improves Survival Following Traumatic Brain Injury in Mice

Rita Campos-Pires\textsuperscript{1,2,3}, Tobias Hirnet\textsuperscript{4}, Flavia Valeo\textsuperscript{1}, Bee Eng Ong\textsuperscript{1}, Joanna Saville\textsuperscript{1}, Konstantin Radyushkin\textsuperscript{5}, Christopher Edge\textsuperscript{6,7}, Nicholas Franks\textsuperscript{6}, Serge Thal\textsuperscript{4}, Robert Dickinson\textsuperscript{1,2}

\textsuperscript{1}Anaesthetics, Pain Medicine and Intensive Care Section, Department of Surgery & Cancer, Imperial College London, London, United Kingdom, \textsuperscript{2}Royal British Legion Centre for Blast Injury Studies, Department of Bioengineering, Imperial College London, London, United Kingdom, \textsuperscript{3}Charing Cross Hospital, London, United Kingdom, \textsuperscript{4}Department of Anesthesiology, Medical Centre of Johannes Gutenberg University, Mainz, Germany, \textsuperscript{5}Mouse Behavioural Outcome Unit, Johannes Gutenberg University, Mainz, Germany, \textsuperscript{6}Department of Life Sciences, Imperial College London, London, United Kingdom, \textsuperscript{7}Royal Berkshire Hospital, Reading, United Kingdom

Background: Traumatic brain injury (TBI) is a leading cause of morbidity and mortality. TBI is increasingly being recognized as a complex and dynamic process that results in long-term neurodegeneration and disability, leading to reduction in life expectancy. Currently, TBI treatment is mainly supportive and no specific neuroprotective drugs are available. Xenon is neuroprotective in a number of models of brain ischemia but has been less investigated in the context of TBI [1,2,3,4].

Objectives: Evaluate xenon’s long-term neuroprotective efficacy on cognitive, histological and survival outcomes, using the reproducible and well-established controlled cortical impact animal model of TBI.

Methods: Adult C57BL/6 male mice (n=72) received a right parietal cortical impact, using a custom-made electro-pneumatic impactor [1]. Sham animals underwent an identical procedure, but no craniotomy or impact were performed. Animals were randomly assigned to control (75% nitrogen:25% oxygen) and xenon-treatment groups (75% xenon:25% oxygen). Outcomes were measured by researchers blinded to treatment. Neurological outcome score (NS) was assessed at 24 hours, and a contextual fear conditioning (CFC) test was done 2 weeks and 20 months after injury. Histological outcomes were analyzed at 24 hours (contusion volume) and 20 months (contusion volume, GFAP expression, neuronal and microglial cell count). Survival was assessed in a cohort (n=50) kept for 20 months after injury. P-values of less than 0.05 were taken to indicate significance.

Results: Xenon significantly (p<0.05) reduced secondary injury development and improved neurological score (p<0.001) at 24 hours. At 2 weeks, none of the groups exhibited memory deficits using the CFC test. However, at 20 months, the control TBI group developed significant (p<0.05) memory deficits when compared with the sham animals. Strikingly, xenon-treated animals had no deficit and were not different from the sham group. At 20 months we found a significant increase in GFAP stained area in ipsilateral & contralateral hypothalami (p<0.01 & p<0.05, respectively) and ipsilateral retrosplenial cortex (p<0.01) in control animals when compared with sham animals. Xenon treatment prevented or reduced these increases. Control TBI animals had higher mortality than sham animals from 6 months after injury. Survival in the xenon-treated animals was significantly improved (p<0.05) up to 12 months after injury compared to the control TBI group.

Conclusions: We show for the first time that xenon-treatment prevents development of TBI-related late-onset associative memory deficits, prevents or reduces reactive astrogliosis in brain areas involved in associative memory formation, and improves long-term survival after TBI in a rodent model. These findings support the idea that xenon treatment may offer long-term neuroprotection and improved outcome in TBI patients.
1. Campos-Pires et al, 2015, Critical Care Medicine, v43 p149.
3. Harris et al, 2013 Anesthesiology, v119 p1137
The Effect of Traumatic Brain Injury Severity on Structural Connectivity: a Graph Theory Study

Reut Raizman\textsuperscript{1}, Ido Tavor\textsuperscript{1,2}, Anat Biegon\textsuperscript{3}, Sagi Harnof\textsuperscript{2,4}, Chen Hoffmann\textsuperscript{1,2}, Galia Tzarfaty\textsuperscript{1,2}, Abigail Livny\textsuperscript{1,5}

\textsuperscript{1}\textit{Department of Diagnostic Imaging, Sheba Medical Center, Ramat-Gan, Israel}, \textsuperscript{2}\textit{Sackler Faculty of Medicine, Tel-Aviv University, Tel-Aviv, Israel}, \textsuperscript{3}\textit{Department of Radiology and Neurology, Stony Brook University School of Medicine, , United States}, \textsuperscript{4}\textit{Department of Neurosurgery, Rabin Medical Center, Belinson, Israel}, \textsuperscript{5}\textit{The Joseph Sagol Neuroscience Center, Sheba Medical Center, Ramat-Gan, Israel}

Traumatic brain injury (TBI) is a major cause of death and disability worldwide. TBI is often characterized by white matter damage producing alterations in brain connectivity. These alterations are commonly suspected to disrupt the function of large-scale networks that support cognition. One analytic approach to examine these alternations is graph theory, which examines the brain from a network perspective.

The present study aimed to examine whether injury severity modulates structural connectivity and the association between brain connectivity alterations and cognitive deficits post-TBI.

Graph theoretical network analysis was applied on diffusion MRI in order to assess differences in structural connectivity between TBI and healthy control subjects. We performed DTI scans of 22 patients with chronic TBI in different injury severities (mild and moderate-severe TBI) defined by Glasgow Coma Scale (GCS) score, and 22 healthy control subjects. White matter connections between 90 gray matter brain regions were defined using tractography. Weighted brain structural matrices were constructed for each subject, and network measures were calculated. An objective cognitive deficits score of non-verbal abstract reasoning in TBI patients was calculated by subtracting pre-injury from post-injury performance on a nonverbal abstract reasoning test. In order to assess the injury severity effect on network measures, we performed ANOVA between controls, mild TBI and moderate-severe TBI on cluster coefficients, strength, efficiency, betweenness centrality and characteristic path length. These network measurements were analyzed in both global and local levels. To examine the effect of injury severity on cognition, Pearson's correlations were computed between network properties and deficit scores of the abstract reasoning test in TBI patients.

From both global and local perspectives, we found an effect of injury severity on network strength. As injury severity increased, the strength decreased. In addition, injury severity affected the centrality of hub regions, causing specific regions to become a hub solely in one group of injury severity, including the thalamus, precuneus, superior parietal cortex, middle temporal and superior occipital gyri. Further exploration of the graph measures in distinct hub regions, revealed that efficiency may serve as an important diagnostic tool to detect subtle brain injury specifically in mild TBI patients. In addition, reduced network efficiency in the left precuneus was associated with a greater deficit in nonverbal abstract reasoning performance in TBI patients.

Disconnection of network hubs led to a less efficient network, which in turn may have contributed to the cognitive impairments manifested in TBI patients. We conclude that injury severity modulates the disruption of network organization, reflecting a “dose response” relationship.
Utilization of the Return on Investment Methodology to Improve Cerebral Spinal Fluid Infection

Brenda Bousfield¹, Keisha Jack¹, Dale Bialas¹, Susan Disabitino¹, Mark Jefferson¹, Cheryl Main², Dominik Mertz², Almunder Algird², Anna Curkovic²

¹Hamilton Health Sciences, Hamilton, Canada, ²Mc Master University, Hamilton, Canada

Hamilton Health Sciences (HHS) is an acute Neurosurgical center in the province of Ontario which serves twenty-two community hospitals for neurosurgical diagnoses. The hospital provides neurosurgical services to approximately 2.3 million people within the region.

CritiCall Ontario is a dynamic and progressive healthcare organization dedicated to supporting access to and delivery of urgent and emergent care within the province. Through the CritiCall service, Hamilton Health Sciences received 2598 -3378 urgent or emergent calls between the years of 2015-2018 for the Neurosurgical program.

External ventricular drains (EVDs) are used frequently for the monitoring of intracranial pressure and for the treatment of acute hydrocephalus. Cerebral spinal fluid (CSF) infection rates associated with EVDs was of increasing concern at approximately 20%.

Definition of Infection Used for Data Collection: EVD infection was identified if there was a positive CSF culture along with at least one of the following: an Infectious Diseases expert confirmation, imaging consistent with infection, positive CSF cell count consistent with infection and treatment of infection for at least 2-3 weeks and evidence of no infection prior to the insertion of an EVD.

Method: Using a Return on Investment (ROI) methodology, an environmental assessment of current state and infection rates across the province was performed. Recognizing that HHS had the highest infection rate in the province, a working group of experts and stakeholders was developed within the organization and met monthly to review processes, identify gaps and opportunities for improvement.

Utilizing the ROI methodology, it was recognized that there were multiple factors involved in the root cause of infection rates. The factors included insertion method, sampling, drain care and maintenance in addition to many non-standardized practices. Retrospective data collected for the years 2014 and 2015 included infection rates and isolated organisms contributing to CSF infections.

Processes were reviewed and all possible opportunity for the introduction of infection was carefully examined. Improvements that were implemented included a comprehensive change in standard practice such as polices, protocols along with a new procedure room and a process for sustaining the change.

Results: Data collected pre-intervention in the years 2014 and 2015 showed infection rate was approximately 20%. Post implementation, EVD associated CSF infection rates was 9% in 2016 and 2% in 2017.

Conclusion: Through utilization of the ROI methodology, the change in standard practice of the procedural and care management processes for EVDs has demonstrated a significant ROI with improved patient, staff and organizational outcomes (such as decreased length of stay & cost).
The intangible benefits included staff satisfaction, decrease workload and improved team work.
Influence of Concussion History on the Performance of the Attention Network Task (ANT-I) in Female Varsity Athletes

**Samantha Roberts¹, Alma Rahimi¹, Tracy Meloche¹, Lauren Sergio¹, Magdalena Wojtowicz¹**

¹York University, Toronto, Canada

Objective: Although the vast majority of athletes who sustain a concussion recover within approximately 30 days, some may have neuropsychological sequelae that continue for months post-injury. More specifically, some individuals with mild traumatic brain injury or concussion have difficulties in sustained visual attention and slower choice decision making. The objective of the current study was to investigate the association between concussion history and performance on a computerized test of attention and executive functioning (i.e., the attention network test; ANT-I).

Method: Collegiate female varsity athletes completed a health history questionnaire, the Sport Concussion Assessment Tool-5 (SCAT-5), and the ANT-I during pre-season testing. Only participants with a 90% accuracy rate on the 288 trials of the ANT-I were included in the study. The final sample included 31 female varsity athletes divided into two categories; 16 females with a history of concussion (range of 1-6 previous concussions) and 15 females without a history of concussion. Participants ranged from 18 – 25 years of age (M= 19.90, SD= 1.72) and engaged in a variety of sports (e.g. field and ice hockey, volleyball, basketball, soccer). Mean reaction times were calculated for separate attention networks (i.e. alerting, orienting, and executive) and intra-individual variability was measured by calculating the individual standard deviations (ISD) to examine the stability of performance across the trials. Mann-Whitney U-Tests were conducted to compare between groups with concussion history (with and without a concussion history) as the dependent variable and ISD, mean reaction time, alerting score, orienting score, executive score, and SCAT-5 scores entered as the independent variables.

Results: Female athletes who had a history of one or more concussions had lower orienting network scores than female athletes with no history of concussion (p=.05; Cohen’s d=0.68). When examining performance in athletes with a history of two or more concussions, female athletes had lower orienting network scores (p=.04; Cohen’s d=0.66) and more errors on balance testing (i.e., the Modified Balance Error Scoring System; M-BESS from SCAT-5, p=.04; Cohen’s d=0.15).

Discussion: The ability to select and attend to specific spatial information using visual cues (orienting) may be negatively impacted by a history of one or multiple concussions in female varsity athletes. Future research needs to be conducted in larger samples to better understand the influence of the level of contact, gender differences, and concussion severity on this relationship.
Xenon Treatment Reduces Secondary Injury Development and Prevents Neuronal Loss and Microglial Proliferation in a Rat Model of Traumatic Brain Injury

Rita Campos-Pires1,2,3, Nada Mohamed-Ali1, Maria Balaet1, Jitka Aldhoun1, Laura Abelleira-Hervas1, Phillip Aitken1, Christopher Edge4,5, Nicholas Franks4, Robert Dickinson1,2

1Anaesthetics, Pain Medicine and Intensive Care Section, Department of Surgery & Cancer, Imperial College London, London, United Kingdom, 2Royal British Legion Centre for Blast Injury Studies, Department of Bioengineering, Imperial College London, London, United Kingdom, 3Charing Cross Hospital, London, United Kingdom, 4Department of Life Sciences, Imperial College London, London, United Kingdom, 5Royal Berkshire Hospital, Reading, United Kingdom

Background: Traumatic brain injury (TBI) is a complex and heterogeneous disorder resulting from external forces applied to the head. The resulting primary injury is immediate and irreversible, and triggers early, long-lasting secondary injury cascades. Secondary injury develops in the minutes, hours, days and weeks following trauma and is believed to underlie most of the functional impairments seen in TBI patients. Current TBI treatment is mainly supportive and no specific neuroprotective drugs are available. Over-activation of N-methyl-D-aspartate (NMDA) receptors after TBI is thought to play a crucial role in secondary injury development. Xenon, a general anesthetic and a competitive inhibitor at the glycine-site of the NMDA receptor [1,2] is neuroprotective in models of brain ischemia. Much less is known about the effect of xenon in the context of traumatic brain injury [3,4,5,6].

Objectives: Evaluate xenon’s neuroprotective efficacy on short-term histological outcomes in rats using the reproducible and well-established controlled cortical impact (CCI) TBI model.

Methods: Adult Sprague-Dawley male rats (n=22) were fixed in a stereotactic frame under anesthesia and underwent a cortical impact in the right parietal area, using a Leica Impact One stereotactic impactor. Sham animals underwent an identical procedure, but no craniotomy or impact were done. Core body temperature was maintained at 37°C throughout using a feedback-controlled heating pad. Animals were randomly assigned to control (75% nitrogen:25% oxygen) or xenon-treatment (50% xenon:25% oxygen, balanced with nitrogen) groups. Treatment was given for 3 hours, starting 30 minutes after TBI. Histological outcomes were measured at 30 minutes (contusion volume), and 24 hours (contusion volume, neuronal and microglial cell count) by researchers blinded to treatment. Statistical significance was assessed using Student’s t-test, one-way and two-way ANOVA with Bonferroni’s post hoc test.

Results: Xenon significantly reduced secondary injury development by 34 ± 11 % (p<0.05) at 24 hours after injury. In control TBI animals, neuronal cell number was significantly decreased in the ipsilateral retrosplenial cortex and contralateral motor cortex (p<0.05) and microglial cells were significantly increased in the ipsilateral somatosensory cortex (p<0.01) at 24 hours. Interestingly, neuronal and microglial cell counts in xenon treated animals were no different to uninjured shams.

Conclusions: Our results show for the first time that xenon is neuroprotective after TBI in rats. We demonstrate that xenon treatment after TBI reduces the development of secondary injury and prevents neuronal cell loss and microglial proliferation in functionally relevant brain regions. These findings support the idea that xenon is neuroprotective and reduces inflammation after TBI.

1. Dickinson et al, 2007 Anesthesiology v107 p756
2. Armstrong et al, 2012 Anesthesiology v117 p38
3. Campos-Pires et al, 2015, Critical Care Medicine v43, p143
5. Harris et al, 2013 Anesthesiology, v119 p1137
Living with Traumatic Brain Injury: Bringing Traumatic Brain Injury Information and Screenings to Community Settings

Olga Garduño-Ortega1, Michelle Smith1, Tamara Bushnik1
1NYU Langone Health, New York, United States

Objectives: To describe an ongoing community outreach project that provides resources, educational materials, and screening opportunities to community members and caregivers affected by Traumatic Brain Injury (TBI). The project’s framework aims to educate communities from diverse cultural backgrounds about TBI and seeks to identify individuals with medically and non-medically documented TBI. The community outreach project is an initial step to assess the feasibility of a mixed-method study utilizing the principles of Community Based Participatory Research.

Methods: The outreach was conducted by a bilingual, bicultural research team at seven community events hosted by Community-Based Organizations and Programs in the New York City area. The team engaged community members by assessing their personal experience or knowledge of someone affected by TBI. Prospective participants confirmed if their injury was medically documented, whereas participants without medically documented TBI were screened with the Ohio State University Traumatic Brain Injury Identification Method (OSU-TBI-ID, a standardized procedure for eliciting a person’s lifetime history of TBI via a 3-5 minute structured interview) by conversation or by utilizing the OSU-TBI-ID form. The study team educated participants about TBI and provided resources to better understand and manage this condition. Participants received a list of available TBI services, including day treatment programs, vocational rehabilitation, support groups, and advocacy services. Additional referrals were provided on a case-by-case basis.

Results: Between August to October 2018, a total of 228 community members were approached presenting with the following language profile: 189 Spanish-speakers, 25 Mandarin-speakers, 12 English-speakers, and 2 Arabic-speakers. Of those, 14 community members were identified as having experienced a moderate to severe TBI (2 medically confirmed; 12 non-medically confirmed); while 8 were identified as having experienced a mild TBI. Two community members identified as caregivers of an individual with a moderate to severe TBI (1 medically confirmed; 1 non-medically confirmed). Community members asked about the following topics as they relate to TBI: managing chronic headaches, resources for children and for the elderly, referrals to low-cost clinics and to neurologists, and Occupational Safety and Health Administration certification. Community members clearly expressed the need and interest for educational materials about TBI prevention and condition management.

Implications: These community outreach efforts demonstrate that a substantial number of individuals have non-medically confirmed TBI. Understanding the specific barriers and facilitators of individuals who were unable to, chose not to go to the hospital, or went to a hospital and were not diagnosed at the time of injury is of paramount importance to improve access to TBI services in community settings. These community outreach efforts strongly suggest that further research is needed to understand the long-term impact of TBI. Research can support the development of culturally tailored and translated educational materials and resources about TBI.
Leading Practice Partnerships - Interior Health and CONNECT

Patti Flaherty¹, Deborah Preston²
¹ Connect Communities, Vancouver, Canada, ² Interior Health, Kelowna, Canada

A decade into a partnership for acquired brain injury and stroke in British Columbia, some powerful outcomes with national recognition affirm that the chemistry is right.

CONNECT provides a transitional rehabilitation service through a funding partnership with Interior Health. Patti Flaherty, President and COO of CONNECT Communities, and Deborah Preston, Health Services Administrator – Central Okanagan Community, Interior Health, would like the opportunity to prepare an interactive presentation for the World Congress about the unique partnership they formed and the life-changing difference it has made to so many individuals and to the health system.

Along with some powerful economic outcomes there are 3 other notable achievements of the partnership that will be shared:

1. The creation of the Life Redesign Model™:
   • A culture of personal accountability, supported risk taking, social capital and meaningful community participation
   • Services planned around what the person wants more of in life. Participation in relevant life situations drives the residents’ goals
   • Leveraging neuroplasticity by pursuing resident goals in real-life, non-institutional settings
   • A “doing-with” coaching approach with blended job roles and a multi-professional coaching team

2. Leading Practice – Accreditation Canada
   The Life Redesign Model™ was deemed Leading Practice by Accreditation Canada in 2016 under client and family centred care for acquired brain injury services.

3. National recognition
   Health Systems from across the country have shown significant interest in CONNECT’s model and the partnership with Interior Health. After extensive research and a competitive process, Hamilton Health Sciences has partnered with CONNECT to build CONNECT Hamilton in Ontario in 2019. The model is firmly based on our Lake Country model.

Together CONNECT Lake Country and Interior Health have filled a significant system gap for persons with brain injury, providing an opportunity in BC to redesign their lives. The partnership has allowed many individuals to avoid long-term care and institutionalization, with 75% of people going home and to the community after CONNECT. Most importantly, the partnership has built a huge number of powerful individual stories that can inspire change and have positive influence for the individual and others.
Cellular Prion Protein (PrPC) as a Molecular Link Between Traumatic Brain Injury (TBI), and Brain Insulin Resistance

Sathiya Sekar1, Raja Salomon1, Hajar Mirazadeh Mahabadi1, Humphrey Fonge1, Changiz Taghibiglou1

1University of Saskatchewan, Saskatoon, Canada

Traumatic brain injury/concussion (TBI) is a growing epidemic throughout the world. It can be caused by head injury due to falls, vehicle collisions, violence, and sports. In Canada, between 2009 and 2010, 99,000 individuals needed medical attentions for brain injuries. It is the leading killer and disabler of Canadians under the age of 40. TBI has been increasingly accepted as one of the major external risk factors in the development/progression of neurodegenerative diseases like Alzheimer’s and Parkinsonism. Various studies showed a positive association between diabetes/brain insulin resistance and neurodegenerative diseases as well. The impairment in brain insulin signaling leads to neuronal dysfunction and increases neurodegeneration. Although evidence suggest alterations in the brain glucose metabolism following TBI, the underlying molecular mechanisms are not clearly understood. Taghibiglou and his team recently reported the release of cellular prion protein (PrPC) from brain to circulation following sport concussion and blast-induced brain injury. In this study, we hypothesize that PrPC may play an important role in central insulin sensitivity and brain glucose uptake/metabolism. Also, TBI causes brain insulin resistance and alters glucose metabolism partly due to the dislodgment of PrPC. Young Adult male C57BL/6 mice will be subjected to single and repeated TBI and monitored for 28 days post-TBI. Cortical, hippocampal, and cerebellar brain will be examined for insulin resistance using F18-FDG in PET scanning. PET scanning was performed once before induction and thereafter once in a week after induction for 28 days. We observed a significant decrease in glucose uptake in cortical, hippocampal and cerebellar regions of TBI (single and double induction) mice brain compared to the normal mice, from day 14. The PrPc levels was found to be significantly decreased in cortical and hippocampal regions of TBI mice when compared to normal mice brain. The results obtained from the present study clearly showed that TBI causes brain insulin resistance by altering glucose uptake in brain regions. This study will pave the way for the potential application of anti-diabetic and insulin sensitizing medications in TBI treatment.
The Effect of a Psychosocial Intervention on Well-Being 6 Months after Stroke

Ellen Gabrielsen Hjelle1, Line Kildal Bragstad1,3, Manuela Zucknick4, Marit Kirkevold1, Berit Bronken2, Randi Martinsen5, Kari Kvigne2, Gabriele Kitzmüller5, Margrete Mangset3, Bente Thommessen6, Unni Sveen3,7,8

1Department of Nursing Science and Research Center for habilitation and rehabilitation services and models (CHARM), Faculty of Medicine, University of Oslo, Oslo, Norway, 2Faculty of Social and Health Sciences, Inland Norway University of Applied Sciences, Elverum, Norway, 3Department of Geriatric Medicine, Oslo University Hospital, Oslo, Norway, 4Oslo Centre for Biostatistics and Epidemiology, Department of Biostatistics, University of Oslo, Oslo, Norway, 5Department of Health and Care Sciences, Faculty of Health Sciences, UiT, the Arctic University of Norway, Narvik, Norway, 6Department of Neurology, Akershus University Hospital, Lorenskog, Norway, 7Faculty of Health Sciences, Oslo Metropolitan University, Oslo, Norway, 8Physical Medicine and Rehabilitation, Oslo University Hospital, Oslo, Norway

Background and Aim: Psychosocial challenges are common after stroke and can affect motivation, long-term functioning, quality of life and reduce the effect of rehabilitation. This study aimed to evaluate the effect of a dialogue-based intervention to promote psychosocial well-being after stroke.

Materials and Methods: Adults with first or recurrent acute stroke, medically stable, with sufficient cognitive functioning and able to understand and speak Norwegian were included within one-month post-stroke. All participants received usual care that included treatment at acute stroke units followed by further treatment and therapy in rehabilitation centres or in the municipality according to needs and availability.

The participants in the intervention group received a dialogue-based intervention in addition to usual care. The intervention consisted of 8 individual 1-1 ½ hour sessions between the stroke survivor and a trained health care professional (registered nurse, occupational therapist) during the period between 1- and 6-months post-stroke.

The intervention targeted feelings, thoughts and experiences related to the life after the stroke. In the sessions, work sheets developed to support the dialogues were used. The work sheets consisted of drawings, figures, unfinished sentences, and key words that pointed to the topic that the participants were invited to address. Each meeting had a guiding topical outline, addressing significant issues described in the research literature like bodily changes, emotional challenges, personal relations, daily life issues, meaningful activities, existential issues and important values.

The primary outcome was mood at 6 months measured by the General Health Questionnaire-28 (GHQ-28). Secondary outcomes included health-related quality of life (Stroke and Aphasia Quality of Life Scale (SAQOL-39g)), depression (Yale-Brown single-item questionnaire) and Sense of Coherence (SOC-13). To explore the effect of the intervention, logistic regression, general linear modelling, independent sample t-tests and paired sample t-tests were applied.

Results: Three hundred and twenty-two participants were randomly assigned to the intervention group (n=166) or the control group (n=156). From baseline to 6 months, the proportion of participants with normal mood increased by 28.9% in the intervention group and 31.8% in the control group. After controlling for the baseline values, no significant benefit was found in the intervention group compared to the control group 6 months after the stroke (OR: 0.882; 95% CI: 0.53-1.45, P=0.621). The secondary outcomes did not show any between-group difference in well-being.
Conclusions: Psychosocial well-being improved during the first six months after stroke in both arms of the trial, but no statistically significant benefit of the dialogue-based intervention compared to usual care was found.
The Use of Osteopathic Manipulative Medicine in the Treatment of Headaches for a Patient with Subdural Hematomas in the Setting of Traumatic Brain Injury

Savitha Bonthala¹, Christopher Falco²
¹Nexus Neurorecovery, Conroe, United States, ²University of Texas Health Science Center at Houston, Houston, United States

Osteopathic manipulative medicine (OMM) is a non-surgical, interventional, hands-on approach to diagnosis and treatment of somatic dysfunction (physiological lesion). It may serve as primary or adjunctive therapy in addressing a wide range of visceral, neurological, myofascial, skeletal, and ligamentous conditions, in combination with other interventions. OMM techniques target lesion patterns in the muscles, bones and their articulations, fascia, ligaments, dura, fluids, viscera, and neural circuitry, and utilize a fulcrum for change to restore motion, balance, and maximal health.

A 61-year-old obese Caucasian male with history of HTN, CAD s/p CABG resulting in left brachial plexopathy and mechanical mitral valve replacement (2015) on chronic warfarin anticoagulation, presented on 9/12/17 for progressive bilateral lower extremity weakness and mild decrease in mental acuity. He had two prior falls with loss of consciousness when traveling to Mexico on 9/8/17 when intoxicated. Symptoms of bilateral leg weakness, decreased mental acuity, and urinary incontinence progressed over 2-3 days until he was unable to stand from a seated position. MRI on 9/14/17 revealed a parafalcine subdural hematoma with edema in the adjacent right cingulate gyrus with no other injuries identified. No surgical intervention was taken, and patient was transferred to The Institute for Rehabilitation and Research on 9/16/17 for functional deficits related to his subdural hematoma. Neurologic exam revealed the following: alert and oriented x 4. Fluent speech, intact immediate recall and able to perform serial 7’s x 4. Cranial nerves 2-12 were intact and reflexes were 2+ throughout with a positive hoffman’s sign on the left and positive babinks sign on the left. Manual muscle testing was intact on the right but decreased on the left. Patient complained of moderate retro-orbital headaches since his fall and patient was started on scheduled Tylenol BID, prn TYLENOL, prn tramadol, and scheduled Gabapentin 300 mg BID. Despite medication management, patient continued to have worsening headaches. He was started on hydrocodone 5-325 mg and took an average of 1-3 tablets daily starting on 9/21/17-9/26/17.

OMM treatments were started as an adjunct therapy for headache management. Treatments focused on the following: somatic dysfunction involving the cranial vault, lymphatic system, bilateral rib cages, and viscera. Treatments lasted between 10-15 minutes and were administered between 9/23/17-10/3/17. Patient experienced a decrease in overall headache symptoms and a decrease in both scheduled and prn pain medications. Upon discharge on 10/13/17 patient no longer required scheduled or prn pain medications and he was able to ambulate around the medical center while following a map with no cues.

This case illustrates the safety of using OMM to treat patients with headaches in traumatic brain injury. Patient experienced no adverse reactions to treatment, had a decrease in headache symptoms and participated in therapy without barriers.
Headache Symptoms in Persons with Post-Traumatic Headache: The Use of K-Means Clustering to Identify Headache Sub-Types in relation to mTBI Sequelae

Devan Phillips1,2,3, Scott Holmes1,2, Diana Sibai1,2, Jaymin Upadhyay1,2, David Borsook1,2
1Boston Children's Hospital, Boston, United States, 2Harvard Medical School, Boston, United States, 3Emmanuel College, Boston, United States

Background: Post-concussive headache is the most common somatic symptom reported by patients diagnosed with mild traumatic brain injury (mTBI). Headaches may be debilitating and are often co-morbid with altered emotional health (e.g., depression) and pain processing (sensitivity). Moreover, post-traumatic headache (PTH) and related symptomology often follow either an acute (symptoms < three months) or chronic presentation (symptoms > three months). It remains unclear how self-reported headache symptoms are related to pain endorsement, altered emotional health, and post-concussive symptoms in persons with an mTBI.

Objective: To evaluate the extent to which headache symptom reporting is related to pain endorsement, emotional health, and standard concussion scores in individuals diagnosed with mTBI and PTH. It was predicted that clinically relevant sub-cohorts could be defined based off of the inter-relationship of headache symptom reporting with commonly reported mTBI sequelae.

Design/Methods: Data was collected from a cohort of mTBI patients (n=28; acute n=11; chronic n=17) at 3-months post-injury. The four domains analyzed were: mTBI (Rivermead survey); headache phenotype (internal post-concussion survey); pain: (Pediatric Pain Screening Tool, Fear of Pain Questionnaire, Pain Catastrophizing Scale, Allodynia questionnaire) and psychological health (Depression: Becks’ Depression Inventory, Children’s Depression Inventory; Anxiety: Revised Children’s Manifest Anxiety Scale, Childhood Anxiety Sensitivity Index). Data was standardized into Z-scores and analyzed using K-means clustering. Optimal cluster number was determined using ANOVA. Pearson’s correlational coefficients were used to evaluate the relationship between domains after clustering.

Results: For statistical analysis of data, K-means clustering of standardized variables identified 3 clusters for analysis: Cluster 1: [Pain (m=-.41; sd=.82); Concussion (m=-.34; sd=.46); Psychological (m=.072; sd=.82); Headache (m=.47; sd=.82); Cluster 2: [Pain (m=.74; sd=1.17); Concussion (m=1.94; sd=1.06); Psychological (m=.84; sd=.61); Headache (m=-.64; sd=.62); Cluster 3: [Pain (m=.72; sd=1.15); Concussion (m=-.28; sd=.71); Psychological (m=-.77; sd=1.25); Headache (m=-.99; sd=.77). Chi-square tests revealed no significant difference in the distribution of acute versus persistent participants between cluster groups, X² = 3.54, p=.170. For Cluster 1, significant relationships were observed between psychological and pain reporting domains, r=.59, p=.009, and between psychological and mTBI symptom reporting, r=.47, p=.046 and headache and pain domains approached significance, r=.459, p=.056. For cluster 2, there were no significant relationships found. In cluster 3 the correlation between headache and mTBI symptoms approached significance, r=.759, p=.080.

Conclusions: These findings show how headache symptoms following mTBI may have sub-types based on their relationship to other post-concussive symptoms. The statistical approach of K-means clustering helps to further differentiate and identify specific trends in mTBI cohorts. Classification of acute versus persistent PTH symptoms did not align with cluster grouping suggesting that headache subtype is independent of
symptom lingering. Findings can be applied towards improving the diagnostic accuracy and treatment quality for specific mTBI sub-types.
DTI Indicators of White Matter Injury Correlate with EEG-Based Biomarkers of Sports Concussion in Slowly Recovering Collegiate Athletes

Harvey Levin^1,2, Naomi Hunsaker^3, Samantha Scarneo^4, Douglas Casa^4, Roger Newman-Norlund^5, Ashley Ware^6, Elisabeth Wilde^3,7

^1Michael E. De Bakey Veterans Affairs Medical Center, Houston, United States, ^2Baylor College of Medicine, Houston, United States, ^3University of Utah, Salt Lake City, United States, ^4University of Connecticut, Storrs, United States, ^5University of South Carolina, Columbia, United States, ^6University of Calgary, Calgary, Canada, ^7George E. Wahlen Veterans Affairs Medical Center, Salt Lake City, United States

To validate the sensitivity of a novel composite of quantitative EEG with cognitive and vestibular measures in a point-of-care device, the eBrain Function Index (eBFI), we compared the eBFI and diffusion tensor imaging (DTI) of 18 slowly recovering, concussed collegiate athletes (mean age: 19.7, SD=1.8) within 72 hours post-injury to data of 13 noncontact control athletes (mean age:19.9, SD=1.1). Time to return to play was >14 days (mean:22.4 days (SD=) in concussed group. Significant (p<0.05) between group differences in DTI metrics were found in multiple brain regions, including the genu of the corpus callosum (CC), forceps major of the CC, inferior frontal occipital fasciculus (IFOF), and uncinate fasciculus (UF). Mean diffusivity (MD) was significantly correlated with the eBFI for right IFOF (r=0.39, p=0.043), and left IFOF (r=0.049, p=0.006). Axial diffusivity (AD) was significantly correlated with eBFI in left ILF (r=0.51, p=0.005), forceps minor of the CC (r=0.34, p=0.033), and left IFOF (r=0.039, p=0.035). Radial diffusivity (RD) was significantly correlated with eBFI for the forceps major of CC (r=0.44, p=0.020) and right RIFOF (r=0.43, p=0.024). Our data provide preliminary validation of eBFI’s sensitivity to white matter injury in subacute SRC as shown by significant correlations with DTI metrics which differed significantly from the control group’s imaging. Further analysis will examine followup DTI and eBFI data obtained 45 days postinjury. Current findings provide preliminary support for the prognostic utility of eBFI in collegiate athletes.
Sex Differences in Strangulation Injuries: A Population-Based Analyses

Binu Jacob1, Nora Cullen1,2, Vincy Chan1, Halina (Lin) Haag3,6, David Stock1,4, Angela Colantonio1,3

1Toronto Rehabilitation Institute, University Health Network, Toronto, Canada, 2West Park Healthcare Centre, Toronto, Canada, 3Rehabilitation Science Institute, Toronto, Canada, 4Dalhousie University, Halifax, Canada, 5Institute for Clinical Evaluative Sciences, Toronto, Canada, 6Wilfrid Laurier University, Waterloo, Canada

Background: Strangulation is a highly prevalent form of domestic violence that occurs across all genders, with the potential for severe brain injury such as hypoxic ischemic brain injury. However, no population level data is available on individuals who experience this type of injury and continues to be drastically under-reported. Population-level data on these individuals and the damaging impacts of injury on their subsequent health care utilization is crucial to initiate health care policies, and to enhance public awareness initiatives.

Objective: The overall goal of this study was to describe the profile of individuals who had a strangulation-related injury and were seen in the emergency department (ED) or acute care settings in Ontario, Canada, and to explore the care pathways through the healthcare system among the survivors, stratified by sex.

Methods: A retrospective cohort study was conducted using population-based health administrative data in Ontario, Canada. Adults aged 15 years and older with a strangulation-related injury (identified using International Classification of Diseases Version 10 codes X91 or Y20) seen in the ED or acute care settings between fiscal years 2002/03 and 2016/17 were included in this study. The healthcare utilization of these patients within one-year of discharge was identified, and data were stratified by sex to explore sex differences and similarities between males and females.

Results: Between 2002/03 and 2016/17, there were 656 individuals with a strangulation-related injury, the majority of whom were seen in the ED setting (89%), was predominantly females (66%), aged 35 years or younger (59%), and of lower income quintiles of ≤3 (72%). Of the 636 individuals who survived the index injury, 52% had a subsequent ED visit within one year of discharge, of which 6% were due to another strangulation. In sex-stratified analysis, a higher proportion of males were found in age group 15 to 20 years compared to females (17% vs. 13%, p=0.05); more females were discharged home (86% vs. 72%, p<.001) and had higher ED visits within one-year of discharge (55% vs. 41%, p=0.004) compared to males.

Conclusion: This study shows sex differences in strangulation-related injuries and subsequent use of ED services. These data underscore the need to improve health care practices related to strangulation screening and for further research in this area to support the development of evidence-based optimal care for this vulnerable, under-studied population.
Anhedonia and Reward-Related Deficits in Traumatic Brain Injury: Implications for Development of Depression Post-Injury

Amanda Ceniti1,2, George Foussias2,3, Sakina Rizvi1,2,4, Mark Sinyor2,5, Tom Schweizer1,2,4, Sidney Kennedy1,2,4,6
1St. Michael's Hospital, Toronto, Canada, 2University of Toronto, Toronto, Canada, 3Centre for Addiction and Mental Health, Toronto, Canada, 4Li Ka Shing Knowledge Institute, Toronto, Canada, 5Sunnybrook Health Sciences Centre, Toronto, Canada, 6Toronto Western Hospital, Krembil Research Institute, Toronto, Canada

Introduction: Traumatic brain injury (TBI) frequently affects the frontal cortex, which can have widespread behavioural effects including disruption to the reward system. This disruption may manifest clinically as anhedonia, the reported loss of interest or pleasure thought to be linked to dysfunction in reward circuitry. It may also be measured experimentally through tasks probing various facets of reward including motivation, effort, anticipation, and reward responsivity. Notably, anhedonia is a core symptom of Major Depressive Disorder (MDD). Thus, the presence of anhedonia and reward dysfunction post-TBI may predict the future development of psychiatric disorders including MDD. The aim of this current review is to synthesize the published literature on reward processing and anhedonia in TBI, and to discuss the psychiatric implications of these findings.

Methods: A literature search was conducted to identify and summarize the published literature on reward processing and anhedonia in TBI populations using the search engine PubMed, with no restriction on publication year. The review was limited to primary research papers which enrolled adult participants and were available in English.

Results: The literature search identified 155 articles, of which 21 articles met criteria for inclusion. Across included studies, the most frequently used measure of reward (n=9) was the Iowa Gambling Task (IGT), which probes various facets of reward including anticipation, hedonic response, and feedback integration. These studies generally demonstrated impaired performance on the IGT in TBI as compared to non-injured controls, though some conflicting results were found, possibly due to small sample sizes. Reward valuation, assessed through temporal discounting and auction tasks, was also shown to be impaired in TBI across studies. At the neurophysiological level, electroencephalography (EEG) studies consistently demonstrated that rewarding stimuli were not processed by TBI patients in the same way as controls. Few studies measured anhedonia in TBI; one reported an association between anhedonia and damage to the ventrolateral prefrontal cortex. Two included studies also reported the effectiveness of various therapeutic options, including psychotherapy and pharmacological agents that target the reward system (e.g. dopamine agonists) in improving reward function post-TBI.

Implications: Findings of this review underscore the value of assessing anhedonia and reward deficits following TBI. Importantly, anhedonia may be a key factor in the development of psychiatric sequelae post-injury, as this symptom has shown promise in predicting MDD onset and treatment outcome. Therefore, the presence of anhedonia and reward processing dysfunction following TBI may be a potential marker of risk for depression.
Early Intervention for Impairing Post-Concussion Symptoms in Adolescents and Young Adults: Results from a Randomized Trial

Mille Moeller Thastum1, Charlotte Ulrikka Rask2, Erhard Trillingsgaard Naess-Schmidt1, Astrid Tuborgh2, Oana-Veronica Frederiksen3, Jens Sondergaard Jensen1, Susanne Wulff Svendsen3, Joergen Feldbaek Nielsen3, Andreas Schröder1

1Aarhus University Hospital, Aarhus, Denmark, 2Department of Child and Adolescent Psychiatry, Aarhus, Denmark, 3Hammel Neurorehabilitation Centre and University Research Clinic, Hammel, Denmark

Background: Up to 15% of individuals with concussion continue to experience impairing physical, cognitive and emotional symptoms for more than 3 months. Currently, methodologically rigorous studies on intervention are scarce, and no standardized intervention is available.

Aim: To examine the efficacy of Get going After concuSsion (GAS), a newly developed, early intervention for young patients (15-30 years) with persisting post-concussion symptoms (PCS) in a randomized trial (ClinicalTrials.gov ID NCT02337101.)

Methods: One hundred and thirteen consecutively recruited patients with persistent PCS (defined as a score on Rivermead Post-concussion Symptoms Questionnaire (RPQ) >20 2-6 months post-concussion) were randomized to either 1) Enhanced Usual Care (EUC), i.e. education about concussion and advice about adaptive illness behaviors, or 2) EUC + GAS, i.e. 8 weeks of individually-tailored, interdisciplinary intervention focusing on maladaptive illness perceptions and illness behaviors. Patients completed self-report measures at inclusion (baseline), at end of intervention, and at 3-months follow-up (FU). The overall effect of treatment was assessed by the RPQ (primary outcome). Secondary outcomes included illness worry measured by the Whiteley-7, quality of life measured by the Quality of Life After Brain Injury – Overall Scale, psychological distress measured by the Symptom Checklist-8, and physical, mental and social functioning measured by the Short Form (36) Health Survey. Process measures were the Brief Illness Perception Questionnaire and the Behavioral Response to Illness Questionnaire.

Results: Patients allocated to EUC + GAS (n=57) reported significantly larger improvements in PCS (38.5 to 21.0 vs. 37.4 to 27.8 points) compared with patients allocated to EUC (n=56), with a mean difference at 3-months FU of 7.5 points (95% CI 1.96; 13.06, p=0.008). The Risk Ratio of still having persistent PCS at 3-months FU was 0.6 (95% CI 0.44; 0.89, p = 0.008) in favor of GAS. Number Needed to Treat for prevention of one additional case of persistent PCS 11 months post-injury was 3.7 (95% CI 2.2; 11.3). Improvements in PCS were accompanied by larger improvements in illness worry, and physical and mental health, as well as a larger decrease in negative illness perceptions and maladaptive illness behavior in EUC + GAS compared with EUC only. Furthermore, patients' satisfaction with GAS was high. No adverse events were reported.

Conclusion: GAS + EUC markedly reduced the risk of having persistent PCS 11 months post-injury compared with EUC only. Furthermore, GAS was safe, feasible, and associated with high patient satisfaction. Replication trials in other health care systems are needed to confirm our findings. Additional data is required to explore the long-term impact of the observed symptom reduction on objective outcomes such as work ability and health care use.
Implementation of Evidence-Based Practices in Cognitive Rehabilitation: Determinants Influencing Implementation

Marc-André Pellerin¹,³, Valérie Poulin²,³, Marie-Eve Lamontagne¹,³, Anabelle Viau-Guay¹,⁴, Alexandra Jean²
¹Université Laval, Québec, Canada, ²Université du Québec à Trois-Rivières, Trois-Rivières, Canada, ³Centre interdisciplinaire de recherche en réadaptation et en intégration sociale (CIRRIS), Québec, Canada, ⁴Centre de recherche et d'intervention sur la réussite scolaire (CRIRES), Québec, Canada

Introduction: Implementation of evidence-based practices in cognitive rehabilitation post-acquired brain injury (ABI) is challenging, as it involves complex and individualized interventions. To foster practice change, the use of strategies that are tailored to team’s needs, multimodal, active and social is suggested. However, further efforts are needed to better understand determinants influencing implementation of best practices.

Study objective: To identify perceived facilitators and barriers to the implementation of evidence-based practices in cognitive rehabilitation post-ABI.

Methods: An implementation study was conducted with two multidisciplinary teams including occupational therapists, neuropsychologists, speech therapists and educators (Team A: n=11 and Team B: n=14). A tailored and multifaceted knowledge translation intervention, using learning tools, interactive workshops and additional exchange sessions as needed by each team was developed to implement one evidence-based practice chosen by each team. Six months following the implementation, each team participated in a focus group to elicit perceived facilitators and barriers faced during the implementation process. Content analysis was applied using a deductive approach based on the Consolidated Framework for Implementation Research, which categorize implementation determinants into 5 domains (i.e. Intervention characteristics, Outer setting, Inner setting, Characteristics of the individuals involved, and the Process of implementation).

Results: Both teams reported good motivation throughout the implementation (Characteristics of the individuals). Team A highlighted the positive influence of the implementation (Process) which fostered team mobilization and an improved interprofessional collaboration. As the new practice was highly related to their context (Intervention characteristics), the team felt that the intervention helped them to structure and deepen their clinical interventions. Organizational environment (Inner and outer setting) did not play a major role for this team. Team B appreciated the multiples meetings which kept the implementation momentum and helped them to stay involved (Process). They particularly valued the given opportunities to discuss with colleagues with whom they had little occasion to exchange before. The collaboration developed helped them to overcome the high workload, the organizational changes and the staff turnover during the project (Inner and outer setting). Nevertheless, the team managed to put the practice in place as it made sense in their practice, even though the new practice was seen as complex at the beginning (Interventions characteristics).

Conclusion: This study suggests that the implementation of a new practice can be eased by implementing practice align with professionals’ clinical context. Moreover, it reveals that an implementation intervention using interactive workshops and exchange sessions can foster collaboration between professionals and sustained implementation momentum. It also has the potential to support the teams facing challenges, such as the organizational constraints, during implementation.
Neurorehabilitation Using the Portable Neuromodulation Stimulator (PoNS®) for Treating Patients with Chronic Balance Deficit Due to Mild-to-Moderate Traumatic Brain Injury (mTBI): A 26-Week Study

Mitchell Tyler¹, Kim Skinner², Vivek Prabhakaran³
¹Department of Biomedical Engineering and Department of Kinesiology, University of Wisconsin, Madison, United States, ²Department of Kinesiology, University of Wisconsin, Madison, United States, ³Department of Radiology, University of Wisconsin, Madison, United States

Background: Neurostimulation is becoming a valuable therapeutic tool for neurorehabilitation after traumatic brain injury (TBI). The Portable Neuromodulation Stimulator (PoNS®) targets the trigeminal and facial cranial nerves (V and VII) in the tongue through translingual neurostimulation (TLNS). When combined with targeted physical therapy (PT), TLNS improves outcomes for patients with neurodegenerative disease or spinal cord injury. This study (NCT02158494) was developed to compare the efficacy of high (HFP) and low frequency pulse (LFP) TLNS plus targeted physical therapy (PoNS® treatment) in patients with balance deficit due to mTBI.

Methods: Patients were 18-65 years of age with a mTBI that occurred ≥1 year before enrollment. A balance deficit determined by the NeuroCom® Sensory Organization Test (SOT) composite score ≥16 points below normal was required. All patients had previously received PT and plateaued in recovery. Enrolled patients were randomized into HFP or LFP PoNS® treatment groups. The double-blinded study design consisted of 14 weeks of PoNS® treatment, then 12 weeks of normal activity without PoNS® treatment. The primary endpoint was change in the SOT composite score from baseline to week 14. SOT scores were also evaluated at the end of weeks 2 and 26. Secondary endpoints included gait and headache assessments. In a structural magnetic resonance imaging sub-study (n = 9), scans were performed at baseline, and after 2 weeks of treatment to assess changes in gray matter volume (GMV) and cortical thickness.

Results: Forty-three patients were randomized into HFP (n = 22) or LFP (n = 21) groups. There was no significant difference in composite SOT score between treatment groups at weeks 2, 14, or 26 (P = 0.41, P = 0.47, P = 0.99, respectively). Both groups, however, had significant within-group improvements from baseline SOT scores at all evaluation points (P < 0.001). Post-hoc analysis of HFP and LFP groups when combined demonstrated highly significant (P < 0.0005) improvements in SOT composite score from baseline to weeks 2 and 14. Significant improvements were maintained after treatment was discontinued. Secondary endpoint results also indicated significant improvements from baseline. Brain regions involved in balance-control (eg, cerebellum) and multisensory integration (eg, right superior temporal gyrus) had the largest GMV increase post-treatment and correlated with changes in functional assessments performed at 2 weeks. Areas for planning, visual, or cognitive function showed variable changes.

Conclusions: PoNS® treatment produced significant improvements in balance with no significant difference noted between HFP and LFP groups. GMV increased in balance-controlling and multi-sensory integrating brain regions while variable changes occurred in executive or visual control areas post-treatment. PoNS® treatment benefits were sustained for 12 weeks after the intervention was discontinued. Overall, PoNS® treatment appears safe and effective at promoting neuromodulation to improve persistent balance deficit in patients with mTBI.
Applying the Science of Happiness to Life After Brain Injury

Carolyn Lemsky¹, Daniel O’Driscoll¹, Roby Miller¹
¹Community Head Injury Resource Services of Toronto, Toronto, Canada

Introduction: Positive psychology has offered many insights into the building blocks of well-being (Seligman, Steen, Park & Person, 2005). Although several authors have commented that the concepts related to charter strengths and resilience have great relevance in rehabilitation medicine few have explored the potential impact of a psycho-educational group on the well-being of long-term survivors of moderate to severe brain injury.

Objective: Development and piloting of a two 12-week psychoeducational groups that introduced based on the concepts and interventions of Positive Psychology.

Setting: Community-based brain injury support service (Community Head Injury Resource Services of Toronto).
Participants: 30 survivors of moderate to severe brain injury.

Intervention: Two positive psychology workshops (a total of 24 weeks of content) were developed using key concepts and exercises presented in Authentic Happiness (2002). The Happiness workshop provided an overview of the elements of well-being (positive emotional, engagement, Positive Relationships, Meaning and Achievement). Exercises related to savoring, gratitude, positive affect were introduced. The Strengths Workshop introduced the concept of signature strengths. Participants completed an adapted version of the Global Assessment of Character Strengths (McGrath, 2017). Participants were assisted in setting goals based on using their signature strengths. The format of both workshops included a ‘check-in’ emphasizing what went well in the previous week, review of homework, presentation of new materials, and homework assignment. The mode of presentation included power-point presentations, videos, role plays and modeling.


Results: Preliminary findings indicated that 71% of participants reported improvement in satisfaction of life with 92% reporting improvements in satisfaction with social interaction. Participants reported a high level of satisfaction with the group. We conclude that the psychoeducational workshops are well-received and have the potential to improve quality of life for people living long-term with acquired brain injury.
Creating an Integrated System to Support Individuals with Acquired Brain Injury, Mental Health and Addictions in the HNHB LHIN: A Model to Implement Best Practice

John Zsofcin¹
¹Hamilton Health Sciences, Hamilton, Canada

Background: Individuals living with complex co-morbid conditions such as acquired brain injury, mental health and addictions present some of the most challenging to our healthcare system as programs often report feeling ill equipped and lacking capacity to support their care.

From a Provincial perspective:
- 12.7% of all TBIs occur in the HNHB LHIN
- 11.7% of persons with a TBI across the province have an existing mental health diagnosis
- 8.9% of persons in HNHB LHIN get to rehab; those with mental health diagnoses are over represented in rehab (14.4% across the province)
- 15% of those across the province who get rehab will have more than 1 rehab stay within 365 days
- Hamilton Health Sciences triaged over 900 new ABI referrals over the past year

Hamilton Health Sciences received specialized funding from the Ontario Neurotrauma Foundation in order to support implementation of the INESSS-ONF Guidelines for moderate to severe TBI. Specific emphasis was placed on recommendations A2.1 and A2.2 which were identified as high priorities within the HNHB LHIN and throughout the province.

These recommendations state: Collaboration and continuity mechanisms should be established with mental health services (and addiction/substance use services) and programs in order to develop optimal management strategies for individuals with co-morbid traumatic brain injury and mental health (and adduction/substance use) issues.

The collaboration mechanisms will involve cross training and education strategies for professionals and stakeholder organizations who will strengthen their ability to recognize and to address the issues particular to individuals living with these complex conditions.

A consensus building day was held on October 12, 2018 bringing together professionals and leaders from across several sectors in the HNHB LHIN including acute care and rehab hospitals (both Mental Health and ABI), specialized community agencies working with ABI, mental health and/or addictions, corrections, court services, government, etc.

The consensus day focused on identifying current pockets of excellence with respect to caring for this patient population, identifying current gaps within our system, bringing forward opportunities which we may impact in the next 2 years and finally prioritizing concrete tasks to move forward.

4 strategic priorities were identified, and commitment gathered in order to move forward with this initiative. Oversight and governance will be provided by the HNHB Network where progress will be measured and shared. It is hoped gains will be made within each organization and as a system in order to enact more collaborative care in the HNHB LHIN.
This presentation will focus on progress made with these 4 strategic priorities and initial data will be shared highlighting success to date. It is hoped this model will then be able to be spread to other communities also struggling to care for these complex individuals.
Evaluating Post-Traumatic Headaches in Patients with mTBI in the Acute and Chronic Settings: Resting-State fMRI Identifies Unique Network Changes

Jordan Lemme¹,², Scott Holmes¹,², Diana Sibai¹,², Jaymin Upadhyay¹,², David Borsook¹,²
¹Boston Children’s Hospital, Boston, United States, ²Harvard Medical School, Boston, United States, ³University of New England College of Osteopathic Medicine, Biddeford, United States

Background: Post-Traumatic Headaches (PTH) are common symptoms from mild traumatic brain injury (mTBI) that typically resolve within 3 months post-mTBI. However, in a sub-group of patients’ symptoms persist beyond the three-month period. It remains unclear if brain functional networks contribute to the lingering symptoms in patient’s experiencing persistent PTH symptoms. The objective of this investigation was to evaluate the extent to which resting state functional network connectivity is altered between a group of patients with resolved versus persistent PTH symptoms relative to healthy controls. It was predicted that persons with persistent symptoms would show distinct functional network abnormalities relative to healthy controls compared to the resolved symptom group.

Methods: Patients diagnosed with PTH fulfilled the ICD-9 criteria for mTBI and reported to have developed a headache within 8 days after mTBI. Subjects were placed into two cohorts according to headache status R-PTH <3 months or P-PTH >3 months. All subjects were ages 12-21 at time of participation (12=Healthy, 14=Persistent, 9=Resolved). Rivermead Post Concussion symptom survey and RSN scans were obtained from all mTBI subjects at the 3-month study visit. RSNs were identified using FSL melodic tool restricted to 29 components. The group maps were dual regressed in-order to determine alterations between study cohorts (Healthy, P-PTH, R-PTH).

Results: The mean score for the Rivermead survey was significantly elevated in the P-PTH (14.9; SD=12.3) relative to R-PTH (4.3; SD=5.6) group, t=2.43 p=0.02. Eight resting state networks were positively identified in the data set. Five networks showed significant group differences (p<0.003). The healthy control cohort did not show increased connectivity relative to either mTBI group. Increased functional connectivity was observed for the P-PTH in the R-Frontal Parietal (p=0.0012) and Auditory (p=0.0012) networks within the orbitofrontal cortex and post central gyrus, respectively. In the R-PTH group, the Lateral Visual (p=0.0014), R-Frontal Parietal (p=0.0012) and L-Frontal Parietal (p=0.0016) networks had increased functional connectivity relative to healthy controls. Changes were observed within the frontal medial cortex and frontal pole within the Frontal-Parietal network and lateral occipital cortex within the Lateral Visual network.

Conclusion: Network functional changes are observed in both mTBI cohorts with resolved and persistent PTH symptoms. Changes in the same resting state networks (RSN) but distinct anatomical regions may underlie functional network alterations and why symptoms may resolve in some, but not other patients. Increased functional connectivity within the Visual and Frontal Parietal networks has also been reported in pediatric migraine patients potentially implicating a similar pathway for PTH and migraines. By understanding the RSN connectivity alterations in Persistent and Resolved PTH, findings may supplement clinical diagnostics or treatment efforts and may inform return-to-play/return-to-sport protocols.
Clinicians' Use of Evidence-Based Practices for Self-Awareness Retraining Following A Knowledge Translation Intervention

Valérie Poulin1,3, Marc-André Pellerin2,3,4, Marie-Eve Lamontagne2,3, Anabelle Viau-Guay2,4, Alexandra Jean1
1Université Du Québec À Trois-rières, Trois-rières, Canada, 2Université Laval, Québec, Canada, 3Centre interdisciplinaire de recherche en réadaptation et en intégration sociale (CIRRIS), Québec, Ontario, 4Centre de recherche et d'intervention sur la réussite scolaire (CRIRES), Québec, Canada

Rationale: Self-awareness deficits are common post-acquired brain injury, including stroke, and affect participation in rehabilitation and everyday living outcomes. Recent research evidence supports the use of self-awareness retraining for improving activity and participation outcomes (Engel et al., 2017). Key elements for self-awareness retraining may include experiential practice, external feedback (verbal, visual or video-taped), guided discussion, metacognitive strategy training (e.g., predicting and evaluating performance), patient and family education. However, the extent to which these various intervention components can be applied within the clinical context remains unknown. Further research is needed to document the implementation of interventions for self-awareness.

Objective: To describe clinicians’ perceived use of evidence-based practices for self-awareness retraining within the next six months following a knowledge translation (KT) intervention.

Methods: A tailored and multifaceted intervention to support implementation of self-awareness retraining was provided to an interdisciplinary stroke rehabilitation team (n=3 neuropsychologists, 6 occupational therapists and 1 educator) offering inpatient and outpatient services. The intervention consisted of: provision of learning tools (e.g., videos, pocket cards) created based on the results of a rapid review and consultations with team members; and an interactive workshop to foster sharing of experiences and knowledge integration. Practices implementation was measured using (1) checklists completed by clinicians for monitoring use of the intervention components with their clients (up to three months post-intervention); (2) individual interviews to elicit further information on how they applied these practices (3 months post-intervention); (3) focus group discussion 6 months post-intervention.

Results: Six of the 10 participants in the KT intervention completed checklists that indicated implementation of some intervention components. The most frequently used were verbal feedback (n=5 clinicians), guided discussion (n=4) and metacognitive strategy training and education (n=3 each). In individual interviews, they reported that the use of these specific intervention components was compatible with the organizational constraints, as well as their previous practices. The integration of video-taped feedback was only reported by one therapist, who used it more specifically for repeated training of specific functional tasks, and as a complement to other intervention components she had tried (e.g., verbal feedback). At 6 months post-intervention, clinicians reported that their use of the intervention components was more structured and consistent than at pre-intervention, and that it was fostering inter-professional collaboration. However, they perceived that patients with self-awareness deficits needed to have some pre-requisites (such as sufficient cognitive abilities and emotional readiness) in order to fully engage in self-awareness retraining.

Conclusion: Clinicians reported varying levels of use of the intervention components for self-awareness retraining following their participation in the KT intervention. Selecting and implementing interventions for self-awareness retraining requires considering various factors (e.g., characteristics of the practices, individuals and environmental context) that will be further analyzed in the next steps of this project.
Application of Quality Improvement Framework to Reduce Incidents of Aggressive and Abusive Behaviours In an Inpatient Acquired Brain Injury Unit

Nora Cullen¹, Naomi Abegunde¹, Karl Gunnarsson¹, John Davis², Steve Orenczuk³
¹West Park Healthcare Centre, Toronto, Canada, ²Hamilton Health Sciences, Hamilton, Canada, ³St Joe’s Hospital, London, Canada

Purpose: To apply a Quality Improvement Framework in reducing the number of aggressive and abusive behaviour incidents from patients with acquired brain injury (ABI) towards others in an inpatient rehabilitation acquired brain injury (ABI) unit.

Relevance: Incidents of aggressive and abusive behaviours among patients with ABI are exceptionally common in inpatient ABI units. A large proportion of these incidents occur within a dedicated brain injury unit, placing both patients and staff safety and wellbeing at risk. Minimizing the occurrence of these incidents is of utmost importance to safeguard patient and staff safety.

Methods and Analysis: A retrospective review of incidents of abusive and aggressive incidents that occurred hospital-wide over a one-year period was completed. The incidents were categorized by patient to patient, patient to staff, patient to inanimate object, verbal, physical, and both verbal and physical combined. The incidents were analyzed to identify the most frequently occurring incident type. Incident rate was calculated by dividing the total number of reported abusive and aggressive behaviour incidents by total patient days X 1000. Incident descriptions and patient information were reviewed to identify patterns or risk factors. Surveys, interviews and quality improvement tools were utilized to identify the issues and a plan for quality improvement was implemented.

Study Sample or Initiative Scope: Patients were 18 years or older who sustained an ABI as a result of trauma or illness, and admitted to an inpatient ABI unit for cognitive, physical or behavioural treatment.

Findings: Baseline data showed that a total of 165 incidents of abusive and aggressive behaviour hospital-wide occurred with 114 (69%) incidents related to ABI patients, 51% were physical, 6% verbal, and 43% both physical and verbal. 6% resulted in mild harm to patients and staff including pain/ discomfort and swelling. Aggression towards staff accounted for 59% (67 incidents) while aggressions towards other patients accounted for 11% (12 incidents). Contributing factors for these incidents were identified as underlying illness, confusion/ disorientation, sensory impairment, communication impairment, change in routine, environmental factors and changes to medications. Lack of role clarity among staff, ineffective communication and interaction between patients and staff, environmental factors, restrictions/ denial of service were identified as issues needing to be addressed. Data will be presented that addresses these concerns.

Conclusions: The application of quality improvement processes in assessment and problem solving is effective in improving the safety and wellbeing of patients and staff.
Assessing the Validity of the Switch Task to Be Used for Concussion Evaluation

Alexe Simard¹, Veronik Sicard¹, Gabriel Lavoie¹, Robert Davis², Dave Ellemberg¹

¹University of Montreal, Montréal, Canada, ²Arnold School of Public Health, Columbia, United States

Introduction: The search for sensitive tests to evaluate concussion persists. The Switch task is believed to be sensitive to various medical conditions, including traumatic brain injury as it reflects cognitive control. Accordingly, we developed two alternate versions of a color-shape switch task. The Switch task includes two rule-sets (color and shape) and requires the participants to alternate from one rule to another, depending on a cue. Variability in the task switching ability is traditionally seen through three switch-costs: the global switch cost, thought to be a measure of global cognitive control; the local switch cost, believed to be a measure of cognitive flexibility; and working memory cost, thought to reflect working memory (WM). The aim of this study was to evaluate the effect of administrator, participant sex, and version of the task as well as the construct validity of the different switch-costs and the primary variable (IES) of the Switch task.

Methods: 128 healthy participants completed standardized measures of executive functions and the Switch task. Because the inverse efficiency score (IES) allows for a comprehensive measurement of combined reaction time and accuracy, the different IES switch-costs were computed. A series of 4 (administrator) × 2 (participant sex) × 2 (version) was conducted for global IES cost, local IES cost, working memory IES cost, and primary variable IES.

Results: No significant interactions were observed on any of the variables, ps≥.14. A significant effect of participant sex was observed for local cost and primary variable IES, where females exhibit a higher IES than males, ps≤.02. No significant effect was observed on global IES cost and working memory IES cost, ps>.05. A significant correlation was observed between global IES switch-cost and the CTMT, rs>.22, ps<.03. No significant correlation was observed with the Global Executive Component of the BRIEF-A and the inhibition condition of the Color-Word Interference (D-KEFS), ps>.07. The Local switch-cost did not correlate with scores on the CTMT, on the switching condition of the Color-Word Interference (D-KEFS), on the Cognitive Flexibility Scale, and on the Shift scale from the BRIEF-A, ps>.07. Correlations between WM cost and scores on the Digit Span test (WAIS-III), and on the WM scale from the BRIEF-A were not significant, ps>.26. Further, primary variable IES was correlated with both CTMT trail 4 and composite score, ps<.04.

Conclusions: Researchers should take sex into account in their experiments when they use the Switch task. Further, the results of the current study suggest that the primary variables IES show a greater convergent validity than the traditionally computed switch-costs. The Switch task seems to be a measure of general executive functions that does not allow for individual measurement of cognitive flexibility and working memory.
Who Will Make It Through? Predicting Non-Sedated MRI Success in Young Children with and without Traumatic Brain Injury

Carola Tuerk¹, Jessica Lacombe-Barrios¹,², Fanny Dégeilh¹,², Mathieu Dehaes¹,², Ramy El-Jalbout¹,², Thuy Luu¹,², Chantale Lapierre¹,², Miriam Beauchamp¹,²

¹University of Montreal, Montreal, Canada, ²CHU Sainte-Justine Research Center, Montreal, Canada

Objective: Neuroimaging is a method central to the assessment of cerebral development and integrity throughout the lifespan. Acquiring structural magnetic resonance images (MRI) of the brain during early childhood can inform on the rapid maturational changes that occur in the brain during this time, as well as on the impact of acquired injury on the developing brain. However, between birth and 6 years of age, imaging success is limited given the inherent challenges associated with scanning young children (i.e. movements, anxiety). Various preparation procedures may help to improve MRI acquisition success rates in young children (e.g., Thieba et al., 2018). In this pilot project, using a behavioural familiarization protocol for scanning young children without sedation, we describe factors related to successful imaging as well as image outcomes in healthy control (HC) children and how these may be applied to children who sustain TBI.

Participants and Methods: Thirteen typically developing children or children with TBI (5 females, 8 males) aged 36 to 71 months underwent a behavioural MRI familiarization procedure using introductory materials and a play/mock session before attempting structural MRI. Anatomical image quality was quantitatively assessed using the cat12 toolbox running in SPM and Matlab. Likelihood of success was analyzed using technician and parent questionnaires that were completed before the child went into the scanner. Children chose a movie to watch during scanning.

Results: The overall MRI success rate was 75%. Among those who succeeded, three participants repeated sequences. Overall, image quality was very high with an average grade of A- following preprocessing (weighted average of n=9: 91.21%). Of those children who successfully completed the scan, predicted likelihood of success was high or very high prior to the scan (parent: 66.6%; MRI technician: 66.7%). In the unsuccessful group, predicted likelihood of success was lower (parent: 33% average; MRI technician: 33.3% no success).

Conclusions: Preliminary results of this pilot study indicate a success rate of 75% following a familiarization procedure which allows for the acquisition of high-quality MRI images in children under 6 years of age without sedation. Success rates may be predicted prior to scanning through interaction with the child and during familiarization. This procedure is currently being applied to the study of mild TBI in young children. Future analyses could include behavioural data in order for better success prediction models. Ultimately, the findings could improve longitudinal follow-up of healthy and brain injured children under 6 years.
Efficacy of a Couples Intervention to Promote Relationship Quality after Traumatic Brain Injury

Jennifer Marwitz¹, Jeffrey Kreutzer¹, Adam Sima¹, Kristin Graham¹, Nancy Hsu¹, Herman Lukow¹
¹Virginia Commonwealth University, Richmond, United States

Objective: Research suggests at least one of every three survivors is in a marital or coupled relationship at the time of injury. The literature examining postinjury marital breakdown has yielded widely varying results with estimates of breakdown rates ranging from 15-78%. Whereas early studies suggested a majority of marriages ended in divorce, more recent studies have indicated that marital breakdown rates for people with brain injury are substantially lower than the general population. At the same time, research has suggested that many people remain together even though the quality of the relationship is sorely diminished. The primary purpose of the present investigation was to evaluate the efficacy of a structured, curriculum-based intervention to promote marital quality following traumatic brain injury (TBI).

Methods: The Therapeutic Couples Intervention was designed to address post-TBI needs, concerns and challenges, emphasizing education, skill building, and psychological support. Seventy-five couples with mild to severe TBI were assigned to either a treatment or wait list control group. Delivered by doctoral-level psychologists and counselors, the manualized treatment focused on highly relevant topics (e.g., common injury effects, healthy communication, managing stress, setting achievable goals, effective problem solving, rebuilding intimacy, and effective parenting strategies). The intervention was delivered in five to six, two-hour sessions with outcome measurement pre- and post-treatment. The primary outcome measure was the Revised Dyadic Adjustment Scale (RDAS). The RDAS yields an overall score and allows for classification of relationships as distressed or non-distressed (scores < 48 are indicative of a distressed relationship).

Results: Treatment group participants showed a significant improvement in RDAS scores, whereas controls did not. For survivors in the treatment group, pre-treatment scores climbed from a mean of 44.0 (SD=11.3) to 48.1 (SD=8.5) following intervention. Their partners’ pre-treatment scores climbed from a mean of 44.9 (SD=9.7) to 49.4 (SD=9.1). RDAS scores remained unchanged after a 5-week waitlist timeframe for the survivors in the control group (Mean=45.9, SD=10.5 vs. Mean=45.3, SD=10.9) and their uninjured partners (Mean=42.6, SD=12.0 vs. Mean=42.3, SD=11.3). The percentage of treatment group participants describing their relationship as distressed declined post-treatment. For survivors, 53% characterized their relationship as distressed pre-treatment, whereas 38% described their relationship as distressed post-treatment. Similarly, 59% of uninjured partners characterized their relationship as distressed pre-treatment, whereas 38% characterized the relationship as distressed post-treatment.

Conclusions: Investigation provided evidence that a structured, curriculum-based education, skill-building, and support intervention for couples improve relationship quality for individuals with TBI and their partners. Additional research is needed to ascertain the longer-term benefits of intervention and the efficacy of alternative delivery methods (e.g., via telephone and the Internet).
Post-Exertion Cognitive Testing to Assess Persisting Deficits in Concussed Athletes

Veronik Sicard1, Gabriel Caron1, Dave Ellemberg1
1Université De Montréal, Montréal, Canada

Introduction: Following a sport-related concussion, most athletes are thought to be recovered within 2 weeks, having returned to baseline performance on commercial sport-concussion testing batteries (McCrory, Meeuwisse et al. 2017). However, some research indicates that higher-level executive functions could still be disrupted several months after injury (Ellemberg, Henry et al. 2009). Further, physical exertion can alter cognitive performance in recently concussed athletes who are otherwise symptom-free and who have normal results on cognitive tests performed after a period of physical rest (McGrath, Dinn et al. 2013). No study examined the effect of physical exercise on cognitive performance beyond the acute phase of injury.

Aim: This study determined if a physical exertion protocol could reveal persisting cognitive alterations in varsity athletes with a history of concussions (HOC; mean time since injury = 29.38 months; mean number of concussions = 1.85).

Methods: Sixty-eight athletes (34 with a HOC; 34 controls) participated in this study. Athletes with a history of concussion were matched with non-concussed athletes for age, sex, and sport. The research protocol consisted of a 20-min exertion protocol on stationary bike at 80% (80.98 ± 2.44%) of their theoretical maximal heart rate. Following physical exertion, participants performed a series of cognitive tasks: Switch task (assessing inhibition and flexibility); Cogstate test battery (assessing working memory with the 2-back task) (Sicard, 2017, 2018). One-way ANOVAs compared accuracy (Acc) and response time (RT) between HOC and control athletes on the Switch task and the 2-back task. Further, because the study population is assumed to be heterogeneous, we ran a chi-square test to determine if there was a group difference in the proportion of participants who underperformed by having a score that was at least 2SD higher (RT) or lower (Acc) than the mean.

Results: Whilst no significant group differences in performance were found for the Switch task and the 2-back task, the chi-square test revealed that significantly more HOC athletes (24%) underperformed relative to the controls (6%; Pearson $\chi^2 = 4.22, p = 0.04$) on the Switch task.

Conclusions: These results are in line with previous research indicating persistent alterations in a minority of athletes who sustained a concussion. They also highlight the importance of considering inter-individual differences in recovery trajectories with this type of heterogeneous population.
Are Visual Functions Diagnostic Signs of the Minimally Conscious State?
An Integrative Review

Berno Overbeek¹²³, Henk Eilander¹, Jan Lavrijsen¹, Raymond Koopmans¹
¹Radboudumc, Nijmegen, Netherlands, ²Azora, Terborg, The Netherlands, ³Kalorama, Beek, The Netherlands

Visual pursuit (VP) and visual fixation (VF) have been recognized as the first signs of emerging consciousness and therefore are considered indicative of the minimally conscious state (MCS). However, debate exists about their status as they are considered either conscious reactions or reflexes. The aim of this study is to review the evidence of the definition, operationalization and assessment of VP and VF in unconscious patients.

PubMed, EMBASE were searched for relevant papers between May 26, 1994 and October 1, 2016. Also, an internet search was done to identify other relevant papers, reports and manuals of assessment methods. Papers were included if the definition, operationalization or assessment method of VP and VF were discussed in patients with disorders of consciousness.

We identified 2364 articles, of which 38 were included. No uniform definitions of VP and VF were found. VP and VF were operationalized differently, depending on which scale was used. The Coma Recovery Scale-revised and the Sensory Tool to Assess Responsiveness were the only diagnostic scales found; the other scales were developed to monitor DOC patients. The use of a mirror was the most sensitive method for detecting VP and VF.

The literature about the importance VP and VF in relation to consciousness is controversial. This integrative review shows a lack of consensus regarding the definition, operationalization and assessment of VP and VF. International consensus development about the definition, operationalization and assessment of VP and VF is recommended.
Rates of Incident Traumatic Brain Injury in Marginally Housed Persons

Tiffany O’Connor1, William Panenka2, Emily Livingston1, Henri Lu1, Amiti Mehta1, Paige Lindahl1, Jacob Stubbs2, Donna Lang2, William Honer2, Allen Thornton1
1Simon Fraser University, Vancouver, Canada, 2University of British Columbia, Vancouver, Canada

Introduction: Marginally housed individuals experience high lifetime prevalence rates of traumatic brain injury (TBI). Although newer research has highlighted the vulnerability of this population to acquire incident TBI (incidence proportion of 17,100 per 100,000 population; Nikoo et al., 2017), reported rates are likely underestimations of the true rate due to limited and distal screening methodologies. The aim of this study was to improve the methodology of TBI screening through repeated and proximal assessments, in order to acquire a more accurate estimate of the rate of TBI in marginally housed persons.

Methods: Participants recruited from single-room occupancy hotels (N = 326) met monthly for TBI education and screening over a one participant-year period using the Ohio State University TBI Identification Method and an additional questionnaire. TBI was defined as a head injury from a known cause with associated loss of consciousness, post-traumatic amnesia, and/or daze and confusion. Interviews were performed by research assistants trained in the sequelae of traumatic brain injury and common issues in screening for TBI in this population.

Findings: Across 326 participants, 2520 screening assessments were completed (mean = 7.7 screens, median = 8, mode = 10, SD = 3.6). Across the possible 326 person-years, 185.6 person-years of data were present, with data found to be missing completely at random. Across all 326 people, 100 people acquired 175 TBI events. The incidence proportion (100 of 326 people) was 30.7 percent, or 30674.9 TBI per 100,000 population. The incidence attack rate (100 people over 185.6 person-years) was 0.538842 persons per year. The incidence event proportion (175 events out of 326 people) was 53.7 percent, or 53680.98 TBI per 100,000 population. The incidence event rate (175 events over 185.6 person-years) was 0.94292 injuries per year. Of the 100 people who acquired at least one TBI, 61 reported only one TBI, while 39 reported two or more TBI (range 0 to 6). Of 175 TBI events, severity classifications were 142 mild (81.1%), 32 moderate to severe (18.3%), and 1 unknown (0.6%). The most common mechanisms of injury were falls (45.1 %), assaults (25.1 %), and blunt force trauma on/by an object (18.9 %). Of these, 17 (9.7 %) occurred in the context of a drug overdose, and at least 48 (27.4%) were acquired when the participant was acutely intoxicated by drugs or alcohol.

Conclusions: Among marginally housed persons, rates of incident TBI are remarkably higher than previously reported. The incidence proportion and rate observed in this vulnerable sample were almost double those previously reported in marginally housed persons, and more than 50 times the pooled North American estimates (Nguyen et al., 2016). Prevention strategies targeted towards these individuals may decrease the burden of traumatic brain injury in this vulnerable population.
Smoking Cessation After Brain Injury: A Case Series Using Nicotine-Replacement and Behavioural Intervention for People Living with Neurocognitive Impairment

Carolyn Lemsky¹, Roby Miller¹, Tricia Dunbar¹, Amanda Muise

¹Community Head Injury Resource Services of Toronto, Toronto, Canada

Introduction: Brain injury in childhood has been shown to increase the risk of becoming a smoker (Ilie, et. al. 2015). In addition to the many health-related risks of smoking, tobacco use presents particular risks for ABI survivors. Tobacco use is understood to interact with many psychotropic medications, causing a need for increased doses, and therefore increased motor and cognitive side-effects. Unsafe smoking as well as cigarette-seeking behavior are common barriers to housing and care. We were unable to find any examples of smoking cessation programs designed for adults living with the lasting effects of brain injury. This pilot presents a novel approach to smoking cessation based upon an evidence-based, Ontario-wide program designed for the general population.

Method: The STOP program, designed by the Center for addictions and mental health includes 26 weeks free nicotine replacement therapy (NRT) offered at an escalating dose, determined by patient response, along with patient education. Key modifications for TBI included an increased frequency of counselling meetings, the addition of treatment completion incentives and the use of carbon monoxide breathalyzer monitoring. The approach included motivational interviewing and emphasized functional goal setting designed to support coping with cravings and activity to complete with smoking-related behaviours. The intervention was administered by an interdisciplinary team which included a case manager, neuropsychologist, and behaviour therapist, with consultation from a neuropsychiatrist. Participants were provided with the STOP intervention over a 10-month period.

Setting: Community-based brain injury support service (Community Head Injury Resource Services of Toronto).

Results: Participants were 9 adult survivors of severe brain injury, who smoked from 15 to 50 cigarettes per day, with an average of 22 years of smoking history. Most had experienced adverse health consequences as the result of smoking and/or had put their housing at risk as the result of dangerous use of cigarettes. At the time of this writing, all had substantially reduced their use of cigarettes and along with the associated harms of smoking. Five had achieved abstinence of at least 6 weeks within 8 weeks of starting NRT. Key findings are that a modified smoking cessation protocol is feasible and effective for individuals living with the impact of severe brain injury when implemented in a community-based setting. The authors will provide follow-up data for the 9 individuals included as a part of this pilot project, along with insights about service delivery including recommendations for programming and policy.
Persons diagnosed with disorders of consciousness (DOC) might suffer from motor disabilities, and thus assessing their spared cognitive abilities can be difficult. Recent research from several groups has shown that non-invasive brain-computer interface (BCI) technology can provide assessments of these patients' cognitive function that can supplement information provided through conventional behavioral assessment methods. In rare cases, BCIs may provide a binary communication mechanism.

Here, we present results from a vibrotactile BCI assessment aiming at detecting command-following and communication in 12 unresponsive wakefulness syndrome (UWS) patients. Two different paradigms were administered at least once for every patient: (i) VT2 with two vibro-tactile stimulators fixed on the patient’s left and right wrists and (ii) VT3 with three vibro-tactile stimulators fixed on both wrists and on the back. The patients were instructed to mentally count either the stimuli on the left or right wrist, which elicits a robust P300 for the target wrist only. The EEG data around each stimulus was extracted and subdivided into 8 averages. This data was classified with linear discriminant analysis and used to calibrate a brain-computer interface to test YES/NO communication abilities.

The grand average VT2 accuracy was 38.3 % and the VT3 accuracy 26.3 %. Two patients achieved a VT3 accuracy ≥80% and went through communication testing (one answered 4 out of 5 questions correctly in session 1, whereas the other could answer 6/10 and 7/10 questions correctly in sessions 2 and 4). In 6 other patients, the VT2 or VT3 accuracy was above the significance threshold of 23% for at least one run, while in 4 patients the accuracy was always below this threshold.

The study highlights the importance of repeating EEG assessments to increase the chance of detecting command-following in patients with severe brain injury. Furthermore, the study shows that BCI technology can be useful to test command following in chronic UWS patients and can allow patients to answer YES/NO questions. Beside UWS patients, the principle can be used in locked-in/completely locked in and minimal consciousness patients for assessment and communication.
Telephone Follow-Up: Supporting Community Transition Post Acquired Brain Injury Rehab

**Brianna Bourne**, Edith Ng, Judy Gargaro

Background: Implementation of telephone follow-up after discharge from inpatient rehabilitation was prioritized from the INESSS-ONF Clinical Practice Guideline. Telephone follow-up was first implemented in 2008 but by 2017, most clinicians in the Acquired Brain Injury (ABI) Inpatient Services had discontinued this practice with no replacement. A working group consisting of an interprofessional team from the ABI Inpatient Services as well as patient and caregiver partners was formed to improve the sustainability of this practice.

Purpose: To refine and implement a sustainable telephone follow-up process in the ABI Inpatient Services with objectives to:

- Support use of self-management approach in telephone follow-up.
- Foster sustainability through built-in processes and structure.
- Provide accessible resources for ongoing staff orientation and education.
- Ease transitions to home and independent community living.
- Support optimal rehab outcomes and allow for future program development and personal learning.
- Align with Best Practice Guidelines.

Methods: An Implementation Science framework was used. Staff surveys and 1:1 interviews were completed with both inpatient and outpatient ABI teams to understand current practices and identify facilitators and barriers to the completion and sustainability of telephone follow-up. Clinician feedback, best practice guidelines, and patient/caregiver partners’ inputs were used to refine the purpose, process, and tools. The revised process and tool were piloted and further refined. Education was provided regarding the new process. Outcomes were monitored and Plan-Do-Study-Act cycles continued to further refine the process and tool as needed.

Findings/Results: The revised telephone follow-up process and tool were found to be feasible to implement by staff (93% completion rate) and majority reported the added time to complete follow-up calls was manageable. New processes were embedded in current interprofessional rounds to enhance collaboration and accountability with the goal of fostering sustainability. Patient/caregiver survey outcomes were positive with all finding value in the phone calls. Patients/caregivers found the calls helped answer their questions and empowered them to better self-manage and utilize written resources they had received prior to discharge.

Conclusion: Feelings of being overwhelmed and anxious are common among patients with ABI and caregivers during discharge transitions. Speaking with familiar clinicians from their inpatient stay may provide comfort and reassurance, and an opportunity for them to ask/clarify questions or issues that may arise after discharge.

Key principles, learnings, and tools developed can be useful and generalizable to aid development and implementation of telephone follow-up in other services and organizations to enhance discharge transitions of patients with ABI. Better post-discharge management may also have a wider health system impact, such
as readmission rate. Sustainability of outcome will be re-measured in 6 months’ time (February 2019) to evaluate if telephone follow-up remains an active part of daily practice and to explore opportunities for further learning.
Traumatic Brain Injury from Intimate Partner Violence: Understanding the Foundations of a Health Inequity

Amanda St Ivany, Donna Schminkey

Dartmouth Hitchcock Medical Center, West Lebanon, United States, University of Virginia School of Nursing, Charlottesville, United States

True prevalence of traumatic brain injuries (TBI) in the context of intimate partner violence (IPV) remains unknown given the hesitancy of women in abusive relationships to disclose abuse and to seek medical treatment unless the abuse is severe. Research estimates that 75% of women with a history of IPV have sustained TBI from IPV with nearly 50% women reporting receiving multiple TBI. When women do seek treatment for TBI or IPV, they must choose between a women’s shelter where they will not receive medical treatment or a clinical setting where they may not feel safe from the abuser.

To understand the full nature and context of a woman receiving TBI during an episode of IPV it is integral to think through levels and across sectors, including personal and social risk factors for violence and abuse and missed opportunities to access resources. While health disparities like these are becoming more widely acknowledged, the siloing of TBI and violence research and policy has obscured the reality that TBI from IPV is better understood as a health equity issue: one in which the health disparities are largely avoidable.

Three concepts will be used to aid in describing TBI from IPV as a health inequity: intersectionality, syndemics, and structural violence. Intersectionality explains how the interactions between identities of race, class, ability, and gender affect individual experiences, opportunities, and social value. Structural violence is a phenomenon wherein a policy, structure, or institution prevents someone from accessing resources to meet their needs. Syndemics can be described as the ways in which two or more diseases interact in social conditions to create an excessive burden on health. These concepts are defined and explained as an equation to visualize how individual-level labels and characteristics (intersectionality) interact with sociocultural systems-level discrimination (structural violence) to lead to increased health risk and burden in communities (syndemics). Canadian First Nation and Inuit women will be used as case studies to demonstrate intersectionality of characteristics leading to increased risk for TBI from IPV in communities.

Violence and trauma prevention must be priorities at community and policy levels with approaches that are tailored to account for the fact that certain populations are at increased risk for multiple TBI. This theoretical reframing can lead to developing a more nuanced operationalization of structural violence and trauma-informed care with implications for research, practice, and policy for women living with TBIs from IPV.

Note: while this abstract can be presented on its own, it has been developed in collaboration with Lin Haag and Deanna Befus to facilitate its inclusion in a panel format with theirs.
Narrative Discourse of Older Adults with Traumatic Brain Injury

Lindsey Byom, Meredith Borton

University of North Carolina - Chapel Hill, Chapel Hill, United States

Objectives: Traumatic brain injury (TBI) is a risk factor for negative social outcomes across the lifespan. However, little is known about the social functioning of older adults with TBI. This gap is concerning because TBI incidence has risen among older adults, and this population is especially vulnerable to the negative effects of social isolation. The objective of this study was to examine one aspect of social functioning in older adults with TBI, narrative discourse. Younger adults with TBI have been characterized as less productive and efficient story tellers. Older age is also associated with declines in narrative efficiency. We therefore hypothesized that our sample of older adults with TBI would produce shorter stories characterized by more frequent repetitions and revisions than typically aging older adults.

Methods: Participants were 6 adults aged 55 years and older who had sustained a moderate-severe TBI and 6 comparison participants, matched to the TBI group for age and sex. Data were accessed from the TalkBank database. As part of the TalkBank protocol, participants completed a story retell task in which they reviewed a Cinderella picture book and then retold the story. These narratives were transcribed, and each transcript was analyzed for language production (total utterances, total words), lexical diversity (Moving Average Type-Token Ratio), syntactic complexity (Mean Length of Utterance words, verbs per utterance), and fluency (restarts, repetitions). All participants gave written informed consent to have their language samples contributed to the TalkBank database and this study was approved by the University of North Carolina – Chapel Hill Institutional Review Board.

Results: Results indicated that on average the group of older adults with TBI produced significantly shorter stories than the comparison group, however this difference was statistically significant only when measured by total words produced (U = 5.00, p = .40), and not total utterances (U = 9.00, p = .18). Lexical diversity was similar between the groups (U = 13.00, p = .49) and while the TBI group’s stories were less syntactically complex on average, these differences were not significant (MLU: U = 11.00, p = .31; Verbs/Utterance: U = 10.00, p = .24). The groups were also similar in the number of restarts (U = 14.00, p = .59) and repetitions (U = 13.50, p = .49), though on average the TBI group had fewer restarts and repetitions.

Conclusions: Results of this preliminary study suggest that like younger individuals, older adults might be at risk for narrative discourse impairments, particularly in language production. This preliminary data must be interpreted with caution given the small sample size, but if replicated in larger studies, could provide a critical description of the narrative discourse of older adults with TBI.
Examining the Mediating Effect of Cognition on the Relationship Between Epilepsy and Child's Behavioral Problems Using a Multiple-Informant Approach

Ayelet Bord¹,², Orly Polak¹,², Bruria Ben-Zeev³, Miriam Levav³, Ronny Geva¹, Tamar Silberg¹,²
¹Department of Psychology, Bar-Ilan University, Israel, ²Edmond and Lily Children’s Hospital, Tel-Hashomer, Israel, ³Leumit Health Services, Israel

Background: Epilepsy, a condition characterized by abnormal excessive synchronous neuronal activity in the brain, is often related to relatively high rates of psychological problems. Many factors have been associated with these undesirable psychological outcomes, among them the type of epilepsy, number of antiepileptic drugs (AEDs), age at onset and time elapsed since diagnosis. As a ‘network disorder,’ epilepsy is also often related to multiple cognitive and behavioral impairments throughout child’s development. Differences between the home and the school environments have also been associated with the psychological adaptation of children with epilepsy.

In the current study we sought to examine if emotional and behavioral symptoms are associated with, or perhaps mediated by cognitive functioning in children with a history of epilepsy. We also aimed at examining level of agreement between parents and teachers' reports on child's psychological state. Specifically, we hypothesized that epilepsy severity would be associated with higher rates of emotional and behavioral problems, and that cognitive problems would predict more severe ratings of symptoms among both parents and teachers.

Methods: The sample comprised 155 children (50% girls) diagnosed with epilepsy from the Pediatric Neurology Department, the Sheba Medical Center, Israel. Child’s mean age at the time of evaluation was 9.3 years (SD = 3.1). All children completed a brief neuropsychological evaluation, assessing four cognitive domains including visuomotor, verbal, memory, and attention. Parents completed the Child Behavior Checklist (CBCL) and teachers completed the corresponding Teacher's Rating Form (TRF), to assess the child’s emotional and behavior problems during the past six months.

Results: All cognitive scales were negatively associated with number of AEDs. Level of agreement between parents and teachers ranged between poor on the internalizing problems scale and poor/moderate on the externalizing and total-problems summary scales. Path analysis was used to examine the mediating role of cognition on the association between epilepsy severity and child's outcome. No significant direct associations were found between epilepsy related factors and child's emotional and behavioral problems, according to both parents and teachers. Yet, a significant mediation effect was found for cognitive functions on the association between epilepsy and teachers' reports on child's emotional and behavioral problems.

Conclusions: Given that there is no biological marker for the presence of an emotional or a behavioral problem due to epilepsy, collecting data from multiple sources should be considered as 'best practice' in assessing child’s psychological state. Furthermore, the role that cognitive functions play in mediating the association between epilepsy severity and child's emotional and behavioral problems is also related to the informant's perspective. Therefore, it is crucial for clinicians to attend the behavioral as well as the cognitive aspects of the child’s functioning from an ecological perspective when diagnosing and treating epileptic disorders.
A Biopsychosocial Model for Predicting Attention Problems in Children After Traumatic Brain Injury: A Systematic Review

Priya Bolikal1,3, Megan Narad1, Stacey Raj2, Megan Kennelly3, Brad Kurowski1,3

1Cincinnati Children's Hospital, Cincinnati, United States, 2Xavier University, Cincinnati, United States, 3University of Cincinnati, Cincinnati, United States

Background: Traumatic brain injury (TBI) is a global problem. After TBI, children are at increased risk of developing secondary attention problems compared with the general population. Several studies have examined individual risk factors for development of secondary attention problems after TBI; however, to our knowledge, no comprehensive review examining the existing literature exists. The goal of this study was to determine factors associated with an increased risk of secondary attention problems after pediatric TBI and to develop a comprehensive model that incorporates biological, psychological, and social factors associated with the development of attention problems after pediatric TBI.

Method: Online searches of MEDLINE, PsycINFO, and Cinahl database were conducted on April 21, 2017 and April 30, 2018. Studies included utilized pediatric TBI populations and evaluated the association of any risk factors with development of attention problems after TBI. Attention problems were defined as clinical symptoms measured by a symptom rating scale or clinical interview. Studies were excluded if the cohort was primarily adults (> 18 years old) or exclusively non-TBI participants (e.g., stroke, tumor). Additionally, articles that used task-oriented attention measures in the absence of clinical symptoms of attention problems, review articles, editorials, books, and unpublished dissertations were excluded. Bias was assessed using the Modified Downs and Black Checklist.

Results: A total of 2846 articles were obtained using our search criteria. After application of inclusion and exclusion criteria, a total of forty-one articles were included. All risk factors discussed in the included studies were grouped into the broad categories of biological factors, social factors, and psychological factors. Biological factors included age at injury, time since injury, injury severity, sex, lesion location, diffusor tensor imaging findings, and serum biomarkers. Social factors included socioeconomic status (SES), family functioning, family psychiatric history, and parenting behaviors. Psychological factors included pre-injury attention deficit hyperactivity disorder (ADHD), pre-injury behavior problems, and pre-injury adaptive functioning. Overall findings were mixed but with trends suggesting that younger age at injury, presence of pre-injury ADHD, poorer pre-injury adaptive functioning, lower SES, and poorer family functioning were associated with increased risk of developing attention problems post-TBI.

Conclusions: The development of attention problems after pediatric TBI is complex. Of the existing literature, there is significant heterogeneity in the populations studied as well as the symptom rating scales and questionnaires used to determine the presence of attention problems, making it difficult to draw broad conclusions from the existing literature. Further research is necessary to characterize a biopsychosocial model for the development of attention problems after pediatric TBI.
Patients with Severe DOCs – Do They Sleep at Night or During the Day?

Friedemann Müller1, Isabella Nopper1,2, Yuri Pavlov2, Susanne Diekelmann2, Christine Barner2, Boris Kotchoubey2

1 Schön Klinik Bad Aibling SE&COKG, Bad Aibling, Germany, 2 Universität Tübingen, Tübingen, Germany

Patients with severe brain damage due to hypoxia or traumatic brain injury usually suffer from severe disorders of consciousness (DOC). The diagnostic criterion for differentiation from coma depends on eye opening and signs of day/night cycle. The group of patients in the Unresponsive Wakefulness Syndrome (UWS, formerly called VS) does not show voluntary behavior, while patients in Minimally Consciousness State (MCS) show inconsistent, but reproducible indications of awareness and voluntary behavior. The diagnostic procedures to differentiate these two states are still to be improved, as the rate of wrong categorization has been estimated to be as high as 40%. Our study addresses the sleeping behavior of both groups as this is a relevant diagnostic characteristic. In addition, we try to find out what could be appropriate time windows for better diagnostic decisions and whether sleep can be used as an independent marker to differentiate.

Methods: We used 24 hours continuous polysomnographic recordings (PSG) in the familiar environment of the patient, i.e. in the regular hospital room. In addition, behavioral sleep was analyzed by videotaping eyes open and eyes closed periods in intervals of 30 seconds. Our study included 32 patients with DOC (16 UWS, 16MCS) und 10 paralyzed and bed-bound patients without impairment of consciousness as a control group. Stages of sleep were rated by three blinded but experienced raters. For analysis the definitions by Rechtschaffen & Kales (1968) were adjusted to the patient group. For group analysis we compared differences of total amount of sleep and the respective sleep stages separately for periods of day (08.00-20.00), night (20.00-08.00) and during the total recording duration.

Results: The total amount of sleep did not differentiate between groups. The overall frequency distribution of eyes-closed and eyes-opened epochs was close to 50/50% and was not significantly different between groups. Significant differences were found for the proportion of being awake during the night between UWS patients and controls (F (2,39) =6.50, p=.004), and an increased proportion of being awake (in minutes) of UWS patients (M=538.85, SD=162.89), compared to controls (M=346.70, SD=92.50). Amount of sleep stage S1 differed between patient groups (F (2,39) =3.36, p=.045) as well as the amount of REM sleep (F (2,39) =7.41, p=.002).

Conclusions: The behavioural sleep data highlight the differences between patients with severe disorders of consciousness and bed-ridden conscious patients concerning sleep-wake cycle. UWS patients show a considerably altered pattern and to a higher degree than MCS patients. It has to be concluded that DOC patients do not primarily sleep only during the night and that circadian rhythm is considerably disturbed. We conclude, that sleep recordings in DOC patients should focus on recordings over 24 h.

Disclosures: This research was supported by the Deutsche Forschungsgemeinschaft (DFG; KO-1735-1).
From Service to Success

William Robbins, Megan Vaughan

Veterans Affairs, Richmond, United States

Background: Traumatic brain injury (TBI) is common among US service members and Veterans and a signature injury in the post 9/11 Middle Eastern War theater. In the US, TBI typically occurs between the ages of 15 to 24 years, when risk-taking behaviors are more common. To address this need there are currently five Polytrauma Veterans Affairs programs in the United States and one Service Member Transitional Advanced Rehabilitation (STAR) program, an interdisciplinary transitional treatment paradigm piloted in 2012 in Richmond Virginia, designed specifically for successful return to work and academics.

Clinical Program Overview: STAR provides graduated therapeutic physical, cognitive, psychological and vocational therapies focused on vocational rehabilitation including skills assessment, work/ academic readiness, hardening, re-entry, and supports to reintegrate the individual into an appropriate occupational role or college/education program. The average age of the total STAR population served is 29 years of age with a current population average of Active-Duty 79% and 21% Veterans. Current average etiologies of TBI served are 14% blast injury without fragments, 32% vehicular, 18% fall, 11% GSW and 18% other, with an increase noted in stateside (71%) injuries.

Teaching Points: This presentation will give an overview of the STAR program and its application to other clinical programs. Overview of the interdisciplinary therapies will be given as well as an overview of the graduated re-entry program conducted by vocational therapists in tandem with speech, social work, occupational, physical, recreational and neuropsychological therapies. Statistical effectiveness of the program and various outcome measures will also be discussed, such as the Vocational Preparation Effectiveness Tool, created and normed by the STAR program, as current outcome effectiveness measures STAR has shown over 90% effectiveness rating of understanding potential work stressors and effective coping strategies.
Using Concussion Symptoms as a Proxy for Mental Health: Baseline Concussion Symptoms May Be Predictive of Depressive Symptoms

Christopher Riegner¹², Eric Hall¹², Kirtida Patel¹², Ethan Williams¹², Katherine Arbogast¹², Robert Conder³, Caroline Ketcham¹²

¹ Elon University, Elon, United States, ² Elon BrainCARE Research Institute, Elon, United States, ³ Carolina Neuropsychological Service, Raleigh, United States

Depression is highly prevalent in college students and mental health is an overall concern. Student-athletes have shown slightly lower rates of depression but do report higher depressive symptoms following an injury (i.e. concussion). As part of this increased concern, NCAA has recommended that schools include mental health screening as part of their preparticipation examinations. Current concussion management protocols call for thorough baseline neurocognitive assessments of student-athletes, but not for psychological screening. This study aims to determine whether a commonly used baseline neurocognitive assessment can be predictive of depressive symptoms in student-athletes. 516 collegiate student-athletes completed both the Immediate Postconcussion Assessment and Cognitive Test (ImPACT; ImPACT Applications, Inc., Pittsburgh, PA) and the Beck Depression Inventory-II (BDI-II; Beck, 1996) as part of the university’s baseline concussion management protocol. ImPACT is a computerized neurocognitive assessment which includes demographic information and a 22-item symptom survey. Each participant also completed the BDI-II, a 21-item commonly used depression diagnostic assessment. Three models were tested to determine whether concussion symptoms could predict depressive symptoms. For Model 1, a linear regression was done between total concussion symptom score and total BDI-II score. In the first step (step 1), gender, treatment for psychiatric condition and migraines, as well as ADHD diagnosis were entered and significantly accounted for 13.1% of the variance. In step 2, total symptom score was entered and accounted for an additional 18.9% of the variance with the whole model accounting for 32.0% of the variance. For model 2, a stepwise linear regression was run between all concussion symptoms and total BDI-II score after inclusion of step 1. Six concussion symptoms were included: nervousness (R²change = 0.175), sadness (R²change = 0.035), trouble falling asleep (R²change = 0.022), vomiting (R²change = 0.013), fatigue (R²change = 0.010), and visual problems (R²change = 0.007). Total R² of this model was 0.393. For Model 3, another stepwise linear regression was then done according to a selection of concussion symptoms shown to have a correlation of 0.3 or higher with total BDI-II score after inclusion of step 1. Five concussion symptoms were included: nervousness (R²change = 0.175), sadness (R²change = 0.035), trouble falling asleep (R²change = 0.022), difficulty concentrating (R²change = 0.010), and fatigue (R²change = 0.007). Total R² for this model was 0.380. These models suggest that a subset of concussion symptoms from baseline testing can serve as a screening tool for student-athletes; particularly those at risk for depressive symptoms. Assessments of concussion symptoms are often part of preparticipation examinations and could help sports medicine staff identify student-athletes who might need additional targeted mental health screening and or support.
Evaluating a Post-Concussion Return to School Group Program for Secondary and Post-Secondary Students in Southwestern Ontario, Canada

**Penny Welch-West**1, Shannon Janzen2, Swati Mehta2, Mitchell Longval2, Robert Teasell1,2,3

1St. Joseph's Health Care, Parkwood Institute, London, Canada, 2Parkwood Institute Research, Lawson Health Research Institute, London, Canada, 3Schulich School of Medicine and Dentistry, Western University, London, Canada

**Background:** Mild traumatic brain injury (mTBI) is a steadily growing public health concern. Young adults with mTBI find themselves having to navigate not only the physical, cognitive, and somatic aspects of their recovery, but also self-advocate for accommodations and services when they return to school. The skills required to be an effective student upon returning post-injury are paramount to continued success in returning to life. However, there is a gap in the literature in terms of evidence-based return to school (RTS) programs for those with mTBI.

**Objective:** The aim of the current study is to examine effectiveness of an outpatient RTS intervention on students’ executive function and post-concussive symptoms.

**Methods:** In this pre-post-trial, an RTS program was delivered to students attending post-secondary institutions with a diagnosis of a concussion. The group based RTS program consisted of 2-hour sessions delivered over 7 weeks. The program included sessions consistent with the Practice Standard Guidelines for Cognitive-Communication put forward by the College of Audiologists and Speech-Language Pathologists of Ontario. Participants were asked to complete questionnaires related to demographic factors and a formal battery of cognitive-communication assessments. Participants who completed the RTS Program were also sent a survey link, with questions about their injury and school status. Primary outcome measures included: Attention Processing Training (APT), Woodcock-Johnson III Test of Cognitive Abilities (WJ-III), and Rivermead Post-Concussion Symptoms Questionnaire (RPQ) at baseline and post-treatment. Pre and post assessment scores were compared using paired samples t-tests.

**Results:** 38 students participated in the study. According to survey results, the number of students who continued/enrolled in academic studies increased from 24 to 33 after attending the RTS program. Additionally, the number of students using learning supports increased from 17 (post injury-pre RTS program) to 29 (post RTS program). Overall satisfaction with the RTS program was high with 37 out of 38 participants stating they would recommend it to others looking to return to learning. Significant improvements were seen in attention including complex sustained attention (p<.001), selective attention (p<.001) and alternating attention (p=.004) on the APT. Significant improvements were also found on decision speed (p<.001), pair cancellation (p=.027), rapid picture naming (p<.001), and reading fluency (p=.029) from the WJ-III. No significant improvement in the RPQ was reported.

**Conclusions:** Results from the study suggest improvement in the management of skills beyond simply academic performance and into improved cognitive symptoms in general. Future research should examine if improvements in cognitive-communication symptoms result in significant change in learning strategies, information uptake, and academic achievement. Studies incorporating multidisciplinary management for learners including rehabilitation professionals and academic centers are warranted.

**Keywords:** concussion, return to school, Speech-Language Pathologists
Effect of Transauricular Vagus Nerve Stimulation on Disorders of Consciousness: A Feasibility Study

Enrique Noé, Lucía Torres, Marta Server, María Navarro, Myrtha O'Valle, Ana Villalba, José Olaya, Carmen García, Alejandro Galvao, Joan Ferri, Roberto Llorens

1 NeuroRHB - Servicio de Neurorrehabilitación de Hospitales Vithas, Valencia, Spain, 2 Neurorehabilitation and Brain Research Group, Universitat Politècnica de València, Valencia, Spain

Introduction: Patients in vegetative state/unresponsive wakefulness syndrome (VS/UWS) or minimally conscious state (MCS) share a common neuropathological substrate that includes neocortical and thalamic neuronal death, dysfunction, or disconnection. Connectivity up-regulation involving cortico-cortical and cortico-subcortical networks has been proposed to explain positive behavioral responses. Vagus nerve stimulation has been reported to modulate cortical excitability through enhancing neuronal thalamic activity. Two recent case studies including invasive and non-invasive vagus nerve stimulation after severe traumatic brain injury have shown promising results at increasing the level of consciousness. The objective of this study was to determine the effectiveness of non-invasive transauricular vagus nerve stimulation (taVNS) in a sample of individuals in VS/UWS or MCS after a cerebrovascular or traumatic incident.

Methods: Eleven subjects (n=6 female), aged 41±18 years, either in VS/UWS (n=4) or MCS (n=7) for more than 6 months after a traumatic (n=6) or non-traumatic (n=5) brain injury participated in the study. Experimental intervention consisted of 40 30-minute sessions, administered twice a day, with a minimum resting period of 5 hours between sessions. The Parasymp (Parasym Ltd., London, UK) was used to administer the stimulation (Sinusoidal waveform; Pulse rate=20Hz, Pulse width=200μs, I=20mA). Participants were assessed by a blind experienced therapist with the Coma Recovery Scale-Revised (CRS-R) one month before the intervention, before the intervention (baseline), after 1, 2, 3, and 4 weeks after the beginning of the intervention, and one month after the intervention. During all the study, participants received multisensory stimulation that did not include other brain or nerve stimulation.

Results: Although clinical diagnosis (VS/UWS or MCS) remained unchanged during the study, a significant increase in the total CRS-R score was detected from baseline to 1-month follow-up (paired t test, 9.4±2.7 vs 10.2±3.3, p=0.04). None of the individuals in VS/UWS showed any change. In contrast, five of the seven individuals in MCS showed an improvement during the study (range: 1 to 3 points) (chi-square=5.2, p=0.02). Improvements in the CRS-R were detected during the last week of the intervention in only one responder, and at 1-month follow-up in all other cases, and were evidenced in only one subscale of the CRS-R in all responders (three individuals in the motor subscale and another in the visual subscale) but in one case, who showed improvements in motor, visual and verbal subscales. All patients finished the study with no noticeable side-effects.

Conclusions: taVNS could be a safe and promising tool to improve recovery in severely brain injured patients. A delayed effect, primarily on motor responses, was the main positive response detected in our study. As in other non-invasive stimulation techniques, the efficacy of taVNS seemed to rely on partial preservation of cortico-thalamic-cortical connections.
Systems Thinking Tools for Identification, Assessment, Intervention, and Evaluation of Traumatic Brain Injury (TBI) from Intimate Partner Violence (IPV): Canadian Indigenous Women as a Paradigmatic Case

Deanna Befus¹, Halina (Lin) Haag², Amanda St Ivany³

¹Western University, London, Canada, ²Wilfrid Laurier University, Waterloo, Canada, ³Dartmouth-Hitchcock Health Care System, Lebanon, United States

The Centers for Disease Control and Prevention estimate that 38 million women (1:4) in the United States have experienced IPV. Between 60-92% receive associated facial or head injuries. By even the most conservative estimates, the number of women receiving TBI from IPV is greater than the number of women with breast cancer. In spite of high prevalence and strong evidence of physical, cognitive, behavioral, and psychological impacts across role domains, TBI from IPV remains under-acknowledged and understudied, resulting in knowledge and service gaps that put millions of women’s lives at risk. Populations occupying marginalized social locations bear disproportionate burden in incidence, severity, and negative outcomes of TBI from IPV.

In Canada, Indigenous women recipients of TBI from IPV face numerous multi-level barriers to recovery, including being part of a socially, economically, and historically marginalized population and occupying the intersection of two disciplines with—thus far—minimal overlap (TBI and violence work). They are at higher risk for TBI from IPV and have access to fewer supports across levels: culture of shame and stigma around TBI and IPV; lack of accessible healthcare and shelter resources; language barriers, and; a history of colonialism and exploitation by medical, legal, and governmental structures often resulting in current experiences of judgment, paternalism, and retraumatization when engaging with systems ostensibly designed to help them.

TBI from IPV in the Indigenous context is an example of a “wicked problem”: one that involves multiple, interacting human and non-human agents evolving over time in constantly changing contexts and often in non-linear, complex patterns. Systems thinking is a broad term associated with theories, methods, and tools that have been developed and deployed in diverse disciplines to address wicked problems. Systems thinking entails investigating interrelationships, behaviors, and outcomes of complex systems at high and granular levels. In this way, these paradigms allow us to connect individual outcomes to broader structures, institutions, and sociocultural dynamics.

Addressing the dynamic, interacting complexities of TBI from IPV at personal, community, and institutional levels requires approaches of commensurate complexity, engaging the wicked problem on multiple levels and across sectors. Systems thinking approaches offer innovative, effective tools and models for better understanding the complexities of TBI from IPV and helping professionals locate their opportunities and responsibilities, regardless of their level or role. Examples of systems thinking approaches will be discussed across points of engagement—policymaking, research, health systems, community organizations, individual and family contexts—with concrete methods and tools such as systems dynamics and agent-based modeling, causal loop diagramming, group model building, and process mapping.
Long-Term Employment Outcomes for Individuals Following Moderate to Severe Traumatic Brain Injury: A Systematic Review and Meta-Analysis

Mirinda Gormley¹, Monika Devanaboyina¹, Juan Lu¹

¹Virginia Commonwealth University, Richmond, United States

Background: Returning to employment following traumatic brain injury (TBI) is critical for a survivor’s social, financial and psychological well-being, as employment status is positively associated with quality of life and social integration. Yet many TBI survivors experience cognitive and psychological sequelae that may significantly hinder their work performance or prevent them from returning to work altogether. Current literature regarding long-term employment outcomes following TBI are inconsistent due to the heterogeneity of study population and varying outcome measures and length of follow-up periods. Although individuals with moderate-to-severe TBI are more likely to experience post-injury employment difficulties, there are no systematic reviews on employment outcomes for this population. The objectives of this study are to systematically synthesize literature on the evidence of employment outcomes following moderate-to-severe TBI and best inform effective employment intervention and support programs.

Methods: The study searched databases PubMed, PsychINFO, and CINAHL, using the prompt: (“Traumatic Brain Injury” OR “Moderate to Severe Traumatic Brain Injury”) AND (“Employment” OR “Return to Work”) OR (“Traumatic Brain Injury” AND “Long-Term Outcome”). Studies were eligible if the objective was to investigate employment outcomes following TBI; outcome was measured ≥ 1-year; participants were diagnosed with moderate-to-severe TBI and 15 years or older; and sample size was ≥ 60. Information on study characteristics and employment outcomes were extracted using a standardized form created by the authors. The prevalence of post-injury employment and return to pre-injury level of work at various follow-up periods were summarized through meta-analysis; other employment outcomes were reported descriptively.

Results: A total of 38 studies were included in this review. The employment outcome most often reported was post-injury employment prevalence (n=35), followed by job stability (n=6), and return to pre-injury level of work (n=4). Of all, 12 (26.0%) studies provided employment outcomes at 1 year, 17 (44.7%) up to five years, and 9 (23.7%) beyond 5 years post-injury. Of 35 studies that reported post-injury employment prevalence, the overall pooled estimate was 42.2% (95% CI=34.8-47.9%; I²=4.1%); whereas of four studies reported return-to-work prevalence, the overall pooled estimate was 33.0% (95% CI=15.1-50.8%; I²=0%). Moreover, the prevalence appeared to increase over time, from 34.9% (95% CI=23.9-46.0%; I²=0%) at 1-year to 42.1% (95% CI=37.4-46.6%; I²=26.6%) up to 5-years and 49.9% (95% CI=44.7-55.1%; I²=0%) beyond 5-years.

Conclusion: Although post-injury employment is often reported, additional quantitative and qualitative outcomes should be measured to provide a more comprehensive vocational outlook for survivors of moderate-to-severe TBI. The findings from this review highlight the need for appropriate resource allocation and comprehensive intervention programs, not only to assist this population to return to employment but also to maintain job stability for those returning to work. Future researchers are recommended to standardize employment outcome measures to enable better comparison of outcomes across studies.
The Family as a Resource for Improved Patient and Family Functioning After Traumatic Brain Injury – Preliminary Description of Baseline Functioning in a Study Population

Mari Rasmussen1,2, Nada Andelic1,2, Tonje Haug Nordenmark1, Juan Carlos Arango-Lasprilla3,4, Helene Søberg1,5

1Department of Physical Medicine and Rehabilitation, Oslo University Hospital, Oslo, Norway, 2Faculty of Medicine, Institute of Health and Society, Research Centre for Habilitation and Rehabilitation Models & Services (CHARM), University of Oslo, Oslo, Norway, 3BioCruces Health Research Institute, Cruces University Hospital, Barakaldo, Spain, 4IKERBASQUE. Basque Foundation for Science, Bilbao, Spain, 5Faculty of Health Sciences, Department of Physiotherapy, Oslo Metropolitan University, Oslo, Norway

Objectives: Sustaining a traumatic brain injury (TBI) has impact on the family as a whole. The objective of this study was to assess functioning at baseline for patients with TBI and their family members participating in an ongoing randomized controlled trial (RCT) (ClinicalTrials.gov NCT03000400). The RCT is testing the effectiveness of a family centered intervention, the TBI Family Intervention (Stevens et al. 2016), in improving HRQL, mental health, and reducing the caregiver burden. The RCT has two arms comparing the family intervention consisting of eight weekly sessions with treatment as usual for the patients.

Methods: Patients between 16-65 years admitted to Oslo University Hospital with TBI of all severities were included 6 to 18 months post injury. The patients nominated family members between 18-65 years for participation. Information about socio-demographics and injury severity variables was recorded and will be reported. The primary outcome measures were the SF-36 Mental Component Summary (MCS) for all participants, and caregiver burden assessed by the Caregiver Burden Scale. Secondary outcome measures included Quality of Life after Brain Injury (QOLIBRI) total score, and Family communication and Family satisfaction assessed by the Family Adaptability and Cohesion Evaluation Scale (FACES IV). Additional measures were Patient Health Questionnaire-9 (PHQ-9) and Generalized Anxiety Disorder-7 (GAD-7). All participants completed the baseline assessment after randomization, and we present preliminary results from the descriptive analysis.

Results: Baseline assessment was obtained from 75 participants, including 37 persons with mild to severe TBI mean age 48.9 (SD 11.4) years, 48.6 % women, and 38 family members mean age 42.4 (SD 11.6) years, 56.4 % women. Mental health on the MCS was 44.4 (SD 10.1) representing clinically significant lower mental health as compared to the population norm, Caregiver burden on CBS was 2.0 (SD 0.5) indicating a moderate burden. The mean scores on PHQ-9 and GAD-7 were 8.4 (SD 5.4) 5.1 (SD 4.4) respectively indicating a mild depression and anxiety. The patients score on the QOLIBRI was 52.4 (SD 9.5) indicating substantially reduced HRQL, Family communication on Faces IV was 41.0 (SD 9.1) indicating good communication, Family satisfaction was 38.4 (SD 6.9) indicating moderate satisfaction. The patients had significantly lower scores than the family members on MCS, PHQ-9, GAD-7 (p-values <0.01), but not for Family communication and Family satisfaction. Updated results will be presented at the conference, as the inclusion in the RCT is still ongoing.

Conclusion: The preliminary baseline assessment demonstrates that consequences of TBI and caregiver burden should be recognized and treated with targeted intervention in order to improve family functioning and maintain quality of life of patients and their family members.
The Role of Decompressive Craniectomy in Traumatic Brain Injury

Petr Waldauf¹, Pavel Haninec¹, Frantisek Vyhnanek³, Andrej Callo¹, David Girsa², Libor Mencl¹

¹Department of Neurosurgery, 3rd Faculty of Medicine, Charles University, Hospital Kralovske Vinohrady, Prague, Czech Republic, ²Department of Radiology, 3rd Faculty of Medicine, Charles University, Hospital Kralovske Vinohrady, Prague, Czech Republic, ³Department of Surgery, 3rd Faculty of Medicine, Charles University, Hospital Kralovske Vinohrady, Prague, Czech Republic

Traumatic brain injury (TBI) remains a leading cause of mortality and disability worldwide. The annual incidence is estimated at 260 per 100,000 in Europe, with a fatality rate between 0.9 and 7.6%. Surgical interventions are a key component of severe TBI management. The use of decompressive craniectomy remains a controversial topic in management of traumatic brain injury and is regarded as the last tier in the management of raised intracranial pressure. Clear benefits have been demonstrated in terms of ICP reduction and improvements in brain tissue oxygenation, cerebral perfusion. However, the improvement in terms of patient outcome were less apparent and led to the launch of two large randomized trials recently. Reduction in mortality achieved by surgical intervention in these trials, was due to an almost direct increase in the number of survivors with severe disability or in a vegetative state. This study retrospectively analyzed patients who underwent unilateral decompressive craniectomy from 2012 to 2018 for traumatic intracranial hypertension or acute subdural hematoma. A total of 180 patients (138 males and 42 females) were included in this study. The median age of the cohort was 56 years (range 18–79 years). 152 patients underwent DC due to acute subdural hematoma and 28 patients suffered from traumatic intracranial hypertension. Glasgow Outcome Scale was used to assess functional outcomes of all patient enrolled in this study. Factors associated with poor outcome were identified and analyzed based on preoperative clinical status and CT findings. The decision to perform decompressive craniectomy is challenging and the question remains as to whether there is a subset of patients who can profit from surgical decompression.
Trends in Recovery Modifiers Among Children and Youth with Persistent Symptoms following Concussion

Jacqueline Ogilvie1,2,3, Janice Gray1, Sara Somers1, Mary-Ellen Kendall1
1Thames Valley Children's Centre/PABICOP, London, Canada, 2Children's Hospital, London Health Sciences Centre, London, Canada, 3Western University, London, Canada

Current understanding regarding the typical recovery course of concussion indicates that 70% (Zemek, RL, et al 2016) of youth recover within four weeks. In an attempt to further understand what factors may be contributing to persistent symptoms in the remaining 30%, we examined multiple pre-existing factors hypothesized to impact recovery in children and youth in a large clinical sample of clients referred to an outpatient paediatric brain injury program.

The Paediatric Acquired Brain Injury Community Outreach Program (PABICOP) implements a multidisciplinary approach to support the physical, educational and psychosocial needs of the child and family. With increased awareness of the complexity of concussion management, particularly in adolescents with persistent symptoms, PABICOP has tracked referral trends over the past six years. PABICOP is a sub-acute, needs based program, and patients with persistent symptoms following concussion are inherently over represented in this population.

Method: A six-year retrospective chart review (2012-2018) was conducted to explore the trends in concussion referrals, in particular, the prevalence of multiple recovery modifiers. Recovery modifiers were based on a literature review of factors associated with slower recovery following concussion [Lumba-Brown, A., Yeates, K.O., et al 2018] including gender, pre-existing mental health, family stress, anxiety, learning and developmental issues, ADHD, LD and migraines/headaches. Data was extracted from patient files. In this Program, an extensive client assessment/history is documented for all youth with persistent symptoms.

Results: Of a total of 875 referrals for acquired brain injury, 82% were concussion (55% females versus 45% male). 67% of concussion referrals were identified as having persistent symptoms (lasting longer than 4 weeks and causing functional impairment). Of those with persistent symptoms 69% were identified as having at least one recovery modifier present. Prevalence of these recovery modifiers were more frequent in females than males.

Among females with pre-existing factors, half identified symptoms of anxiety. 52% of males versus 18% of females were identified as having pre-existing learning issues including ADHD and LD diagnoses. Prevalence of family stress was 30% among females and males.

Discussion: Female gender and anxiety has been increasingly recognized as a factor in the recovery trajectory of children and youth following concussion (Ewing-Cobbs, L., et al, 2018). Our clinical experience mirrors this. As the main referral site for children and youth in our region with persistent symptoms and functional impairment this sample reflects this specific population. Clinical experience with this complex, resource intensive population in a multi-disciplinary community outreach program will be further explored. Children and youth with persistent symptoms following concussion have high medical and psychosocial complexity; increasing recognition of these factors will improve clinic service models in the future.
Creative Convergent and Divergent Thinking Abilities Following Traumatic Brain Injury

Nirav Patel1, Arianna Rigon1, Justin Reber2, Melissa Duff1

1Vanderbilt University Medical Center, Nashville, United States, 2University of Iowa, Iowa City, United States

Creative problem-solving involves the generation and application of novel approaches to complex problems. The cognitive process of thinking creatively can be divided into divergent and convergent thinking abilities. Convergent thinking is focused on narrowing possibilities to a workable solution. On the other hand, divergent thinking assesses the ability to generate multiple ideas or solutions to a problem. While deficits in traditional neuropsychological domains (memory, attention, language) have been well-documented, little is known about the consequences of traumatic brain injury (TBI) on these creative problem-solving abilities.

The aim of the current study was to determine the effects of TBI on convergent and divergent thinking. We administered tests of creative divergent problem solving (Abbreviated Torrance Test for Adults, Alternate Uses Task), creative convergent problem solving (Remote Associate Task), and a battery of neuropsychological tests to individuals with moderate-severe TBI (n=29) and healthy comparison (HC) participants (n=20). The neuropsychological battery included: the California Verbal Learning Test to measure verbal learning and memory, the processing speed index of the Wechsler Adult Intelligence Scale as a measure of processing speed, the Trail Making Test to measure executive functioning and task switching, and the Brief Symptoms Inventory (BSI) to measure psychological well-being. Participants with TBI performed significantly below HCs on all tasks except for the creative divergent problem-solving tasks. Our findings suggest that following moderate-to-severe TBI, convergent thinking can be compromised, whereas divergent thinking abilities might be spared. Preserved divergent thinking abilities following TBI may be leveraged in educational, occupational, and rehabilitation settings.
Neurodevelopmental Disorders and Risk of Concussion: Findings from the NCAA-DOD Concussion Consortium

Brett Gunn¹, Andrew Lapointe², Thomas McAllister³, Michael McCrea⁴, Steven Broglio², Davis Moore¹
¹University of South Carolina, Columbia, United States, ²University of Michigan, Ann Arbor, United States, ³Indiana University School of Medicine, Indianapolis, United States, ⁴Medical College of Wisconsin, Milwaukee, United States

Objective: Neurodevelopmental disorders (NDs) are a class of comorbidities gaining considerable attention by concussion researchers. Accumulating evidence suggests NDs may be associated with increased history and risk for concussion. However, no studies have compared the differential likelihood of incurring a concussion within ND sub-types: learning disability (LD), attention deficit/hyperactivity disorder (ADHD), and comorbid (LD+ADHD).

Methods: Data from the NCAA-DOD Grand Alliance: Concussion Awareness, Research, and Education (CARE) Consortium were used to evaluate the likelihood of incurring a concussion for athletes with LD (n=429), ADHD (n=1513), and LD+ADHD (n=323), relative to controls (n=31130). All groups were evaluated retrospectively (odds of concussion history) and prospectively (risk of incurring concussion within a season).

Results: The odds ratio of concussion history at baseline for athletes with LD was 1.61 (95% CI, 1.31 to 1.97) and relative risk of LD for incurring a concussion within a season was 1.22 (95% CI, .88 to 1.69). The odds ratio of concussion history at baseline for athletes with ADHD was 1.92 (95% CI, 1.72 to 2.14) and relative risk of ADHD for incurring a concussion within a season was 1.51 (95% CI, 1.29 to 1.77). The odds ratio of concussion history at baseline for athletes with LD+ADHD was 1.85 (95% CI, 1.47 to 2.33) and relative risk of LD+ADHD for incurring a concussion within a season was 2.62 (95% CI, 2.05 to 3.35).

Conclusions: Overall, NDs are associated with increased odds and relative risk of incurring a concussion. Further, athletes with comorbid LD+ADHD appear to have the greatest risk of incurring a concussion. Given the prevalence of NDs, additional steps should be taken to prevent concussions in these athletes. The authors acknowledge that CARE does not capture adequate control for athletic exposures like most sports epidemiology studies. Individuals with neurodevelopmental disorders could have similar risk once exposure is controlled for.
Neural Correlates of Behavioural Signs of Consciousness: What Can We Learn from the MCS*?

Aurore Thibaut1, Olivia Gossseries1, Helena Cassol1, Géraldine Martens1, Steven Laureys1, Camille Chatelle1

1University of Liège, Liege, Belgium

Objectives: This retrospective cross-sectional study aimed to determine the brain regions that are needed to demonstrate behavioural signs of consciousness. Regional brain metabolism and brain connectivity differences were measured between patients in an unresponsive wakefulness syndrome (UWS; Laureys 2010), patients clinically UWS with a partial brain metabolism preservation compatible with the diagnosis of MCS (i.e., MCS* - Gossseries, et al, 2014) and patients in MCS (Giacino et al, 2002).

Methods: We looked at the 18fluorodesoxyglucose Positron Emission Tomography (FDG-PET-scan) of 18 UWS, 24 MCS*, 61 MCS and 34 healthy subjects. All patients were in a chronic stage (> 28 days post injury) and were repeatedly assessed with the Coma Recovery Scale-Revised (CRS-R; Wannez et al, 2017). The diagnosis of MCS* was based on the FDG-PET relative preservation of global brain metabolism as assessed by 3 experts. We first measured regional brain metabolism in MCS* and compare it to UWS and MCS. Using seed-based approach, we then investigated which brain regions correlate with the areas found to be more preserved in MCS as compared to MCS* (i.e., brain regions supposedly necessary to demonstrate behavioural signs of consciousness).

Results: Beside the relative preservation of the fronto-parietal network bilaterally in MCS* as compared to UWS patients, a higher brain metabolism was also measured bilaterally in the mesiofrontal regions, the anterior and posterior cingulate cortex, and the precuneus. Compared to patients in MCS, patients in MCS* had lower brain metabolism in the precuneus bilaterally, the right supplementary motor area, superior temporal gyrus and visual cortex. When looking at the connectivity between these regions (MCS*<MCS), we found a higher correlation between the right superior temporal gyrus (seed) and the premotor and supplementary motor cortices, the somato-sensory associative areas, the dorsolateral prefrontal cortex, the inferior frontal gyrus and the thalami.

Discussion: Our findings showed that MCS* demonstrate a higher brain activity in the lateral and medial fronto-parietal networks than UWS patients, consistent with what was previously observed in MCS patients (Thibaut et al, 2012). Interestingly, we found a higher metabolism in the motor region, the visual cortex and the precuneus in patients in MCS as compared to MCS*, as well as a higher connectivity between the superior temporal gyrus and the sensory motor regions, the prefrontal areas and the thalami, showing the importance of the (partial) preservation of brain activity and connectivity between these brain regions in the clinical demonstration of signs of consciousness.

Conclusion: The integrity of the connectivity between the superior temporal gyrus and the sensori-motor regions as well as the prefrontal cortex and the thalami, is crucial to clinically demonstrate signs of consciousness in brain-injured patients with disorders of consciousness.
Do Serotonergic Antidepressants Increase the Risk of Traumatic Intracranial Bleeding?

Harri Isokuortti1, Tuomas Mäntykoski2, Anneli Kataja3, Antti Brander3, Milaja Nikula2, Juha Öhman4, Grant Iverson5, Teemu Luoto4

1Department of Neurology, Helsinki University Hospital and University of Helsinki, Helsinki, Finland, 2Faculty of Medicine and Life Sciences, University of Tampere, Tampere, Finland, 3Medical Imaging Centre, Department of Radiology, Tampere University Hospital, Tampere, Finland, 4Department of Neurosurgery, Tampere University Hospital and University of Tampere, Tampere, Finland, 5Department of Physical Medicine and Rehabilitation, Harvard Medical School & Home Base, A Red Sox Foundation and Massachusetts General Hospital Program, Boston, United States

Objective: Serotonergic antidepressants (SAs) are commonly prescribed for depressive and anxiety disorders. There is evidence that SAs increase the risk of upper gastrointestinal tract bleeding and spontaneous intracranial hemorrhage. The literature on the possible risk of traumatic intracranial bleeding in patients using SAs is sparse.

Methods: A consecutive series of patients who underwent head computed tomography (CT) due to an acute head injury (n=3,023; August 2010-July 2012) at the Emergency Department of Tampere University Hospital (Finland) was included. A detailed retrospective data collection was conducted on demographics, injury-related data, premorbid health, medication, clinical characteristics, and neuroimaging findings. Antidepressants that were considered serotonergic were: (i) citalopram, (ii) escitalopram, (iii) sertraline, (iv) fluoxetine, (v) paroxetine, (vi) venlafaxine, (vii) duloxetine, (viii) bupropion, (ix) mirtazapine, (x) vortioxetine, (xi) moclobemide, (xii) amitriptyline, (xiii) nortriptyline, (xiv) doxepine, and (xv) trimipramine. All head scans were systematically interpreted by a neuroradiologist. The focus was on hemorrhagic CT lesions (epidural hematoma, subdural hematoma, subarachnoid hemorrhage, contusion, intracerebral hemorrhage, and intraventricular hemorrhage).

Results: The median age of the whole sample (n=3,023) was 57 years (interquartile range: 35-77 years), 56% (n=1,705) were men. A ground-level fall was the most common cause of injury (n=1,584, 52%). The majority of injuries were mild based on GCS (13-15 points: n=1,716, 57%; 9-12 points: n=142, 5%; 3-8 points: n=108, 4%, GCS undetermined: n=1,057, 35%). Of the whole sample, 579 (19%) had a positive head CT, and 539 (18%) had a hemorrhagic lesion. Subdural hematoma (n=389, 13%) was the most common lesion type. Antithrombotic medication was used by 710 (24%) patients, 301 (10%) used oral anticoagulants, 353 (12%) used oral antiplatelets, and 56 (2%) were on low molecular weight heparin. SAs were used by 318 (11%). Citalopram (n=79, 3%), escitalopram (n=69, 2%), and mirtazapine (n=58, 2%) were the most frequently used antidepressants. Patients using SAs were older (median age: 71 vs. 55y), more likely women (60% vs. 42%), had more circulatory system diseases (60% vs. 37%), mental and behavioral disorders (52% vs. 23%), and nervous system diseases (43% vs. 22%) than those without SAs (all p<0.001). Anticoagulant (14% vs. 10%; p<0.001) and antiplatelet (28% vs. 10%; p<0.001) usage was more common in the SA group. There was no statistically significant difference in the incidence of hemorrhagic CT lesions between the patients with versus without SA use (n=57, 18% vs. n=482, 18%; p=0.963). Among the patients using antiplatelets (n=353, 71 CT+ and 282 CT-), the use of SAs was not associated with increased incidence of hemorrhagic CT lesions (SA+: n=14, 16% vs. SA-: n=57, 22%; p=0.256).

Conclusions: The use SAs was related to greater comorbidity and age, female gender, and more frequent use of antithrombotics. SAs were not associated with a higher incidence of traumatic intracranial bleeding.
Co-Creating Research: A Participatory-Action Workshop on Integrating Services for Traumatic Brain Injury, Mental Health, and Addictions

Catherine Wiseman-Hakes1, Angela Colantonio1,2,8, Halina (Lin) Haag3, Flora Matheson1,4, Pia Kontos1,2, Alisa Grigorovich1,2, Robert Balogh5, Robert Mann1,6, Emily Nalder1, Bonnie Kirsh1, Richard Riopelle7, Vincy Chan2
1University of Toronto, Toronto, Canada, 2Toronto Rehabilitation Institute - UHN, Toronto, Canada, 3Wilfred Laurier University, Waterloo, Canada, 4St. Michael’s Hospital, Toronto, Canada, 5University of Ontario Institute of Technology, Oshawa, Ontario, 6Centre for Addiction and Mental Health, Toronto, Canada, 7Ontario Neurotrauma Foundation, Toronto, Canada, 8Institute for Clinical and Evaluative Sciences, Toronto, Canada

Introduction: Historically, programming and services for individuals with traumatic brain injury (TBI) and mental health and/or addictions (MHA) have been fragmented, particularly for those who experience homelessness, legal involvement, and among women survivors of intimate partner violence (IPV). A provincially funded research grant to the authorship team, entitled ‘Integrating Brain Injury, Mental Health, and Addictions’ (PI: Colantonio A.), was developed with consumer organizations serving the TBI and MHA populations to address this fragmentation through research and knowledge transfer activities.

Objective: To describe the results of a one-day participatory action meeting that was held at the beginning of this Research Program, aimed at identifying emerging/ongoing gaps and further refining the research methodology for this program.

Methods: Representatives from consumer organizations serving the TBI and/or MHA populations were invited, including frontline workers from housing and criminal justice sectors, non-governmental organizations, non-profit advocacy associations, individuals with lived experience of TBI and MHA, researchers, government/regulatory associations, and professional/industry associations. Breakout working groups were conducted to facilitate discussion and networking across sectors. An evaluation form was distributed to attendees at the end of the day to anonymously collect feedback on the meeting.

Results: Seventy individuals participated in the meeting, who identified the following emerging/ongoing gaps: (a) knowledge gaps exist regarding the prevalence and consequences of TBI among those who are incarcerated, homeless, or survivors of IPV; (b) provision of accommodations that will support cognitive and communication challenges and sensitive communication practices are need; (c) there is currently limited information on the barriers and challenges facing caregivers for individuals with TBI, and how to mitigate them; and (d) training and education about TBI, including how to screen and access supports for TBI is needed. The following feedback was provided to further refine the research methodology: (a) stigma, judgement, and fear of disclosure are of paramount importance during the development of research questions, and training and educational materials; (b) a TBI can occur even without a loss of consciousness – it is important to capture these individuals in screening; and (c) training and education materials should be trauma-informed and incorporate respectful, cultural, and gender-neutral and gender-sensitive language.

Conclusions: Our participants evaluated this meeting as excellent (average rating of 3.4 out of 4), highlighting information exchange, learning opportunities, and networking as positive features of the meeting. Seventy percent voted for this to be an annual event, and some participants noted that a 2-day event should be considered. This meeting was an important first step in continuing the co-creation of research that is central to our research grant to support the integration of services for those with TBI and MHA.
Randomized Controlled Trial of a Brief Intervention for Substance Misuse following Moderate or Severe TBI

Jennifer Bogner¹, John Corrigan¹, Chelsea Kane¹
¹Ohio State University, Columbus, United States

Objective: Compare the effectiveness of a Screening, Education and Brief Intervention for alcohol misuse accommodated for persons with recent moderate or severe traumatic brain injury (adapted SBI) to a Screening and Education condition (SEA).

Background: Screening and Brief Intervention (SBI) is the standard of care for addressing excessive alcohol and other drug use among patients seen in health care centers. However, the research on this intervention has generally excluded persons with moderate-severe TBI. The exception is a series of studies that has examined the effectiveness of screening and education specifically targeting substance misuse issues related to TBI. The previous studies have reported modest, indirect or nonsignificant effects on alcohol use. The purpose of the current study was to compare the effects of a Screening and Education intervention previously found effective with changing beliefs regarding alcohol use (indirectly impacting actual alcohol use) with a Screening, Education, and Brief Intervention that included cognitive accommodations to assist with retaining and using strategies and goals developed during the brief intervention. Both conditions were provided during inpatient rehabilitation, emphasized overall health and wellness and included a booster session.

Study Design: Single-masked, parallel group, randomized controlled trial with follow-up at 3, 6- and 12-months post-rehabilitation discharge.

Participants: 58 persons who sustained a TBI requiring inpatient rehabilitation.

Results: At 12 months after discharge, 32% of persons who received the adapted SBI had returned to alcohol use, compared to 63% of persons with received SEA (p<.05). The number of people who resumed use in the SEA group gradually increased at each time point (16% at 3 months, 36% at 6 months, 63% at 12 months), while the percentage of people who resumed use in the SBI group varied minimally across the 3 timepoints (27% at 3 months, 29% at 6 months and 32% at 12 months). Significant differences were not observed for drinks/week, binging, or the number of facts recalled regarding the effects of alcohol use following TBI.

Conclusion: Screening, education and brief intervention with cognitive accommodations is more effective with reducing the resumption of alcohol use than screening and education alone.

Limitations: The sample size was smaller than originally projected, reducing power to detect significant effects. In addition, some participants did not receive the booster session.
The Utility of Single-Photon Emission Computed Tomography/Computed Tomography (SPECT/CT) in mild Traumatic Brain Injury (mTBI): Case Report

Isabel Borras-Fernández¹, Irma Molina-Vicent¹, Cecilia Soler-Llompart¹, Neishaliz Díaz-Acevedo²

¹VA Caribbean Healthcare System, San Juan, United States

Traumatic Brain Injury (TBI) is defined as damage to the brain resulting from an external force. TBI, a global leading cause of death and disability, is associated with serious social, economic, and health problems. In cases of mild brain damage, conventional anatomical imaging modalities may or may not detect the cascade of metabolic changes that have occurred at the intracellular level. Nuclear medicine imaging can be used to characterize brain damage, as it provides direct visualization of brain function, even in the absence of overt behavioral manifestations or anatomical findings. Nuclear medicine neuroimaging can also serve as a biomarker to measure treatment outcomes. We report the case of a 40-year-old Hispanic male Veteran, with multiple combat and non-combat TBI(s), who developed cognitive and neuropsychological symptoms, in the setting of negative brain magnetic resonance imaging (MRI). The most significant event was a blast exposure incident in 2003 after an Improvised Explosive Device (IED) detonated in front of his palletized load system (PLS) vehicle less than 20 feet away. His medical history was pertinent for chronic Post Traumatic Stress Disorder (PTSD), depression, Chronic Pain Syndrome and prior history of Cannabis use. From 2004-2007 he underwent treatment for his TBI residual symptoms at the Department of Defense (DoD) until he was medically discharged. In April 2015 he was evaluated at the VA Caribbean Healthcare System (VACHS), Polytrauma Network Site (PNS) for mild TBI. At that moment, the patient complained of cognitive, behavioral, pain, and executive function symptoms. The initial imaging evaluation consisted of a Single Photon Emission Computed Tomography-Computed Tomography (SPECT/CT) with Tc99m Bicisate in May 2015 showed multiple areas of hypoperfusion along the Cingulate gyrus, bilateral basal ganglia, superior frontal and posterior parietal regions, medial temporal lobes bilaterally, the right inferior temporal lobe, and the left occipital lobe. A non-contrast structural MRI performed in May 2015 did not reveal any abnormalities. Clinical course was complicated by exacerbation of his depression requiring a partial psychiatric hospital admission. Upon mental health stabilization, he continued his treatment at the PNS, and cognitive retraining was resumed. In April 2016 the patient presented with mental fatigue and declined cognitive function for which oral Amantadine 100mg twice a day was prescribed. Close monitoring was provided and improvement in cognitive function was evidenced. Follow up perfusion SPECT/CT on May 2017 showed mildly decreased perfusion in the left occipital cortex, the basal ganglia and the right thalamus. Significant improvement was observed upon comparison with prior study.

Conclusion: This case provides evidence in the utility of perfusion SPECT/CT for diagnosis and follow up of patient with mild TBI in the setting of negative structural imaging.
The Relationship between Physical Activity, Depression and Symptom Burden in Individuals with Persistent Post Concussion Symptoms: A chart review

Leah Mercier¹, Kristina Kowalski², Chantel Debert¹,³

¹Department of Clinical Neurosciences, Division of Physical Medicine and Rehabilitation, University of Calgary, Calgary, Canada, ²Department of Psychology, University of Calgary, Calgary, Canada, ³Hotchkiss Brain Institute, University of Calgary, Calgary, Canada

Introduction: Individuals with Persistent Post Concussion Symptoms (PPCS) are at greater risk for depression and often experience exercise intolerance contributing to increased sedentary activity. Physical activity (PA) alone has been shown to reduce symptoms of mild to moderate depression to the same extent as standard treatments. Additionally, people who are regularly physically active assign higher ratings to their mental health. In Canadian youth, both physical inactivity and sedentary activity were significantly related to symptoms of depression. While there is increasing evidence that aerobic exercise following concussion can improve recovery, the relationship between depression, PA and symptom burden in individuals with PPCS has not been characterized.

Objective/Hypothesis: This study seeks to shed light on the relationship between depression, PA and symptom burden in adults with PPCS. We anticipate those with increased sedentary behavior and lower levels of PA will have greater depressive scores. Additionally, we hypothesize that those with greater symptom burden will have higher rates of depression, participate in less PA, and engage in more sedentary behaviors.

Methods: A prospective cohort chart study of adult patients referred to the Calgary Brain Injury Program at Foothills Medical Centre in Calgary, Alberta, CAN between 2012-2017 was conducted. Inclusion criteria was a diagnosis of both concussion and persistent concussion symptoms (i.e., greater than 3 months). Patient demographics and injury characteristics were collected. The Patient Health Questionnaire-9 (PHQ-9) was used to screen for depression. PA levels were measured using the Godin Leisure Time Exercise Questionnaire (GLTEQ), while sedentary behaviors were accessed using the Rapid Assessment Disuse Index (RADI). Symptom burden was quantified using The Rivermead Post Concussion Symptoms Questionnaire. Descriptive statistics were applied for patient demographics. Spearman correlations were run between the RADI inactivity risk index and PHQ-9 scores/ Rivermead scores and between the GLTEQ and PHQ-9 scores/ Rivermead scores. Spearman correlations were also run between PHQ-9 scores and Rivermead scores.

Results: Of the 604 records reviewed, 46 individuals (43% male, 57% female) met inclusion criteria. Participants had a mean age of 35.6 (13) years at time of injury with 46% having a history of prior head injury. Spearman’s correlation analyses revealed no significant correlation between PA and depression or symptom burden. A significant positive correlation was found between the RADI inactivity risk index, and depression scores, rs (46) = .389, p = .008. Additionally, increased symptom burden was positively correlated with increased depression scores, rs (46) = .531, p < .001.

Conclusion: These findings provide insight into the contribution of sedentary behavior to levels of depression in individuals with PPCS. This suggests that while the benefits of physical activity may be abundant, although not observed in this population, focus on decreasing sedentary behaviors should also be emphasized.
Psychological Effects of Traumatic Brain Injury Measured after Objective, Diagnostic Assessment of Physiologic Disruption at Multiple Time Points

Shivani Venkatesh¹,², Maxwell Thorpe¹, Uzma Samadani¹,²
¹Hennepin Healthcare, Minneapolis, United States, ²University of Minnesota- Twin Cities, Minneapolis, United States

Introduction: Traumatic brain injuries (TBIs) are associated with several negative outcomes, such as cognitive deficits, vision deficits, mood disorders, and risk for increased substance use. The purpose of this study was to assess the long-term impact of TBI in patients who were assessed with an objective measure of physiologic brain function serially after injury.

Method: 4 metrics, Box Score, Right Area Median, Left Area Median, and Conjugate Box Score, from a passive automated eye tracking task were compared to a psychological outcome measure in order to determine the relationship between oculomotor dysfunction and psychological outcome six months after injury. Fourteen head-injured subjects were recruited from a Level 1 trauma center and compared to 58 healthy controls. The TBI cohort was assessed at the initial and six-month time points. The Sports Concussion Assessment Tool-3 (SCAT-3) measured cognitive deficits (SAC) and symptoms of mood disorders (SSS). The Medical, Socioeconomic, and Lifestyle Questionnaire (MSL) was used to assess substance use and psychiatric history.

Results: At the time of injury, TBI subjects in comparison to controls, were more likely to have a previous psychiatric history (38.4% vs 23%) and have worse cognition (SAC p=.005), tracking metrics (Box Score p=0.05; Conjugate Box Score p=.00368), and mood (SSS p=<.001). Alcohol and drug use increased in the TBI group from 23% to 31% and 0% to 8%, respectively from the initial to the six-month time points. However, controls reported drinking more alcohol and using more drugs (87%; 17%) in comparison to the TBI subjects (23%; 0%). Psychological problems still persisted long term as individuals with TBI, compared to controls, still had symptoms of mood (p=.003291) but not cognitive dysfunction (p=.443) or visual deficits (Box Score p=0.994; Conjugate Box Score p=.5687; Right Area Median p=.9037; Left Area Median p=0.8588 six months from the time of injury. Initial eye tracking metrics were not able to predict long term symptoms of mood, but significantly predicted long term deficits in cognition (p=.00806).

Conclusion: Overall, the results show that there are differences in controls and TBI subjects at time of injury. Subjects seem to recover at the six-month time point, with regards to cognition, vision, and mood, but not substance use. Eye tracking metrics predict impaired cognition at 6 months. Limitations include the small number of subjects participating in long term follow up.
Treatment Outcomes in Mild Traumatic Brain Injury (mTBI): A Systematic Review of Randomised Controlled Trials

Rollo Sheldon1, Mohammad Arbabi3, Niruj Agrawal1,2
1South West London & St George’s MH NHS Trust, London, United Kingdom, 2St George’s University of London, London, United Kingdom, 3Tehran University of Medical Sciences, Tehran, Iran

Objectives: Mild traumatic brain injury (mTBI) is a controversial, under-researched area, despite the overwhelming majority of TBIs being classed as mild; and evidence of significant long term sequelae in some. Many different approaches have been used in treatment but the relative benefits and quality of evidence of each are unclear. We proposed to systematically review the literature on treatment outcomes of mTBI.

Methods: A systematic review of literature was carried out using Web of Science, Scopus, Medline, Pubmed, Cinahl, and PsychInfo databases. Randomised Controlled Trials (RCTs) of treatments for mTBI in adults were included, published 1980-2017. Review of the methodological quality of the studies was conducted using the Scottish Intercollegiate Guideline Network (SIGN) checklist for RCTs to evaluate risk of bias, and synthesis of studies was conducted.

Results: 3993 studies were identified, of which 25 met inclusion criteria, and a total number of participants of 3213. Mean age was 35. 10 studies had <100 participants, 15 studies 100-395. Studies were grouped into education and early intervention (9), rehabilitation (8), psychotherapy (4), and pharmacotherapy (4). 10 studies were assessed as being at low, 7 moderate, and 8 high/unacceptable risk of bias. Inconsistency of definitions and outcome measures used precluded meta-analysis.

Conclusions: Contrary to expectations, traditional educational and early intervention approaches have the weakest efficacy compared to other approaches. RCTs in the psychotherapy group showed most efficacy and lowest risk of bias. However further work is required to confirm this and international agreement of definitions and outcome measures used is needed.
Risk Factors for In-Hospital Mortality Among Persons with Hypoxic Ischemic Brain Injury: Results from a Population-Based Study

Binu Jacob, David Stock, Vincy Chan, Angela Colantonio, Nora Cullen

Background: Hypoxic ischemic brain injury (HIBI) is a leading cause of morbidity and mortality. The population-level view of characteristics of patients who are admitted to acute care and the risk factors of hospital death are poorly understood.

Objectives: The main objectives of this study were to describe the demographic and clinical characteristics of patients with HIBI who were admitted in an acute care setting, and to identify risk factors for in-hospital mortality.

Methods: Adults aged 20 years and older who were admitted in acute care hospitals following HIBI between fiscal years 2002/03 and 2016/17 were identified using population-based health administrative data in Ontario, Canada. The main outcome of interest was in-hospital mortality (yes vs. no). Multivariable logistic regression was used to identify risk factors associated with in-hospital mortality.

Results: Of the 7512 patients hospitalized with HIBI, almost 72% died within the acute care setting. Majority of HIBI patients hospitalized were males (66%), aged 50 years or older (81%), and of lower income quintiles of ≤3 (65%). The in-hospital mortality was associated with female sex (OR: 1.41, 95% CI: 1.23-1.61) and having alternate level of care days (OR: 0.06, 0.05-0.07). There were significant increasing trends in in-hospital mortality toward increasing age, higher comorbidity score measured using John Hopkins Aggregated Diagnostic Groups scores, and shorter length of stay in special care unit.

Conclusions: The findings indicate high in-hospital mortality following hypoxic ischemic brain injury, with 8 in 10 patients die in the acute care setting. There is a critical need for prevention strategies targeting reduced in-hospital mortality.
Identity Factors Predict Concussion Reporting Behaviors in Collegiate Student-Athletes

Nicole Thomas¹, Caroline Ketcham¹, Emily Beamon², Emily Kroshus³, Katherine Arbogast¹, Christopher Riegner¹, Kirtida Patel¹, Ethan Williams¹, Eric Hall¹

¹Elon BrainCARE Research Institute, Elon University, Elon, United States, ²University of North Carolina at Greensboro, Greensboro, United States, ³Department of Pediatrics, University of Washington, Center for Child Health, Behavior, and Development, Seattle Children’s Research Institute, Seattle, Australia

Failing to report a sports-related concussion (SRC) and continuing to play without proper care, can lead to short-term and long-term neurological and functional consequences in student-athletes (SAs) (McCrory et al., 2017). Although collegiate student-athletes in the United States receive annual concussion education in compliance with National Collegiate Athletic Association Policy, a large percentage of SRCs go unreported (Langlois, Rutland-Brown, Wald, 2016). There is a critical need to developing improved approaches to intervention with a goal of shifting concussion reporting behavior. This may require taking a step back from proximal cognitions such as concussion knowledge or attitudes about concussion reporting to identify aspects of the individual’s identity or self-concept that may influence reporting behavior. The goal of the present study was to determine the extent to which conformity to masculine norms, athletic identity, academic identity and concussion knowledge predicted concussion reporting intentions. Participants were 535 student-athletes (DI Varsity (n=133) and Club (n=402)) who completed a survey at the time of their pre-season concussion baseline testing. Survey content included: demographic information (sport type- varsity, club; gender- male, female; year in school- first-year, sophomore, junior, senior; NCAA contact classification- no-contact, contact, contact with collision; and race/ethnicity- US Census categories), and validated scales assessing concussion knowledge (Rosenbaum & Arnett, 2010; Kroshus et al, 2015), academic identity (Was & Isaacson, 2008, athletic identity (Brewer et al., 2004) and conformity to masculine norms (Mahalik et al., 2003). A multivariate linear regression was tested to predict concussion reporting intention. Included in the model but were not significant variables were gender, ethnic identity, contact classification, concussion knowledge and athletic identity (p>0.05). Significant variables included sport type (p<.05), academic identity (p<.01), and conformity to masculine norms (p<.001). Together sport type (varsity), high academic identity, and low conformity to masculine norms accounted for 9% of the variance among student-athlete intention to report. The implications of this study suggest that to improve reporting behaviors universities should support initiatives that strengthen academic identity and reduce conformity to masculine norms across all their student-athletes. Such efforts may require a re-conceptualized approach to intervention that moves beyond concussion-related knowledge translation to encompass efforts that help athletes strengthen non-athlete elements of their identity.
Sex-Specific Neural Changes Following Concussion and Sub-Concussive Impacts

Reema Shafi, Alexandra Carleton, Adrian Crawley, Angela Colantonio

Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada; Toronto Rehabilitation Institute, University Health Network, Toronto, Canada; Human Biology, Collaborative Program of the Faculty of Arts & Science and the Faculty of Medicine, Toronto, Canada; Toronto Western Hospital, Toronto, Canada; Institute of Medical Sciences, University of Toronto, Toronto, Canada

Despite the increase in concussion/mild traumatic brain injury (mTBI) research over the past few decades, there continues to be a large gap in our understanding of the sex-specific differences in neural re-organization post injury. More recently, there has been a notable shift in policy across the United States, Canada and Europe that calls for integration of sex/gender in biomedical research, both in data collection and reporting across all human and animal studies including secondary data analyses.

During this talk we will report the findings of our scoping review of the literature with the objective to provide a consolidated perspective on the evidence related to sex-specific differences in neural alterations from the concussion and sub-concussive literature across human studies. The focus of the talk will be tri-fold. We will initially present the emerging evidence pertaining to sex-specific changes in the brain post trauma, then we will highlights the persistent shortcoming in research which may be contributing to the current knowledge gaps and finally we will shed light on the need to utilize a contextual approach to interpret the evidence given known baseline sex-differences in brain structure and function. Our goal will be to identify the known sex-specific vulnerabilities in both males and, more so, in females which clearly warrant further exploration.

Keywords: sex; gender; concussion; mild traumatic brain injury; neuroimaging
The Role of Mindfulness in ABI Rehabilitation: A Scoping Review

Alexandre McDougall¹, Natan Simchovich¹
¹University of Toronto, Toronto, Canada

Acquired brain injury (ABI) is a leading cause of morbidity and mortality worldwide. Mindfulness-based interventions (MBIs) have been identified as potential therapies to enhance recovery after ABI.

The purpose of this study is to complete a scoping review and synthesize the evidence regarding MBIs and their therapeutic effects in ABI.

The methodological framework of Arksey and O’Malley was employed. Databases searched include Medline, EMBASE, and PsychInfo. Two reviewers independently screened titles, abstracts and full texts in a two-step screening protocol to determine final inclusion. Abstracted data included study setting and outcome measures. MBIs included, but were not limited to, meditation, goal management, and mindfulness-based stress reduction.

MBIs were found to be feasible for ABI patients as evidenced by high attendance and satisfaction ratings from patients and administering staff. MBIs were demonstrated to consistently improve mental health, attention, depression, and perceived stress in ABI patients. Additionally, the patients reported having improved self-efficacy, self-awareness and were better able to cope with ABI related symptoms, allowing them to resume important life roles. There were mixed results for physical health, with some studies showing an improvement in functional tasks while others reported no change. These improvements were found to be maintained long term (6-12 months after intervention) and the majority of patients continued daily use of at least some of the MBI strategies. Interestingly, an online interactive MBI was also found to have therapeutic effects and reduce mental fatigue in ABI patients.

MBI is a promising intervention for ABI patients and the results indicates a wide range of possible long-term benefits. Future research using objective measures is needed to investigate the efficacy of this intervention. Few inpatient rehabilitation services have been using MBIs in the subacute inpatient setting.
Assessing Variability of Functional Connectivity in Patients with Disorders of Consciousness using a Multimodal Neuroimaging Approach: A PET/MRI Pilot Study

Sivayini Kandeepan1, Carlo Cavaliere2,3, Marco Aiello2, Demetrius Ribeiro de Paula1, Luca Basso2, Salvatore Fiorenza4, Mario Orsini2, Luigi Trojano5, Orsula Masotta4, Keith St. Lawrence6, Vincenzo Loreto4, Blaine Alexander Chronik1, Emanuele Nicolai2, Anna Estraneo4, Andrea Soddu1

1Department of Physics and Astronomy, Brain and Mind Institute, University of Western Ontario, London, Canada, 2IRCCS SDN, Istituto di Ricerca Diagnostica e Nucleare, Naples, Italy, 3Coma Science Group, GIGA-Research, University and University Hospital of Liege, Liege, Belgium, 4Neurorehabilitation Unit and Research Laboratory for Disorder of Consciousness, Maugeri ICS, IRCCS, Telese Terme, Italy, 5Department of Psychology, University of Campania “Luigi Vanvitelli”, Caserta, Italy, 6Lawson Health Research Institute London, Medical Biophysics, University of Western Ontario, London, Canada

Background: Individuals with disorders of consciousness (DoC) present unique problems for diagnosis and prognosis. Clinical expression of consciousness is often limited, inconsistent and easily exhausted, hampering assessment of cognitive functions. Classification of the patients with DoC is pivotal for optimizing treatment but challenging also due to the minimal amount of difference in the brain activity among these patients. Multimodal neuroimaging techniques not requiring active participation of the patients, integrated with clinical assessments, may provide an improved understanding of neural networks involved with consciousness. In fact, neuroimaging techniques allow collecting a large amount of information inaccessible to bedside clinical evaluation.

Methods: We here give an overview of multimodal imaging by hybrid fludeoxyglucose (FDG-)PET/MR in three patients with severe brain-injury, one in a vegetative state (VS), one in a minimally conscious state (MCS) and one emerged from MCS (EMCS). Repeated behavioural assessments by Coma Recovery Scale-Revised (CRS-R) were performed one week before, the day of and one week after neuroimaging recording to confirm the stabilized clinical diagnosis and gather the best CRS-R total score. PET/MRI data were simultaneously acquired for the three patients in the resting state during one imaging session, in which two resting-state functional MRI (rs-fMRI) series were run at an interval of about 30 min. Independent Component Analysis (ICA) was applied onto the rs-fMRI to extract the nine resting state networks using predefined templates, followed by a graph-based approach to obtain the strength maps of each networks. A ratio of fitness was calculated network by network to select the best graph strength map out of the two acquisitions and was correlated with the FDG uptake. Further, benefits of concatenating the two acquisitions were observed as well.

Results: We observed several differences in the spatial patterns of the resting state networks between the two rs-fMRI acquisitions, affecting in a different way each network and with a different variability in the three patients. Moreover, combined PET/fMRI analysis demonstrated the highest positive correlation between the metabolic rate and functional connectivity for patients in EMCS and MCS compared to VS.

Conclusion: For the first time, we demonstrated relevant variability in the brain functional connectivity investigated within a period of about 30 min. Therefore, we suggest performing multiple acquisitions within the same session to pick the best findings using the highest ratio of fitness and to develop frameworks for longitudinal assessments for reducing diagnostic error and increasing prognostic markers for good outcome.

References:
Sex-Specific Differences in Resting-State Functional Connectivity of Large-Scale Networks in Post-Concussion Syndrome

Reema Shafi1,2, Adrian Dr.3,4, Carmella Tartaglia5,6,7,8, Charles Tator4,6,7,9,10, Robin Green2,6,11, David Mikulis4,6,11, Angela Colantonio1,2

1Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada, 2Toronto Rehabilitation Institute, University Health Network, Toronto, Canada, 3Toronto Western Hospital, Toronto, Canada, 4Institute of Medical Sciences, University of Toronto, Toronto, Canada, 5Tanz Centre for Research in Neurodegenerative Diseases, University of Toronto, Toronto, Canada, 6Canadian Concussion Center, Toronto Western Hospital, Toronto, Canada, 7Division of Neurology, Krembil Neuroscience Centre, Toronto Western Hospital, Toronto, Canada, 8Division of Brain, Imaging and Behaviour-Systems Neuroscience, Krembil Neuroscience Centre, Toronto, Canada, 9Department of Surgery, University of Toronto, Toronto, Canada, 10Division of Neurosurgery, Krembil Neuroscience Centre, Toronto Western Hospital, Toronto, Canada, 11Department of Medical Imaging, Toronto Western Hospital, Toronto, Canada

Background: Concussions may be associated with a range of cognitive, neuropsychological and behavioural sequelae in post-concussion syndrome (PCS) especially that persists beyond one year. While mild traumatic brain injury or concussion can disrupt network-based connectivity, there remains a significant knowledge gap regarding the influence of sex-based differences in resting state functional connectivity (rs-FC) post-concussion.

Objectives: Our goal was to investigate the differences in rs-FC across three large-scale neural networks and to explore the sex-based differences in network-based connectivity in post-concussion syndrome.

Methods: 3T MRI data were collected from a sample of 80 individuals (47 males) who reported a history of post-concussion syndrome and 31 control participants (17 males) with no known history of concussion. Seed-to-seed and seed-to-region connectivity maps were used to assess network-based connectivity using the Functional Connectivity (CONN) toolbox.

Results: Network based statistics were utilized to show that concussed participants had significant differences both within the SN and between the SN-FPN. More specifically, a functional subnetwork constituting of the frontal nodes of both the SN and FPN were hyperconnected in a “fronto-insular” component and the posterior nodes were hypoconnected as a “parietal” component when compared to controls. Seed-to-region analyses revealed significantly reduced rs-FC between the FPN and the association cortices in concussed females relative to both controls and concussed males. Conversely, concussed males showed similar cortical alteration however, the rs-FC was increased and driven by the SN.

Conclusion: This study provides the first evidence for sex specific network-based alterations in rs-FC and point to sex-specific alteration post-concussion.

Keywords: brain injury; concussion; sex differences; neural networks; functional connectivity
Medical Utilization Before and after Traumatic Brain Injury Care in Europe

Kendra Jorgensen-Wagers1,3, Stephanie Maxfield-Panker2
1Defense and Veterans Brain Injury Center, APO AE, Germany, 2Regional Health Command Europe, Sembach, Germany, 3Landstuhl Regional Medical Center, Landstuhl, Germany

The U.S. Army has spent significant resources to understand, identify, treat, and track Traumatic Brain Injury (TBI) in Service Members. The Army’s goal is to promote readiness with optimal effectiveness and efficiency. Therefore, it is incumbent upon the medical health system to determine the true medical load of untreated and treated Service Members having sustained Traumatic Brain Injury. Landstuhl Regional Medical Center (LRMC) is the DoD’s largest medical care facility in Europe, serving beneficiaries across Europe and Africa, and managing evacuations from Combatant Commands in Europe, Africa, and the Middle East. LRMC is resourced to provide inpatient and outpatient medical services for all severities of TBI. In this overview, we demonstrate the health care system burden of patients prior to, during, and after specialty care for Traumatic Brain Injury.

Methods: Healthcare utilization within the TBI Clinic at LRMC was reviewed for patients seen from December 2016 – September 2018 to analyze care patterns for specialties and map clinical pathways for care provision. Patient data on 551 patients was compiled for patients seen during aforementioned time periods. Number of kept appointments were reviewed for the previous five years (2013 – 2018). Patients’ history was parsed into pre-injury utilization, post-injury/pre-treatment, TBI treatment, and post-treatment utilization. Appointment types included Primary Care (PC), Physical Therapy (PT), Occupational Therapy (OT), Pain Management (PM), Behavioral Health (BH), and Other appointments.

Data reflects recent standardization in collection of outcome metrics and capacity to use this data to illustrate the qualitative benefit of TBI specific care and the quantitative impact in describing improved medical burden pre- and post- treatment.

To date, analysis reveals the average length of TBI rehabilitation was 4.84 months. During this time, patients attended an average of 5.7 medical appointments, 2.6-3.5 rehabilitation appointments, and 3.2 behavioral health appointments. The average number of times that a patient was seen varied from 2.6-5.7 visits.

Preliminary data analysis demonstrates patients’ healthcare utilization in specific areas decreased to pre-injury levels. PC appointments increased 25% after injury, prior to treatment. Post treatment, levels of PC utilization normalized to baseline. PT and OT utilization from injury to treatment increased 100% from pre-injury levels. After treatment, PT and OT appointments decreased to pre-injury levels. Similarly, all other appointments combined (to include Orthopedics, Optometry, and other medical specialties other than PM and BH) increased 55% prior to TBI treatment but decreased 24% toward the pre-injury utilization levels.

Conclusion: Analysis of medical utilization for TBI patients within interdisciplinary rehabilitation care reveals patients are able to decrease healthcare utilization in multiple areas after short periods of interdisciplinary TBI specific rehabilitation. This work demonstrates a way to describe patient improvement and potential self-management through decreased burden of these patients on the medical system at large.
Remember Me! An Educational Intervention for Individuals with Brain Injury and Memory Loss

Deborah Tang¹, Anna Cook¹, Natasha D'Souza¹, Dorothy Heidbuurt¹, Judy Gargaro²
¹Mind Forward Brain Injury Services (formerly PHDABIS), Mississauga, Canada, ²Ontario Neurotrauma Foundations, Toronto, Canada

Background and Aims: It is well-established that memory impairments are a significant problem for individuals with brain injuries. According to the OBIA Impact Report (2012), 63% reported having retrograde amnesia as a result of the injury, and 85% reported having anterograde amnesia following brain injury. These issues have a significant negative impact on their overall daily functioning. The purpose of this study was to develop an educational intervention for persons living with brain injury that would help them understand their memory difficulties, and potentially improve quality of life, as measured by depression and anxiety questionnaires.

Methods: In partnership with the Ontario Neurotrauma Foundation (ONF), we adapted Baycrest’s Memory and Aging Program (MAP) curriculum. The original MAP curriculum was designed for healthy normal aging adults (seniors), whereas our target audience was individuals living with brain injury. Edits consisted mainly of reorganizing the material so it would be easier for our clients to understand and retain and adding in content relevant for individuals with brain injury. In this program, education was provided regarding factors affecting memory, process of memory, as well as strategies to improve memory deficits. The curriculum consisted of ten weekly sessions. Our pilot group consisted of a total of N=13. We measured our success by administering three questionnaires before and after the intervention. These questionnaires included a knowledge test, GAD-7 (anxiety questionnaire), and PHQ-9 (depression questionnaire). Memory groups are ongoing, and more data is expected in March 2019. We will also be conducting follow-up questions at 6 months post to determine if the gains experienced in the group are maintained.

Results: Preliminary results showed significant changes in knowledge baseline before and after the group (p<0.001), from 3.56 (+/- 3.89) to 21.25 (+/- 4.87) (N=13). Results from our depression measure (PHQ-9) was also significant (p<0.05), with a pretest score of 8.92 (+/- 8.09) and a posttest score of 6.08(+/- 6.63) (N=13). Preliminary results show that 100% of the participants would recommend this group to others and found the information valuable.

Conclusions: The memory group provided helpful strategies and lifestyle changes to improve memory deficits, increased insight about their memory impairments and assisted in decreasing their level of depression. Further work will focus on determining if these results extend to a larger population, and if the benefits gained persist at 6 months’ follow-up.
Virtual Health to Home: A TBI Pilot Study to Review Feasibility, Quality of Care and Patient Satisfaction

Rachael Lazarus, Kendra Jorgensen-Wagers1,2, Stephanie Maxfield-Panker3
1Defense and Veterans Brain Injury Center, APO AE, Germany, 2Landstuhl Regional Medical Center, APO AE, Germany, 3Regional Health Command Europe, APO AE, Germany

Mild traumatic brain injury (mTBI), is a problem in the military affecting over 312,000 in the U.S. Armed Forces between 2000 and 2017. Concussion affects over 82% of Service Members diagnosed with TBI. While most sequelae from mTBI resolves quickly, the condition remains under reported, unrecognized and untreated, for a variety of reasons, to include difficulty taking time from military duties to seek care.

The Army has built Virtual Health (VH) in the European footprint to enhance access to care for Service Members. Through VH platforms, medical providers can increase their reach, engaging in a more patient-centric and responsive medical care. Use of VH for treatment of diagnoses such as mTBI may also decrease lost work time and medical travel cost expenditures, thereby enhancing military readiness. However, ensuring that these VH systems are feasible, provide comparable care, and result in high patient satisfaction is important for successful implementation and utilization in military medicine.

Landstuhl Regional Medical Center (LRMC), initiated a pilot performance improvement project to expand VH capability to the TBI patients’ home. Once approved, patients were given the option to conduct their intake visit for TBI care via VH to their home. Patients were provided instruction on the conditions for the visit and the IT requirements for their computers, through a web-based link. Synchronous, real time video visits were managed by the RHCE Video Network Center (VNC) to address technical concerns and add unique four-digit PIN numbers to enhance call security.

Patient and provider satisfaction data were collected. Savings to loss of duty time and medical TDY savings were calculated. Continued utilization of telehealth pilot in our second generation for follow-up services and coordination of group education modalities are currently under review and will be included in the Results.

From August 2017 to December 2017, 67 synchronous VH visits were conducted between TBI specialty care providers and patients. Preliminary data indicates that VH for TBI patients to their home environment is feasible and cost-effective. Importantly, providers report the level and experience of care provided equitable to face to face encounters. A review of feedback demonstrated ease of use, and satisfaction with the modality’s ability to minimize time away from military duties. Patients reported a mean average of 4.75 out of 5 for overall patient satisfaction with the VH experience, 5 out of 5 for finding the staff helpful and professional, and 5 out of 5 for satisfaction with the treatment plan.

An analysis of over 67 VH encounters demonstrated effective ways to facilitate treatment and force readiness. Bringing care to the home reduces barriers to care, cost of medical travel, time taken away from training or other military duties, and, in some cases, perceived stigma associated with medical care.
Reliability of the Sport Concussion Assessment Tool 5 Baseline Testing: A 2-Week Test-Retest Study

Timo Hänninen\textsuperscript{2}, Jari Parkkari\textsuperscript{2}, Artu Seppänen\textsuperscript{3}, Vili Palola\textsuperscript{3}, Markku Tuominen\textsuperscript{5}, Grant Iverson\textsuperscript{4}, Teemu Luoto\textsuperscript{1}

\textsuperscript{1}Department of Neurosurgery, Tampere University Hospital and University of Tampere, Tampere, Finland, \textsuperscript{2}Tampere Research Centre of Sports Medicine, UKK Institute for Health Promotion Research, Tampere, Finland, \textsuperscript{3}Faculty of Medicine and Life Sciences, University of Tampere, Tampere, Finland, \textsuperscript{4}Department of Physical Medicine and Rehabilitation, Harvard Medical School, Massachusetts General Hospital for Children Sports Concussion Program, & Home Base, A Red Sox Foundation and Massachusetts General Hospital Program, Boston, United States, \textsuperscript{5}International Ice Hockey Federation (IIHF) / Medical Committee; Finnish Ice Hockey Association; and Medisport Inc., Tampere, Finland

Objectives: To examine the test-retest reliability of the Sport Concussion Assessment Tool - 5th Edition (SCAT5) and to make recommendations for the interpretation of serial test results in professional athletes.

Methods: Preseason SCAT5 baseline testing was administered twice by two assessors, over a 2-week interval, to 62 professional male ice hockey players. Half of the players were tested by the same assessor on both testing sessions.

Results: The reliability coefficients of the SCAT5 components were as follows: (i) Symptom Score: Spearman’s correlation (rs)=0.85 (p<0.05), Kendall’s tau b (tau-b)=0.76 (p<0.05), Wilcoxon signed rank test (sig r): p<0.05; (ii) Symptom Severity: rs=0.84 (p<0.05), tau-b=0.76 (p<0.05), sig r: p<0.05; (iii) Standardized Assessment of Concussion (SAC) total: rs=0.58 (p<0.05), tau-b=0.43 (p<0.05), sig r: p=0.4; and (iv) Modified Balance Error Scoring System (M-BESS) total: rs=0.40 (p<0.05), tau-b=0.31 (p<0.05), sig r: p=0.61. More than half of the athletes (52%) reported at least one symptom (Symptom Score: Md=1, M=2.2, SD=3.3; Symptom Severity: Md=1, M=3.1, SD=3.1) during the first baseline evaluation. The most common symptoms were: fatigue or low energy (32%) and neck pain (31%). The SAC total scores ranged between 28 and 45 (Md=35, M=35.4, SD=4.2). The SAC test-retest change scores varied between 0 and 11 (Md=3, M=3.5). The broad range of SAC scores was mostly due to variability on the Immediate Memory performance (10-item word list: IQR=18-23). Almost all (95%) of the players scored flawlessly (=5 points) on the Orientation test. The majority of the players (84%) scored at least 2 points on the Concentration. For Delayed Recall, a worsening or improvement of 3 or more points was uncommon. All athletes had a perfect performance on the M-BESS Double Leg Stance. The number of Single Leg Stance errors (Md=1, Md 3.2, SD=4.0) was greater than Tandem Stance errors (Md=0, Md=2.0, SD=3.6). There was no significant inter-assessor variability on the SCAT5 components (all p<0.05).

Conclusions: The two-week test-retest reliability of the SCAT5 baseline scores varied between moderate (SAC, M-BESS) and very good (Symptoms). However, there was considerable individual variability on the SAC and M-BESS scores. Individual SCAT5 baseline scores should be used cautiously in post-injury evaluation due to the short-term temporal fluctuation on the test performance.
White Matter Correlates of Theory of Mind Impairment in TBI: Structural Integrity of the Uncinate Fasciculus is Related to performance on the Reading the Mind in the Eyes Task

Malcolm Edwards1,2, Arianna Rigon3,6, Bilge Mutlu5, Lyn Turkstra4, Michelle Voss3, Melissa Duff2

1Department of Psychological and Brain Sciences, The University of Iowa, Iowa City, United States, 2School of Graduate Studies and Research, Meharry Medical College, Nashville, United States, 3Department of hearing and Speech Sciences, Vanderbilt University Medical Center, Nashville, United States, 4School of Rehabilitation Sciences, McMaster University, Hamilton, Canada, 5Department of Computer Sciences, The University of Wisconsin-Madison, Madison, United States, 6Interdisciplinary Neuroscience Program, The University of Iowa, Iowa City, United States

A growing body of work offers compelling evidence for theory of mind impairments in individuals with traumatic brain injury (TBI). However, little is known about the neural correlates of theory of mind impairments following TBI. Deeper knowledge of the neural underpinnings of theory of mind impairments in individuals with TBI can aid in the development of more accurate diagnostic and prognostic tools and shed light on the mechanisms that lead to social dysfunction following TBI.

The present study aimed to examine differences in performance on the Reading the Mind in the Eyes (Eyes) task in individuals with moderate to severe TBI (n=30) and demographically matched healthy comparison participants (n=23). We also sought to further examine the relationship between diffusion tensor imaging (DTI) scalars, in particular (fractional anisotropy (FA) and mean diffusivity (MD), and performance on the Eyes task. We executed an ROI analysis, focusing on three white matter tracts shown to be implicated in theory of mind: the superior longitudinal fasciculus (SLF), the inferior longitudinal fasciculus (ILF), and the uncinate fasciculus (UF).

Mixed effect logistic regression was used to determine group differences in individuals with TBI and demographically matched comparison participants in Eyes task performance and revealed that individuals with TBI were significantly more likely to make mistakes in emotion and state of mind attribution than healthy comparison participants (p<.05).

Neuroimaging analysis revealed a significant positive association between white matter FA in the bilateral uncinate fasciculi and performance on the Eyes task, as well as a significantly negative association between the MD in the left uncinate fasciculus the Eyes task. There were no significant relationships between performance on the Eyes task and other ROIs. Further analysis of the DTI data revealed lower FA, and higher MD, of the bilateral uncinate fasciculi in individuals with TBI.

These findings suggest that the structural integrity of the uncinate fasciculus is related to performance on a well-established task of theory of mind and expand our knowledge on the white matter correlates of Theory of Mind and the neural mechanisms leading to social dysfunction following moderate to severe TBI.
Age Related Differences in Implicit Skill Learning Following Moderate-Severe Traumatic Brain Injury in Children and Adolescents

Leora Packer¹, Moran Gofer-Levi², Janna Landa², Amichai Brezner², Orly Bar², Eli Vakil², Tamar Silberg¹
¹Department of Psychology, Bar Ilan University, Israel, ²Edmond and Lily Children’s Hospital, Tel-Hashomer, Israel

Background: Skill learning (SL) is learning as a result of repeated exposure and practice. SL abilities differ across development, with profound improvement in children between 4-12 years, followed by a rapid decrement thereafter. SL should be a primary focus when addressing consequences of traumatic brain injuries (TBI) in children, considering its importance in daily functioning. Research suggests that skills not yet developed are more vulnerable to disruption after injury than skills that have already been established. However, little investigation has been done to understand the implications of childhood TBI on SL abilities, and even more specifically, whether these abilities are related to child's age at injury.

The objectives of the current study were to examine: (1) the ability of children following moderate-severe TBI (ms-TBI) to acquire implicit skills using the serial reaction time (SRT) task, and (2) the effect of age at injury on child's ability to acquire new skills.

Methods: Participants were 30 children following ms-TBI (30% girls), aged 9-17yrs (M=14.2; +/-2.9) and 28 healthy controls (35% girls), aged 9-17yrs (M= 13.1; +/- 3.5). Children in the ms-TBI group were recruited from a Pediatric Rehabilitation Department at the Sheba medical center, Israel. Children in the control group were recruited from local mainstream schools. Children in both groups were divided into two groups of above and below 12 years at the time of injury and tested individually using a computerized version of the SRT task.

Results: A marginal improvement in performance was found in both TBI and control groups. Yet, children following TBI were significantly slower than controls. In addition, an age-related effect on SL was found in the TBI but not in the control group. Specifically, improvement in performance among children injured under age of 12 years was a result of a more general decrease in reaction time, indicating they did not learn the implicit sequence. In contrast, children injured above age of 12 years demonstrated an explicit and implicit learning curve similar to that of controls. No significant associations were found between length of coma or the time elapsed since injury on child's ability to acquire a new skill.

Conclusions: Children following ms-TBI are slower in their ability to acquire a new skill; however, they do seem to possess a general mastery of the task indicating an ability to improve performance across repeated learning trials. Yet, differences in skill acquisition abilities were related to the child's age at injury. Children younger than 12 years did not seem to learn an implicit sequence compared to children above 12 years-old at the time of injury. Understanding age related differences in SL abilities in children after TBI is critical to guide rehabilitation and educational professionals in creating efficient and effective intervention plans.
The Development of Recommendations for the Care of People Who Are Homeless or Unstably Housed and Living with the Effects of Traumatic Brain Injury

Carolyn Lemsky, Darlene Jenkins, Ben King, Caitlin Synovec, Jan Caughlan, Lillian Gelberg, Steven Hwang, Sue Lapore, Tom Tatlock

1Seaton Healthcare Family, Austin, United States, 2National Health Care for the Homeless Council, Nashville, United States, 3Community Head Injury Resource Services of Toronto, Toronto, Canada, 4University of California, Los Angeles, Los Angeles, United States, 5St. Michael’s Hospital, Toronto, Canada

There is a growing body of evidence indicating that a substantial proportion of people served by programs designed to address homelessness have history of brain injury with cognitive and neuro-behavioural impairment. A study conducted in Toronto, Canada, found that 58% of men and 42% of women experiencing homelessness had a history of TBI, with the first TBI occurring before the onset of homelessness (Topolovec-Vranic et al., 2013). History of brain injury is associated with greater problem complexity and more chronic homelessness. Brain injury is often an invisible disability. Unless brain injury is properly recognized and managed, it may present a significant barrier to gaining access to essential community services and appropriate health care.

Evidence-based guidelines generally fail to take into consideration the unique challenges presented by homelessness which may limit access to needed services and/or adherence to a plan of care. With funding provided by the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services, the Health Care for the Homeless (HCH) Council has developed and revised recommendations for the management of a number of health problems that are common among people experiencing homelessness and present particular challenges for their service providers. Other recommendations developed by HCH are available at: https://www.nhchc.org. In 2018, HCH completed guidelines to address the specific needs of people who are living with brain injury and are homeless and marginally housed.

The purpose of the practice recommendations are to assist professionals, program administrators, and other staff members working with homeless people to recognize and accommodate disability resulting from brain injury. The recommendations were designed to accommodate the varying levels of health and social services made available through homelessness services. The recommendations are also designed to accommodate professionals with diverse backgrounds and levels of formal training.

Recommendations for screening for brain injury, assessing functional and cognitive abilities and adapting communication, intake and client-care and clinical processes are provided in three levels; Basic level for programs with minimal resources; Specific level for programs with some case management and social service resources; and Specialized for programs with dedicated resources and access to interdisciplinary care. The document also includes references to existing evidence-based guidelines for medical care and rehabilitation along with suggestions for how to adapt care for the homeless.

This presentation will provide an overview of the unique challenges faced by health care providers serving people who are homeless or marginally housed as they relate to serving people with a history of brain injury. The recommendations developed by the Advisory Committee on Adapting Clinical Practice for the Care of Homeless Patients with Traumatic Brain injury will be introduced, along with the process used to develop them.
Café-IN: Center of Exchange and Sharing for the Social Inclusion of People with Traumatic Brain Injury

Alice Pellichero1, Frédérique Poncet2, Benoît Durant3, Olivier Piquer3, Emilie Jolicoeur1, Marie-Josée Levert4, Marie-Eve Lamontagne1

1Cirris, Quebec, Canada, 2Université concordia - Laboratory for Adult Development and Cognitive Aging Montréal, Montreal, Canada, 3Association Des Traumatisés Cranio cérébraux Des Deux Rives, Québec, Canada, 4Centre interdisciplinaire de recherche du Montreal Metropolitain (CRIR) Montreal, Montreal, Canada

Social inclusion of people with traumatic brain injury (TBI) remains a challenge. Associations of people living with TBI aim to support their members to have a satisfy participation in the community. However, most of their activities take place inside the associations and stimulate interactions between members. The associations struggle to allow people living with TBI to be included in the society. To improve the inclusion of its members, the association ‘TCC des Deux-Rives’ (ATCCDR) designed an innovative activity, the ‘Café-In’. The ‘Café-In’ is a club café operated by TBI members, which aims to open these members to the community through activities of exchange and sharing with partners of various community organizations (e.g., Aboriginal people, mental health issues, arts interests, etc.), who are invited to discuss about their living environments. Considering the innovative aspect and the potential for generalization of this activity to other TBI associations, assessing acceptability and effectiveness of this social innovation was required.

The purpose of this project is to model and experiment the ‘Café-In’ to evaluate its effectiveness in supporting participation and social inclusion of people living with TBI. The following 3-step sequential process and methodologies will be used: Study 1) will be a cross-sectional study with n=8 participants with TBI to evaluate the effectiveness of cognitive rehabilitation strategies throughout a cooking workshops based on the cognitive rehabilitation’s principles. Evaluations will be conducted before and after the workshops by two occupational therapists. Study 2) will aim to explore the perception of TBI members about their inclusion in their community. After each Café-IN session, people living with TBI will be asked to keep a registered diary to document their perception of their community integration (n = 40 newspapers) in order to understand the perceived effect of participation in the Café-In on the community integration of people living with TBI. Study 3) will explore community members’ perceptions of their participation after their implication in the Café-In. Comments will be recorded, transcribed, and analysed thematically.

The proposed protocol outlines the steps to assess the acceptability and effectiveness of the Café-In, methods to explore the perception of members with TBI and members of the community, and a plan for implementing this innovative activity to other organizations. At the end of this project an innovative activity, which can be sustained for the benefits of TBI members would be modelled. Results of the project would be synthesized in an awareness guide and will be distributed to partner organizations and other community organizations and associations with TBI members. Finally, this guide will serve as a reflective document about social inclusion of people from diverse backgrounds.
Supported Living After Brain Injury: 20+ Years of Lessons Learned

Audrey Nelson¹
¹Reality Unlimited, LLC, Eau Claire, United States

How would a person who has experienced brain injury run a company that provides residential care for individuals with brain injury? Audrey Nelson will share the lessons she has learned doing just that for the last 23 years at the company she owns and operates, Reality Unlimited, LLC.

The significant data related outcomes during 23 years of operation to be shared are a very low incidence of Worker’s Compensation claims (no loss time incidents), no injury/harm to any residents and successful behavior plans that are based on specific person-centered assessments and approaches.

Environmental and staffing approaches to behavior that have been found to be successful, in spite of working with individuals with challenging and violent behaviors, will be shared. Specific architectural considerations, room décor issues, responses to violence, the use of popular (non-clinical) movies & books for staff training, as well as how to teach effective strategies will all be part of the presentation.

These successful approaches are universal and are based on simple concepts such as: All Behavior is Communication, Everyone needs to feel Safe & Free at the same time, check your own response to a behavior and Never Say Never-only, "How can I help you meet your goal?"
Catatonic Features after Brain Injury: A Review of the Literature and Proposed Approach to Diagnosis and Treatment in the Neurorehabilitation Setting

Lindsey Gurin1, Emma Nally1, Keriann Shalvoy1, Katlyn Nemani1, Heidi Fusco1, Brian Im1
1NYU Langone Health, New York, United States

Introduction: Catatonia is a psychomotor dysregulation disorder in which patients have difficulty initiating and/or inhibiting behavior normally. Historically recognized primarily in psychiatric patients, catatonia is known to occur in medically ill patients and is likely underdiagnosed in this population, with some recent retrospective case analyses suggesting that more than half of catatonic hospitalized patients are not diagnosed as such during their admission. Other studies suggest that the majority of “medical catatonia” patients may have an underlying central nervous system disorder, and catatonic features may be of particular importance in stratifying and treating patients with brain injuries. This may be especially true for patients with disorders of consciousness, whose neurobehavioral deficits often overlap with those of catatonia and who in some instances respond positively to pharmacologic agents typically used in catatonia—namely benzodiazepines, zolpidem, and the glutamate NMDA receptor antagonist’s amantadine and memantine. Because the syndrome is frequently reversible, timely identification and treatment is of the utmost importance.

Methods: To evaluate rates of underdiagnosis of catatonia in an inpatient neurorehabilitation population, we retrospectively apply DSM-5 diagnostic criteria for catatonia to a series of 25 patients admitted to our acute neurorehabilitation unit over 5 years with diagnoses of disorders of consciousness following a range of severe brain injury etiologies. We additionally describe our recent experience diagnosing and treating catatonic features in several patients with severe brain injury on a prospective basis.

Results and Discussion: Diagnoses included hypoxic-ischemic injury; autoimmune encephalitis; viral encephalitis; demyelinating disease; intracerebral hemorrhage; traumatic brain injury; and frontal lobe meningioma. We discuss treatment outcomes using lorazepam, zolpidem, amantadine, and memantine. We address common barriers to diagnosis and treatment including adequate recognition; family buy-in; and the absence of a standardized treatment protocol for catatonic features in this patient population, who may show differential responses to benzodiazepines and NMDAR antagonists as a result of their underlying brain injuries. We discuss the difficulty of disentangling catatonic features from brain injury-related static cognitive and motor deficits and specifically discuss the phenotypic overlap with disorders of consciousness. We review the state of the science on proposed theoretical mechanisms of catatonia and potential parallels with proposed mechanisms of disorders of consciousness after brain injury. Finally, we propose a pilot study screening for catatonic features in all patients admitted to our acute inpatient neurorehabilitation unit and suggest a standardized treatment algorithm for brain injury patients in whom catatonic features are identified. Catatonia represents a potentially reversible contributor to persistent neurobehavioral deficits after brain injury, and appropriate recognition and treatment of its characteristic features offers a potential avenue for improving function and reducing lasting disability.
Rehabilitation for Life: Continuing Recovery of patients with a Severe Brain injury Over and Beyond a Ten-Year Period

Lindsey Neal1, Anna Cook1, Chanth Seyone1, Deborah Tang1

1Mind Forward Brain Injury Services, Mississauga, Canada

Background and Aims: The impact of brain injury is life-long, and recovery follows the same time course. While it was once believed that the rehabilitation period lasted up to two years maximum, newer research suggests otherwise (Olver, 1996). In this paper, we present both qualitative and quantitative data on severely brain injured residential clients with severe aggression and behavioural challenges initially on admission to the program. After long-term (decades) multimodal management, we show a significant improvement on quality of life, which demonstrate that recovery from brain injury is lifelong.

Methods: Using a multidisciplinary approach, our clinical team of a neuropsychiatrist, neuropsychologist, social worker, and behaviour therapist, work closely with the residential manager, residential team leader (senior staff) and front-line residential staff to provide consultation and program recommendations at bi-weekly meetings. We collect extensive data on behaviours; antecedent; other psychiatric and medical comorbidity; psychopharmacological management titrated to neuropsychiatric improvement; community involvement; use of resources; and safety of patients, staff and community to name a few to ensure that our treatments remain effective and promote recovery in the long term. A main focus of our approach includes individualized programming using a behaviour support system focused on using an antecedent approach to behaviour management – such as environmental control, incorporating structure and routine (i.e. showers/ ADL’s, etc.) and consistent responses to maladaptive behaviour. This used in combination with carefully monitored psycho-pharmacological intervention promotes and reinforces adaptive/functional replacement behaviours.

Results: Our data demonstrates significant improvement in aggression and other neuropsychiatric parameters of improved functioning in clients with a severe brain injury over a ten-year period. This behavioural stabilization allowed for functional and rehabilitative improvements such as increased ADL independence (presented in one case study) and increased opportunities for engagement (presented in a second case study).

The case studies presented illustrate that with continued and long-term support, ABI survivors can continue to make functional and rehabilitative gains, long after the initial two-year post-brain injury recovery period. Our work also shows that long term behavioural and psychopharmacological intervention can make a huge impact in stabilizing and a continually improving the quality of life for these clients.

Conclusions: Brain injury is a chronic disability that requires life-long support. Although recovery following the two-year period after injury is slower, gains can continue to be made. Our data support the theory that the application of a long-term, dynamic, multidisciplinary support system enables brain injury survivors to continue to make qualitative and functional gains several years post injury.
Using Behaviour Change Theory to Understand Factors Influencing Screening of Traumatic Brain Injuries Among Women Who Have Experienced Intimate Partner Violence

Blake Nicol¹, Paul van Donkelaar¹, Karen Mason², Heather Gainforth¹

¹University of British Columbia Okanagan, Kelowna, Canada, ²Kelowna Women's Shelter, Kelowna, Canada

Background: Women who experience intimate partner violence (IPV) are at a high risk for traumatic brain injury (TBI). Women's shelters that provide support to women experiencing IPV may be an ideal location for TBI screening and resource delivery. However, little to no TBI screening is being done at women's shelters. Behavior change theory has potential to help us understand factors that influence screening at women's shelters and develop interventions to promote screening.

Objective: To use behavior change theory to understand current practices for and factors influencing screening for TBI among staff that work at Women’s Shelters across Canada.

Methods: Participants were staff who work at women's shelters across Canada and attended the National Women’s Shelters Canada National Conference. Upon registration, participants completed an online survey that assessed current TBI screening behaviours, knowledge of TBIs, theoretical factors influencing screening (rated on 7-point Likert scale), and demographic and job details. Surveys were co-designed with a decision maker in a women's shelter and informed by the Theoretic Domains Framework.

Results: Fifty-five participants responded to the survey (Mean age = 45.93 years, SD = 11.03; 100% women). On average, participants worked with clients who have experienced IPV for 15.26 years (SD = 9.66). Only 20.40% of participants had ever screened for TBIs in their work. On average, participants scored 68.21% (SD = 9.39) on the assessment that examined knowledge of TBI signs and symptoms and facts. Regarding factors that support screening, findings indicate that participants want to screen for TBI (Mean = 4.09; SD = 2.63), see screening as a part of their role (Mean = 4.26; SD = 2.45), are confident in their ability to screen (Mean = 4.52; SD = 2.47), and believe that screening will benefit their clients (Mean = 5.70; SD = 1.96). Regarding factors hindering screening, findings indicate that participants are nervous to screen (Mean = 4.50; SD = 2.48), and lack resources (Mean = 3.00; SD = 2.39), training (Mean = 2.21; SD = 2.03), rewards (Mean = 2.33; SD = 2.24), and knowledge (Mean = 2.94; SD = 2.22).

Conclusions: Screening for TBI in women’s shelters is rare and staff’s knowledge about TBIs is lacking. While motivation to screen is present, interventions are needed to promote screening among women’s shelter staff. Interventions need to focus on providing training, resources, and incentives to screen. Interventions will also need to address participants’ worries about screening clients for TBI. Findings will be used to co-develop interventions to support screening of TBIs among women’s shelter staff across Canada. Ultimately, findings may help to improve the support given to women who have experienced IPV and TBI.
Mild Chronic Traumatic Encephalopathy Neuropathology in People with No Known Participation in Contact Sports or History of Repetitive Neurotrauma

Grant Iverson², Pekka Karhunen³, Rudolph Castellani⁴, Teemu Luoto¹

¹Department of Neurosurgery, Tampere University Hospital and University of Tampere, Tampere, Finland, ²Department of Physical Medicine and Rehabilitation, Harvard Medical School; Spaulding Rehabilitation Hospital; MassGeneral Hospital for Children™ Sports Concussion Program; & Home Base, A Red Sox Foundation and Massachusetts General Hospital Program, Boston, United States, ³Department of Forensic Medicine, Faculty of Medicine and Life Sciences, University of Tampere; Fimlab Laboratories and Finnish Cardiovascular Research Center Tampere, Tampere, Finland, ⁴Department of Pathology, Anatomy and Laboratory Medicine; Department of Neuroscience, Rockefeller Neuroscience Institute; West Virginia University School of Medicine, Morgantown, United States

Background: It has been asserted that Chronic traumatic encephalopathy (CTE) pathology is only present in former athletes and others who have been exposed to repetitive concussions, subconcussive blows, or both. However, researchers have recently reported that similar pathology is also present in people who have now known exposure to repetitive neurotrauma. We hypothesized that CTE pathology would be present in men who had no known history of repetitive neurotrauma.

Methods: Comprehensive medical record reviews and health surveys completed by a family member were completed for the eight men in this case series. Post-mortem tissue from multiple brain regions was immunostained for hyperphosphorylated tau (p-tau) to assess for CTE pathology, Braak stage, and aging-related p-tau. Tissue was immunostained for amyloid-β to approximate Thal amyloid phase and CERAD plaque score. The National Institute on Aging-Alzheimer’s Association 2012 consensus recommendations for Alzheimer’s disease neuropathologic changes were used. TDP-43 immunohistochemistry was performed on medial temporal lobe including hippocampus. Amyloid-beta precursor protein and neurofilament protein immunostains were performed to evaluate for possible axonal trauma. Alpha-synuclein immunostains were performed to rule out synucleinopathy. Basal ganglia were stained with the Prussian blue reaction for iron.

Results: Six of the eight cases (i.e., 75%) showed p-tau in neurons, astrocytes, and cell processes around small blood vessels in an irregular pattern at the depths of the cortical sulci. The changes were focal and limited in terms of overall extent. Two of the eight cases had a history of traumatic brain injury and one of them showed CTE pathology. Five of the six cases (83%) with no known history of neurotrauma met consensus criteria for CTE.

Conclusion: This study adds to the emerging literature indicating that CTE pathology (or CTE-like pathology) is present in people not known to have experienced multiple concussions or subconcussive blows to the head.
Investigating the Influence of Cannabis on Symptoms of State Anxiety in Individuals with Mild Head Injury

Rachel Luczon1, Ushna Saeed Saheed1, Mahenoor Jadgal1, Dawn Good1
1Brock University, St. Catharines, Canada

State anxiety reflects an individual’s emotional state that is characterized by perceived feelings of apprehension and tension, and increased physiological arousal (Horikawa & Yagi, 2012). However, individuals with chronic generalized anxiety disorder (GAD) have been found to have lower levels of physiological arousal and respond to psychological stressors with autonomic inflexibility (i.e., decreased variability - Mcleod & Hoehn-Saric, 2000). Other literature has reported that individuals with mild head injury (MHI) also experience increased anxiety levels (Murray & Good, 2017) and present with lower levels of baseline physiological arousal but respond to unanticipated evocative stressors with an exaggerated startle response (Baker & Good, 2014). Indeed, up to 70% of individuals who experience traumatic brain injury are diagnosed with a clinical anxiety disorder (e.g., Hsieh, Ponsford, Wong, Schonberger, McKay & Haines, 2012). Emerging research indicates that individuals experiencing anxiety disorders are more likely to engage in cannabis use with the view that it can help ameliorate their anxiety symptoms (Kedzoir & Laeber, 2014). Alternatively, it has been argued (Bobadilla & Taylor, 2007) that individuals with lower physiological activation experience this state as negative affect and will engage in greater impulsive or risk-taking behaviours, including increased cannabis use, in order to increase activation and subsequently experience anxiety.

The present study aimed to replicate the finding that individuals with MHI would present with lower levels of physiological arousal and enhanced anxiety relative to their non-MHI cohort. In addition, it was investigated whether these factors were related to one another and to an increased engagement in the use of cannabis. It was predicted that these factors would be related since low EDA (electrodermal activity) is associated with decreased anticipation of, and greater reactivity to, outcomes. This reactivity may be experienced as heightened arousal or an anxiety-based state. An individual’s cannabis use would correlate with anxiety state and level of autonomic arousal. 281 students (32% MHI) were recruited for assessment of EDA and completed various self-report questionnaires assessing state anxiety and recreational drug use. Individuals reporting a previous MHI presented with lower baseline EDA (r = -.753, p < .001) compared to non-MHI students. Further, individuals with lower baseline EDA endorsed proportionally increased levels of state anxiety F(1, 158) = 4.68, p < .05, and cannabis use F(1, 158) = 4.01, p < .05, compared to those with typical baseline EDA. These findings have implications for the potential vulnerability of having decreased physiological arousal as a precursor to increased symptoms of state anxiety and overreactivity to anxiety-provoking stimuli, particularly for those who experience MHI. Further, these individuals demonstrate increased risk for engaging in cannabis use perhaps to alleviate their symptoms of anxiety, but potentially introducing a cycle of induced anxiety (Papini et al., 2017).
Increased Physical Aggression Among University Athletes with a History of Repetitive Mild Head Injury

Caitlyn Gallant, Dawn Good

Brock University, St. Catharines, Canada

Among athletes, the incidence of repetitive mild head injury (MHI) is common—research indicates that the likelihood of multiple MHIs is three times greater among athletes with a prior history of injury compared to those without (Guskiewicz et al., 2003) and that this risk is elevated among high-impact athletes, such as football players (Zemper, 2003). In recent years, it has also been demonstrated that repetitive mild trauma can have aggregate effects (Talavage, Nauman, & Leverenz, 2016), resulting in accumulated disruption and more severe symptomatology than a single MHI (Talavage et al., 2014). Indeed, the notion of a spectrum of head injury severity (Iverson & Lange, 2011) suggests that an individual will be more vulnerable to a lower symptomatic threshold as pathophysiological changes are accrued (Talavage et al., 2016); accordingly, repetitive MHIs have been associated with greater memory impairments (Iverson, Gaetz, Lovell, & Collins, 2004) and poorer performance on measures of cognitive flexibility and speeded processing (Collins et al., 1999). Much less is known about the relationship between repeated MHI and affective outcomes, such as emotional dysregulation. Subtle disruption via MHI has been found to be associated with dampened autonomic function (electrodermal activity [EDA]) and the subsequent processing of affective information (e.g., van Noordt & Good, 2011) and reactive aggression, whereby individuals with lower levels of EDA have been found to exhibit heightened reactivity when provoked compared to those with higher levels of arousal (Gallant, Barry, & Good, 2018). Together, these findings imply that individuals with a history of multiple MHIs may be more underaroused than those with a history of a single MHI and therefore, they may be more vulnerable to aggressive overreaction.

The current study examined the relationship between repetitive MHI and three types of aggression (physical aggression, verbal aggression, and aggressive attitude) in a university cohort. Eighty participants completed a series of questionnaires including the Personality Assessment Inventory (PAI; Morey, 1991) and baseline indices of autonomic arousal. Results indicated that individuals with a repetitive MHI had significantly higher scores on the physical aggression subscale of the PAI and lower levels of EDA compared to individuals with a history of only one MHI. Moreover, when EDA was included in the first step of the model, a history of multiple MHIs was no longer predictive of physical aggression. Taken together, these findings imply that students with a history of multiple MHIs exhibit higher levels of physical aggression, rather than other forms of aggression. Further, these results indicate that this heightened reactivity may be due to physiological underarousal and a heightened startle response, rather than premorbid aggressive tendencies.
Introduction: Clinical practice guidelines (CPG) derived from scientific knowledge are more likely to be implemented if they fill practice gaps deemed important by clinical teams. In order to promote implementation, knowledge-to-practice gaps were identified and prioritized by acute and rehabilitation TBI healthcare provider organizations via an online survey. Obstacles to filling these evidence-to-practice gaps were identified; lack of access to targeted funds and staff time were frequent barriers.

Methodology: The organizations who completed the online survey were invited to apply for catalyst grants to implement one or more recommendations from the CPG. The details of the implementation projects were determined by each site based on local relevance, prioritization and feasibility. The amount of the catalyst grant was purposely set to provide one-time funding support without creating dependence. Projects were required to follow an implementation framework with attention to planning, data collection and sustainability. All successful projects were required to have their clinical and implementation tools freely available through the CPG website and write-up their project as a casebook, so others could replicate their methods. All projects had access to an implementation specialist as part of the catalyst grant to advise and support the implementation planning and activities.

Results: Ninety-two percent of the online survey respondents submitted a catalyst grant application and 82% of proposed projects were funded. These projects ranged from implementation of clinical practice recommendations to system-level cross-sector recommendations, and from urban to small-urban settings across the province. Stakeholder identification and engagement were key activities and all projects involved persons with lived experience in the project development process. The degree of senior leadership and direct manager involvement had a direct influence on the success of the project. All projects collected baseline data (i.e., chart audit, staff and patient surveys) as well as process and outcome clinical and implementation data, including on feasibility and sustainability. The data indicate over 80% of site respondents reported the implemented change as a feasible and sustainable improvement. At every site the new practice was embedded as common practice. For those projects addressing system-level change, new cross-sector networks and practices were developed to allow for more efficient care for complex patients with TBI and mental health and/or addiction problems. Care was taken to address issues of privacy and confidentiality and obtain institutional agreements to participate in the new networks.

Discussion: This work has confirmed that targeted effort involving careful planning, broad stakeholder engagement, additional resources and funding, process and outcome data collection, and sustainability planning were necessary to implement practice changes. By having grant recipients have their methods and tools available online, spread and scaling of the implementation efforts is more likely. There has already been interest from new sites to work on implementation projects.
Somatization Following Head Injury: Severity of Somatization Symptomatology Associated with Sympathetic Under Arousal

Sean Robb, Dawn Good

Brock University, St. Catharines, Canada

Many who experience long-term post-concussive symptomatology (PCS) following mild head injury (MHI), the miserable minority, also report symptoms consistent with somatization. Even so, considerable debate exists regarding the relationship between head injury and somatization. Nelson et al. (2016), and other researchers, have argued that a person’s long-term PCS may reflect their tendency for pre-injury somatizations, while others have argued that PCS may reflect an underlying disconnection syndrome resulting from the injury per se (e.g., McCrea et al., 2013; Weber et al., 2018). The term somatization, originally proposed by Wilhelm Stekel (1921; cited in Bos & Groenendijk, 2004), describes a person’s tendency to report psychological distress from somatic symptoms, but implies, at least historically, that these somatic symptoms have no “organic” medical etiology. Current understanding of somatization reflects a greater appreciation of the central nervous system’s role in this phenomenon, and does not require no medical explanation (APA, 2013).

As such, we propose the following: first, for many individuals, an elevated tendency for endorsing somatic symptomatology postinjury reflects an autonomic underarousal (AU); second, more precise terminology is required to describe this somatic underarousal so as to avoid confusion with the historical view that deems symptoms as still lacking an “organic” etiology. In our prior work, individuals with MHI were found to be sympathetically underaroused at rest and in anticipation of decision-making, similar to that observed in orbitofrontal cortex (OFC) lesion populations (Bechara et al., 1996; 2004). The OFC is both highly vulnerable to traumatic injury as well as being important for modulation of sympathetic arousal through its connections with the brain stem via the limbic system (Wallis, 2007). We previously found evidence that this somatic disturbance is related to AU, and that phenomenologically different clinical presentations of depression symptoms are observed postinjury (i.e., more somatic than affective) relative to their noninjured cohort.

The current study focuses on somatization subscales in measures of psychopathology and its relationship to AU in individuals with and without MHI. 325 participants (35% with MHI) were recruited from the University setting to complete a series of neuropsychological and self-report psychopathology measures (SCL-R-90, BDI, PAI) and measures of sympathetic arousal (e.g., electrodermal activation [EDA]). Individuals with MHI were found to have AU and endorsed more symptoms of somatization on measures of the PAI. Moreover, the relationship between indicators of injury severity (e.g., duration of LOC) and somatization was completely mediated by AU at baseline. Conversely, no relationship between somatization symptoms and AU were found in individuals without MHI. These findings imply that mechanisms for psychiatric symptoms postinjury reflect different underlying etiologies than that observed within the non-neurally compromised populations, with autonomic underarousal likely reflecting a key etiological contributor to psychiatric presentations, and potentially requiring very different treatment approaches.
Brain Injury Rehab in the Community and its Complexities: The Interconnection of ABI, Mental Health, and Addictions

Mike Redgers, Andrea Ure, Anna Cook, Chanth Seyone, Deborah Tang

1Mind Forward Brain Injury Services, Mississauga, Canada

Background and Aims: Acquired Brain Injury, mental health, and addictions are multifaceted, requiring a multidisciplinary approach. Currently these disorders have been managed by different systems of care; however, there exists a need for a comprehensive model that is able to treat comorbid disorders as primary. The purpose of this study is to examine the complexities of providing community-based rehabilitation and the interrelation among ABI, mental health, and addictions. Furthermore, by utilizing case studies we will demonstrate that the only way to perpetually enhance the lives and rehabilitation goals of the individual is to treat comorbid disorders holistically.

Methods: We provided community-based rehabilitation support for individuals living in the community with an ABI through a Supported Independent Living (SIL) program. The program is facilitated by five full-time staff, two case managers, and operates seven days a week. Each staff support up to seven clients daily, based on client schedules and identified needs. SIL staff have received a variety of specialized training focused on ABI rehabilitation, mental health, and addictions.

Results: The SIL program provided support to 39 individuals. Within this population, it was discovered there was a mental health prevalence of 80% and an addiction prevalence of 49%. By collaborating with a multidisciplinary team of professionals from the community, client specific support was designed to reflect needs. The program has thus far maintained a 100% success rate in supporting individuals to maintain their independence, and an 85% success rate for individualized goal attainment. However, it is vital to note that the success of these individuals vary significantly. Specific case studies will be drawn upon regarding the complexity of service and degree of success.

Conclusions: By utilizing a multidisciplinary and holistic approach, the SIL program has demonstrated the ability to effectively support individuals with ABI, mental health, and addictions in the community. In order to improve upon the support that is being provided, service providers must be prepared to treat all comorbid disorders as primary. Strategic community partnerships must be developed and a comprehensive model of care must be utilized.
The Incidence of Chronic Subdural Hematomas from 1990 to 2015 in a Defined Finnish Population

Minna Rauhala1, Teemu Luoto1, Heini Huhtala2, Grant Iverson3, Tero Niskakangas4, Juha Öhman5, Pauli Helén4
1Department of Neurosurgery, Tampere University Hospital and University of Tampere, Tampere, Finland, 2Faculty of Social Sciences, Biostatistics Group, Tampere University, Tampere, Finland, 3Department of Physical Medicine and Rehabilitation, Harvard Medical School; Spaulding Rehabilitation Hospital; & Home Base, A Red Sox Foundation and Massachusetts General Hospital Program, Boston, United States, 4Department of Neurosurgery, Tampere University Hospital, Tampere, Finland, 5Faculty of Medicine and Life Sciences, University of Tampere, Tampere, Finland

Objective: To determine the population-based epidemiology of chronic subdural hematoma (CSDH) over a 26-year period.

Methods: A retrospective study of all adult patients [≥ 18 years old Pirkanmaa (Finland) residents] with a diagnosis of CSDH between 1990 and 2015. The cases were identified by using ICD-codes. Detailed data collection was performed from medical records and death certificates. All patients were followed until death or the end of year 2017. The annual number of inhabitants in the Pirkanmaa region was obtained from the Statistics Finland (Helsinki, Finland).

Results: A total of 1,168 patients with CSDH were identified. From 1990 to 2015, the overall incidence doubled from 8.2 to 17.6/100,000/year. Among the under 70-year old population, the incidence remained quite stable, whereas the incidence clearly increased among the over 80-year old population, from 46.9 to 129.5/100,000/year. The median age for a CSDH diagnosis increased from 73 to 79 years during the 26-year period. Head trauma was documented in 59% of cases. A ground-level fall was related to the CSDH in 31% of those under the age of 60 and in 54% of those over the age of 80. The proportion of alcohol-related cases decreased toward the end of the study period (1990-1995: 16% and 2011-2015: 7%), because alcohol abuse was less frequent among the growing group of elderly. In contrast, the percentage of patients on antithrombotic medication almost doubled toward 2015 (1990-1995: 27% and 2011-2015: 49%), mostly due to an increase in anticoagulation (1990-1995: 9% and 2011-2015: 28%). The patients’ neurological condition on admission, based on both Glasgow Coma Scale (GCS <13 1990-1995: 18% and 2011-2015: 7%, p<0.001) and the modified Rankin Scale (mRS 0-2 1990-1995: 8% and 2011-2015: 19%, p<0.001), was better in recent years compared to the early 1990s.

Conclusions: From 1990 to 2015, the incidence of CSDH has increased markedly. The incidence of CSDH among the population aged 80 years or older has nearly tripled since 1990. The use of anticoagulants has increased but there has been no change regarding the ratio between a traumatic and a spontaneous CSDH etiology. As the world population becomes progressively older, the increasing incidence of CSDH will be a burden to patients and a future challenge for neurosurgical clinics.
"Miracle Workers": Managing Expectations in Disorders of Consciousness

Sheital Bavishi¹, Erin Montgomery², Lisa Sewell³, Meghan Maclean⁴, Tracy Shannon⁵, Sara Enright⁶

¹The Ohio State University Wexner Medical Center, Columbus, United States, ²The Ohio State University Wexner Medical Center, Columbus, United States, ³The Ohio State University Wexner Medical Center, Columbus, United States, ⁴The Ohio State University Wexner Medical Center, Columbus, United States, ⁵The Ohio State University Wexner Medical Center, Columbus, United States, ⁶The Ohio State University Wexner Medical Center, Columbus, United States

Disorders of consciousness (DOC) patients are a complex group. Patients that are admitted to the DOC program have been through a great deal as have their families. This brings on high expectations of the rehabilitation professionals working with these patients. The term “miracle workers” became a recurring phrase many used to describe our clinicians and program. While at first the term seemed to be the ultimate compliment, it quickly became an unwanted label that misguided patient and family expectations. When working with families of those in the DOC program we need to ascertain the family’s understanding of the patient’s current level of functioning (e.g., what terminology have they heard, what do common terms such as “minimally conscious” mean to them?), what language are we using in rehab that may be confusing (e.g., what are “team meetings”, what does a “family meeting mean?...Why are we already discussing discharge plans?”) and lastly what have they been told about recovery trajectory.

It is the job of the DOC team to find out what expectations have been placed on the team and quickly align them to more realistic outcomes of DOC patients. Collaborative meetings were established with the DOC team and with patients’ families to establish more realistic ideas of what rehabilitation looks like for these patients, need for training families to care for DOC patients in their current state, community resources, and neuro recovery “helpers”. A focus group was created with representation from an interdisciplinary team: Physiatrist, Rehab Psychologist, Speech Language Pathologist, Occupational Therapy, Physical therapy, and Rehabilitation Manager.

Each discipline in our program has created specific training/education for the families in order to discuss various aspects of care. Our goal of this oral presentation is to share with clinicians how formalized education and processes can help to foster realistic expectations and outcomes for DOC patients. Our panel of Physician, Therapists, Nursing, and Rehabilitation Psychologist will discuss their specific roles in education and training of the families. It is our intention to share an educational checklist and evaluation tool which will streamline the effective education of family members of DOC patients so as to provide for the best patient outcomes possible.

Areas of focus for oral presentation:
Physician discussion with families prior to and on admission of program and goals of care
Length of stay (average LOS and extensions)
Documentation re: insurance and justification of care
Neuro recovery-based therapy vs family training and education including a specified timeframe for these individual intervention focuses
Nursing education check list
Rehab Psychology education on DOC, recovery, and outcomes
Family meetings
Team meetings
Scripts for delivering information
Women Survivors of Intimate Partner Violence and Traumatic Brain Injury: Addressing Gaps in Knowledge and Support

Halina (Lin) Haag, Nora Cullen, Silvia Samsa, Nneka MacGregor, Geoff Sing, Angela Colantonio

Wilfrid Laurier University, Kitchener, Canada, University of Toronto, Toronto, Canada, West Park Healthcare Centre, Toronto, Canada, Women at the Centre, Toronto, Canada, The Cridge Centre for the Family, Victoria, Canada, Women’s Habitat, Etobicoke, Canada

Background: Every year thousands of women experience intimate partner violence (IPV), receiving injuries such as battery to the face, head, and neck, a pattern of violence potentially causing permanent traumatic brain injury (TBI). While the connection between TBI and IPV remains largely unexplored, early investigation has identified elevated TBI rates (35-80%) in women survivors of IPV. Research addressing the identification and support of women survivors of IPV with resultant TBI is extremely limited worldwide, and to date, no Canadian data, other than this team’s recent work, has been identified. Further investigation has been recognized as a priority, however, very little has been done to examine this unique condition and the implications for support providers such as community-based agencies focused on housing, healthcare, and legal services, particularly within a Canadian context. This gap in understanding and service leaves women survivors of IPV vulnerable to increased rates of repeat violence, permanent disability, criminal justice system engagement, unemployment, homelessness, poverty, and mental illness.

Objectives: Our principal objective was to address knowledge and support gaps identified in our previous study, the current literature, and by our community partners in an effort to improve the wellbeing of brain injured women survivors of IPV. The project’s goal was to develop, implement, and evaluate a TBI toolkit for front line workers serving women survivors of IPV.

Method: Building on our previous results, this study utilized qualitative methodology to seek design and content input. Semi-structured interviews and focus groups with key stakeholder groups including women survivors of IPV, agency management and front-line staff were arranged through our existing TBI/IPV networks. These consultation sessions were recorded and transcribed and two team members analysed the data, identifying emergent themes. Further consultation during the toolkit design phase and testing provided invaluable member checking opportunities.

Results: Two groups of themes emerged: 1) practical ones providing direct input into the content and format suggested for a useful toolkit; and 2) broader themes addressing service provision, risk, and societal education needs. Based on these themes a website was designed to provide educational opportunities, practice materials, and referral information for frontline workers serving women exposed to IPV. The findings from this study will be presented along with the website itself.

Implications: This project has direct implications for service provision for women exposed to IPV with resultant TBI. It also provides recommendations for further research agendas and highlights the need for broader educational campaigns with targeted audiences.
Mild Traumatic Brain Injury Exacerbates Limbic and Paralimbic System Microstructural Alterations in Veterans with Post-Traumatic Stress Disorder

Valerie Sydnor1, Sylvain Bouix3, Ofer Pasternak1, Elisabeth Hart1,2, Laura Levin-Gleba1,3, Benjamin Reid1, Yorghos Tripodis4, Jeffrey Guenette1,5, David Kaufmann1,6, Nikos Makris1,7, Catherine Fortier3,8, David Salat3,9, Yogesh Rathi1, William Milberg3,8,10, Regina McGlinchey3,8,10, Martha Shenton1,5,11, Inga Koerte1,6

1Psychiatry Neuroimaging Laboratory, Department of Psychiatry, Brigham and Women’s Hospital, Harvard Medical School, Boston, United States, 2Department of Neurology, University Hospital, LMU Munich, Germany, 3Translational Research Center for TBI and Stress Disorders (TRACTS), VA Boston Healthcare System, Boston, United States, 4BU Alzheimer’s Disease and CTE Center, Boston University, Boston, United States, 5Department of Radiology, Brigham and Women’s Hospital, Harvard Medical School, Boston, United States, 6Department of Child and Adolescent Psychiatry, Psychosomatics, and Psychotherapy, Ludwig-Maximilian University, Germany, 7Center for Morphometric Analysis, Departments of Psychiatry and Neurology, Massachusetts General Hospital, Harvard Medical School, Boston, United States, 8Department of Psychiatry, Harvard Medical School, Boston, United States, 9Imaging Research for Veterans (NeRVe) Center, VA Boston Healthcare System, Boston, United States, 10Geriatric Research, Education and Clinical Center (GRECC), VA Boston Healthcare System, Boston, United States, 11VA Boston Healthcare System, Brockton Division, Brockton, United States

Introduction: Post-traumatic stress disorder (PTSD) afflicts many individuals, yet the neuropathological mechanisms that contribute to PTSD remain to be fully determined. Moreover, it is unclear how exposure to mild traumatic brain injury (mTBI), a condition that is often comorbid with PTSD, particularly among military personnel, affects the clinical and neurological presentation of PTSD. To address these issues, this study explored the relationship between PTSD symptom severity and the microstructure of limbic and paralimbic gray matter brain regions, as well as the impact of mTBI comorbidity on this relationship.

Methods: Participants included 102 male Veterans from the Translational Research Center for TBI and Stress Disorders cohort diagnosed with current PTSD. All participants underwent structural and diffusion magnetic resonance imaging (dMRI), and received the Clinician Administered PTSD Scale to assess PTSD symptom severity. Diffusion images were analyzed using free-water imaging, an advanced two compartment diffusion model that estimates an extracellular compartment and a tissue compartment per image voxel. Fractional anisotropy of the tissue compartment (FAt) was calculated for 18 limbic and paralimbic gray matter regions, and the association between regional mean FAt and PTSD symptom severity was examined using FDR-corrected linear mixed-effects models. This association was examined in Veterans who had a diagnosis of PTSD only (N=54), and in Veterans diagnosed with PTSD who had a history of military mTBI (N=48).

Results: Individuals with a history of military mTBI endorsed significantly more severe PTSD symptoms than those without mTBI history. Across all participants, more severe PTSD symptoms were associated with higher FAt in the amygdala-hippocampus complex, and with lower FAt in the cingulate cortex. These associations were observed in the right hemisphere in the PTSD only group, but bilaterally in the PTSD and mTBI group. Additionally, in individuals with PTSD who were comorbid for mTBI, greater symptom severity was associated with higher FAt in the bilateral nucleus accumbens region.

Conclusions: Symptom severity appears to be influenced by the microstructure of specific limbic and paralimbic brain structures in Veterans with PTSD. While there is overlap between regions underlying symptom severity in individuals with and without mTBI, symptom load is associated with more widespread neurostructural changes, including changes in the nucleus accumbens, in those who are comorbid for mTBI.
These findings suggest that mTBI may exacerbate PTSD-related neural pathology, which may account for the increased symptom severity observed in Veterans with PTSD and mTBI. The dMRI alterations observed in the amygdala-hippocampus complex and the nucleus accumbens (increased FA), and in the cingulate cortex (decreased FA), in relation to more severe PTSD symptomatology likely reflect two distinct, stress-related neurodegenerative processes, potentially dendritic atrophy and cell density loss, respectively. Additional studies that investigate the use of dMRI measures as biomarkers of neurodegeneration in PTSD are needed.
No Evidence for TBI-Related Neurodegenerative Proteinopathy in Military Service Members or Civilians Affected by TBI

Rudolph Castellani1,2, Arushi Tripathy2, Margaret Smith2, Brittany Erskine2, Ashley Shade2, Kristi Bailey2, Abigail Grande2, Joyce DeJong2

1West Virginia University, Morgantown, United States, 2Western Michigan University Homer Stryker MD School of Medicine, Kalamazoo, United States

Recent autopsy case series in athletes have raised the issue of progressive neurodegenerative proteinopathy as a consequence of single or repetitive traumatic brain injury (TBI). Supporting this paradigm is the observation that moderate and severe TBI pose a risk for AD in a dose-dependent fashion. On the other hand, clinical signs downstream of repetitive neurotrauma are inconsistent or absent, and the AD risks following TBI in large scale epidemiological surveys are modest.

In an attempt to address this question, we examined brain tissue at autopsy from two groups of decedents (with IRB approval): 1) former military service members; and 2) unselected civilians presenting for autopsy in a large medical examiner’s office in which death investigation disclosed a TBI history. Proteinopathy burden was compared with 232 age matched controls, obtained as part of a brain procurement study for psychiatric diseases. Of 56 former military service members examined, a range of age-related accumulation of amyloid-beta and tau was noted but was not significantly different from control samples. Some degree of tauopathy was present in most cases examined, either in an age-related pattern or in a pattern of AD neuropathologic change. Scant geographic tauopathy was considered negative for chronic traumatic encephalopathy for the purposes of this study, since it is increasingly identified in people without a TBI history. Of 18 civilians who carried a TBI history as determined by death scene investigators, sixteen had single or multiple remote contusions; eleven had post-traumatic epilepsy, and two had frank dementia related to encephalomalacia from TBI, suggesting that moderate or severe TBI is over-represented in the medical examiner setting, in civilian subjects carrying a TBI history. Nine of the civilian TBI subjects had scant geographic tauopathy, occasionally within or near areas of encephalomalacia, suggesting a traumatic etiology, although these subjects did not differ from controls in terms of overall p-tau burden. The amyloid-beta burden in the civilian TBI subjects did not differ with the control sample. Next-of-kin did not report progressive neurological deterioration in any of the civilian TBI cases, although detailed neuropsychological testing is not available.

In summary, although the numbers of cases and clinical information are limited, geographic tauopathy in the post mortem brain appears to be rare in unselected military veterans, and scant in complicated civilian TBI. Brain injury severe enough to produce cerebral contusion was not associated with increased AD pathology but may be under-appreciated as a cause of morbidity and mortality in civilian TBI. Overall, we found no evidence of neurodegenerative proteinopathy related to military service per se or civilian TBI.
Serum Neurofilament Light is Elevated Differentially in Older Adults with Uncomplicated Mild Traumatic Brain Injuries

Grant Iverson1, Preethi Reddi2, Jussi Posti3, Anna-Kerttu Kotilainen4, Olli Tenovuo5, Juha Öhman6, Henrik Zetterberg7,8,9,10, Kaj Blennow7,8, Teemu Luoto6

1Department of Physical Medicine and Rehabilitation, Harvard Medical School; Spaulding Rehabilitation Hospital; & Home Base, A Red Sox Foundation and Massachusetts General Hospital Program, Boston, United States; 2Department of Biology, Emory University, Atlanta, United States; 3Division of Clinical Neurosciences, Department of Neurosurgery, and Turku Brain Injury Centre, Turku University Hospital, and University of Turku, Turku, Finland; 4Turku Brain Injury Centre, Turku University Hospital and University of Turku, Turku, United States; 5Faculty of Medicine and Life Sciences, University of Tampere, Tampere, United States; 6Department of Neurosurgery, Tampere University Hospital and University of Tampere, Tampere, United States; 7Institute of Neuroscience and Physiology, Department of Psychiatry and Neurochemistry, the Sahlgrenska Academy at the University of Gothenburg, Mölndal, Sweden; 8Clinical Neurochemistry Laboratory, Sahlgrenska University Hospital, Mölndal, Sweden; 9United Kingdom Dementia Research Institute at University College London, London, United Kingdom; 10Department of Neurodegenerative Disease, University College London Institute of Neurology, London, United Kingdom

Background: There is considerable interest in the use of blood biomarkers as diagnostic screening tests for mild traumatic brain injury (MTBI). Neurofilament light (NF-L) may have diagnostic and prognostic potential as a blood biomarker for MTBI. Elevated NF-L is associated with several neurological disorders associated with older age, however, which could confound its usefulness as a TBI biomarker. We examined whether NF-L is elevated differentially following uncomplicated MTBI in older adults with pre-injury neurological disorders.

Methods: In a case-control study, a sample of 118 adults (mean age=62.3 years, SD=22.5, range=18-100; 52.5% women) presenting to the emergency department (ED) of Tampere University Hospital with an uncomplicated MTBI were enrolled in this study. All had a Glasgow Coma Scale score of 14-15. All participants underwent head CT in the ED and showed no macroscopic evidence of injury. Within 72 hours of injury, blood was collected from participants. The mean time between injury and blood sampling was 8.3 hours (Md=3.5; SD=13.5; IQR=1.9-6.0, range=0.8-67.4, and 90% collected within 19 hours). A sample of 40 orthopedically-injured trauma control subjects recruited from a second ED also were examined. Serum NF-L levels were measured and analyzed using Human Neurology 4-Plex A assay on a HD-1 Single molecule array (Simoa) instrument.

Results: A high correlation was found between age and NF-L levels in the total MTBI sample (r=.80), within the subgroups without pre-injury neurological diseases (r=.76) and with pre-injury neurological diseases (r=.68), and in the trauma control subjects (r=.76). Those with MTBIs and pre-injury neurological conditions had higher NF-L levels than those with no pre-injury neurological conditions (p<.001, Cohen’s d=1.01). The subgroup with MTBIs aged ≥60 had higher NF-L levels than those <60 (p<.001, d=1.14). The subgroup of trauma controls aged ≥60 had higher NF-L levels than those under the age of 60 (p<.001, d=1.67). For MTBI patients with no pre-injury neurological conditions, those aged ≥60 had higher NF-L levels than those <60 (p<.001, d=1.18). For MTBI patients with pre-injury neurological conditions, those aged ≥60 had higher NF-L levels than those <60 (p<.001, d=1.12).

Conclusion: Older age and pre-injury neurological diseases are associated with elevated serum NF-L levels during the first 72 hours following uncomplicated MTBI, which limits the value of this biomarker during this time period. Given the relatively slow temporal profile for the increase in NF-L, and sustained elevation, samples taken at later time points might be more clinically useful in older adults.
Current Concussion-Like Symptom Reporting Among Former Professional Rugby League Players

Douglas Terry\textsuperscript{3,4,5,6}, Grant Iverson\textsuperscript{3,4,5,6}, Andrew Gardner\textsuperscript{1,2,3}

\textsuperscript{1}Priority Research Centre for Stroke and Brain Injury, School of Medicine and Public Health, University of Newcastle, Callaghan, Australia, \textsuperscript{2}Hunter New England Local Health District, Sports Concussion Program, Waratah, Australia, \textsuperscript{3}Department of Physical Medicine and Rehabilitation, Harvard Medical School, Boston, United States, \textsuperscript{4}Spaulding Rehabilitation Hospital, Boston, United States, \textsuperscript{5}MassGeneral Hospital for Children Sports Concussion Program, Boston, United States, \textsuperscript{6}Red Sox Foundation and Massachusetts General Hospital Home Base Program, Boston, United States

Background and Objectives: Some retired professional athletes report physical, cognitive, and emotional symptoms in their daily life. We examined the presence of symptoms in retired professional collision sports athletes and matched control participants.

Methods: 86 former Australian professional rugby league players and 36 community-based controls with no history of collision sport participation or neurotrauma completed the Rivermead Post-Concussion Symptoms Questionnaire (RPCSQ) based on their symptom presentation during the 24 hours prior to testing. Each symptom was dichotomized (absent vs. present at any severity level). The total number of symptoms endorsed on the RPCSQ score was compared across groups using a Mann-Whitney U-Test because the data were non-normally distributed. Chi-squared analyses were used to compare the prevalence of individual symptom reporting between groups.

Results: The retired athletes and control participants were group-matched on age (retired players: M=52.7, SD=13.3, range 30-89; controls: M=51.9, SD=14.8, range=31-82, U=1,489.5, p=.74) and education (retired players: M=11.8, SD=2.6, controls: M=12.8, SD=2.69, U=1,269.5, p=.11). The retired athletes reported a median of 12 prior concussions (IQR=6-30). Their most recent concussion was, on average, 20 years prior to testing. Out of 16 possible symptoms, retired players endorsed currently experiencing more symptoms compared to controls (retired players: M=6.76, SD=3.91, Md=7; controls: M=4.05, SD=3.55, Md=3; U=901.5, p<.001, d=0.73). Compared to controls, a significantly greater portion of the retired players noted some degree of depressed mood (44.7% vs 16.7%), feeling frustrated/impatient (67.1% vs. 41.7%), forgetfulness (71.8% vs. 44.4%), poor concentration (68.2% vs. 30.6%), taking longer to think (63.5% vs. 25.0%) and restlessness (50.6% vs. 27.8%, all ps<.05). A similar portion of both groups reported headaches (players=41.2% vs. controls=33.3%), irritability (players=56.5% vs. controls=41.7%), fatigue (player=52.9% vs. controls=50.0%), and sleep problems (players=54.1% vs. controls=47.2%; all ps>.05).

Conclusions: Symptom endorsement was very common in both groups. On average, retired professional athletes reported experiencing a greater number of current symptoms compared to control participants. The etiology of these symptoms is unclear and could be related to a variety of biopsychosocial factors like neurodevelopment, physical health diagnoses, mental health problems, substance abuse, and a history of repetitive neurotrauma.
Traumatic Brain Injury and Intimate Partner Violence: Identifying and Addressing Knowledge and Service Gaps Within a Canadian Indigenous Context

Halina (Lin) Haag1, Melissa Biscardi2, Pauktuutit Inuit Women of Canada3, Noel Smith2, Nneka MacGregor4, Angela Colantonio2
1 Wilfrid Laurier University, Kitchener, Canada, 2 University of Toronto, Toronto, Canada, 3 Pauktuutit Inuit Women of Canada, Ottawa, Canada, 4 Womenatthecentre, Toronto, Canada

Background: Every year thousands of Canadian First Nations and Inuit women experience intimate partner violence (IPV), receiving injuries to the face, head, and neck; a pattern of violence potentially causing permanent traumatic brain injury (TBI). While the connection between TBI and IPV remains largely unexplored, early investigation has identified elevated TBI rates (35-80%) in women survivors of IPV. Research exploring the experiences of Indigenous women survivors of IPV with resultant TBI is extremely limited worldwide, and to date, no Canadian data has been identified. Very little has been done to examine the unique and complex intersections of family and structural violence and the implications for care providers such as community-based agencies focused on housing, healthcare, and legal services. This gap in understanding the structural inequities and their impact on the experiences of Canadian Indigenous women leaves them vulnerable to increased rates of repeat violence, permanent disability, criminalization, unemployment, homelessness, poverty, and mental illness.

Objectives: Our principal objective was to explore the experiences of Canadian First Nations and Inuit women exposed to TBI through IPV. The project’s goal was to identify service needs along with structural barriers and facilitating factors to service provision and uptake, and to develop recommendations for targeted, culturally sensitive, community-based support services.

Method: Building on our previous results, this study utilized qualitative methodology. Semi-structured interviews and focus groups with key stakeholders including women survivors of IPV, agency management and advocacy groups were arranged through our existing TBI/IPV networks. These consultation sessions were recorded and transcribed, and 2 team members coded and analysed the data, identifying emergent themes.

Findings: While there are many similarities between First Nations and Inuit contexts and challenges, there are also complex differences highlighted by the participants. Shared themes included the existence of a holistic worldview and the need for large-scale TBI/IPV educational campaigns. Systemic, racial, and infrastructure challenges were also discussed by both groups and each group described unique concerns dependent upon their geographic location and specific cultural barriers. The findings from this study will be presented and situated within a context of structural violence and systems thinking framework.

Implications: This project has direct implications for service provision for Indigenous women exposed to IPV with resultant TBI. Recommendations for further research and knowledge transfer agendas are given. It also provides a unique approach to understanding the complexities of this intersection within an Indigenous context in order to devise culturally sensitive approaches to identification, support, and advocacy for survivors.
NOTE: While this abstract can be presented on its own, it has been developed in collaboration with Amanda St. Ivany and Deanna Befus to facilitate its inclusion in a panel format together with theirs.
Serotonergic Antidepressants and the Risk Traumatic Intracranial Bleeding in Head Injury

Teemu Luoto, Anna-Kerttu Kotilainen, Jussi Posti, Ksenia Berghem, Grant Iverson

1Department of Neurosurgery, Tampere University Hospital and University of Tampere, Tampere, Finland, 2Faculty of Medicine and Life Sciences, University of Tampere, Tampere, Finland, 3Division of Clinical Neurosciences, Department of Neurosurgery, and Turku Brain Injury Centre, Turku University Hospital, and University of Turku, Turku, Finland, 4Medical Imaging Centre, Department of Radiology, Tampere University Hospital, Tampere, Finland, 5Department of Physical Medicine and Rehabilitation, Harvard Medical School & Home Base, A Red Sox Foundation and Massachusetts General Hospital Program, Boston, United States

Background: Serotonergic antidepressants (SAs) cause an increased risk of gastrointestinal bleeding by inhibiting the aggregation of platelets. Some research suggests that SAs increase the risk of spontaneous intracranial bleeding. We examined the association between intracranial bleeding and use of these medications in patients with acute head injury.

Methods: This prospective cohort study included acute head trauma patients (n=325) treated at Tampere University Hospital’s Emergency Department (Nov 2015-Nov 2016). Injury-related information and clinical findings were collected in the emergency department. Detailed pre-injury health history was collected from electronic medical records. Information on the use of SAs was attained from the Finnish national prescription registry. Antidepressants considered serotonergic were the following: (i) citalopram, (ii) escitalopram, (iii) sertraline, (iv) fluoxetine, (v) paroxetine, (vi) venlafaxine, (vii) duloxetine, (viii) bupropion, (ix) mirtazapine, (x) vortioxetine, (xi) moclobemide, (xii) amitriptyline, (xiii) nortriptyline, (xiv) doxepine, and (xv) trimipramine. Head computed tomography (CT) was performed according to the Scandinavian Guidelines for Initial Management of Minimal, Mild, and Moderate Head Injuries in Adults. CT findings were systematically coded based on the Common Data Elements. Head CT-scanned patients (n=223, men=46%; average age=65 years, SD=22) were included in this study. The focus was on hemorrhagic CT lesions (epidural hematoma, subdural hematoma, subarachnoid hemorrhage, contusion, intracerebral hemorrhage, and intraventricular hemorrhage).

Results: Of the CT-scanned patients (n=223), 88% presented to the emergency department within 24h of injury (average time=15h, SD=60). Clinical traumatic brain injury (TBI) criteria were distributed as follows: (i) GCS: 15, n=208, 93%; 14, n=10, 5%; 12, n=4, 2%; 8, n=1, 0.4%; (ii) loss of consciousness: n=38, 17%; and (iii) post-traumatic amnesia: n=95, 43%. Thirty-four patients (15%) had a positive CT and 29 (13%) had hemorrhagic lesions. Acute subdural hematomas (n=15) and traumatic subarachnoid hemorrhages (n=14) were most common. SAs were used by 62 patients (29%). Mirtazapine (n=25, 40%) and escitalopram (n=17, 27%) were the two most commonly used SAs. Antithrombotics was used by 107 patients (48%). Warfarin (n=61, 57%) and acetylsalicylic acid (n=36, 34%) were the most frequently used antithrombotics. A combination of serotonergic and antithrombotic medication was used by 31 patients (14%). Among all CT-scanned patients, there was no statistically significant difference in the incidence of hemorrhagic CT lesions between the patients with or without SAs (n=8, 13% vs. n=21, 13%; p=0.978). Among the patients using antithrombotics (n=107), the use of SAs was not associated with increased incidence of hemorrhagic CT lesions (SA+: n=7, 23% vs. SA-: n=12, 16%; p=0.404). Patients on SAs suffered more of preinjury neurological diseases (n=31, 50% vs. n=52, 32%; p=0.014). All other background factors (demographics, clinical TBI severity and pre-injury diseases) were similar between the patient with and without SAs.

Conclusions: SAs were not associated with increased risk of traumatic intracranial bleeding.
Battered & Brain Injured: Traumatic Brain Injury Among Women Survivors of Intimate Partner Violence - A Scoping Review

Halina (Lin) Haag¹, Dayna Jones², Tracey Joseph², Angela Colantonio²

¹Wilfrid Laurier University, Kitchener, Canada, ²University of Toronto, Toronto, Canada

Background: Every year thousands of women experience intimate partner violence (IPV), receiving injuries such as battery to the face, head, and neck, a pattern of violence potentially causing permanent traumatic brain injury (TBI). Despite elevated rates of TBI in women survivors of IPV and significant implications for women’s health and wellbeing, this remains an underexplored area. While research addressing the identification and support of women survivors of IPV with resultant TBI is limited worldwide, there is an emerging body of literature exploring this intersection. However, despite a few efforts to comprehensively review the literature, to date, no review has employed systematic or scoping review methodology, leaving large gaps in the reporting of this small but important body of work.

Objectives: Our principal objective was to address this gap by providing the first scoping review of the current literature exploring the intersection of IPV and TBI. Building on existing literature reviews, our purpose was to systematically map all that is currently published on IPV-related TBI and to report findings for use in research and practice.

Method: The systematic nature of this approach to sampling relevant articles ensures that the search is repeatable and comprehensive, while identifying gaps in knowledge and areas of future study. As our purpose is to highlight gender differences and complications unique to women and TBI in this context, the study focuses on IPV-related TBI in women, though the authors acknowledge that IPV takes many forms and affects other related populations. The study followed five major steps of a scoping review: (1) identify the research question; (2) identify relevant studies; (3) select studies; (4) chart data; (5) collate, summarize, and report the results.

Results: The initial search returned 1,739 articles and 38 relevant articles were identified for inclusion in the final sample. Two researchers independently extracted data and compared findings to ensure consistency, using a charting form to organize key variables in order to address the research question. The extracted data was then organized into the following four key domains: (1) estimates of prevalence, (2) screening tools and identification procedures for IPV-related TBI, (3) recommendations for healthcare professionals, and (4) recommendations for future research.

Implications: This review is the first of its kind to employ a scientific methodology providing an overview of current literature exploring the intersection of IPV and TBI. It provides a comprehensive commentary on the existing body of literature, as well as identifying critical areas for future research.
Responding to a Transitional Care Gap: First Year Outcomes of the Acquired Brain Injury Transitional Rehabilitation Service Pilot Project

Areti Kennedy¹, David Borg¹, Kerrin Watter¹, Mandy Nielsen¹
¹The Hopkins Centre and Division of Rehabilitation, Metro South Health, Brisbane, Australia

Background and Objectives: The Acquired Brain Injury Transitional Rehabilitation Service (ABITRS) is a 5-year pilot program established in response to an identified unmet need in the continuum of acquired brain injury rehabilitation services in Queensland, Australia. The service, which commenced in January 2017, aims to facilitate early community reintegration outcomes for persons with ABI and their families (significant others). To determine the impact of the ABITRS on community reintegration outcomes, a mixed-method evaluation is being undertaken. This study presents clinical outcomes from the first year of service delivery (2017–2018).

Method: Persons with ABI (n=71) completed the 12-week ABI TRS community-based program, comprising an intensive, individualised, goal-directed program using an interdisciplinary, client-centred approach. Self or practitioner-rated questionnaires were completed at 0 (baseline) and 3 months. In addition, consented significant others (SOs) (n-23) of ABITRS clients self-completed questionnaires at 0 (baseline) and 3 months. Outcomes for both groups were compared to a quasi-control (CON) where no transitional rehabilitation service existed. Data were analysed using linear mixed models in a Bayesian framework.

Results: (1) Persons with ABI: Baseline ratings in all outcomes measures were statistically worse at baseline compared to CON. There were statistical improvements in measures of global function (MPAI-4) and psychological wellbeing (DASS-21) compared to CON. Psychosocial function (SPRS-2) and health-related quality of life (EQ-5D) were statistically improved at 3 months compared to baseline. (2) Significant Others: SOs had lower ratings of carer strain (CSI) at baseline and at 3 months compared to CON, despite the ABI-TRS clients displaying a greater level of impairment. SO carer strain remained stable at 3 months, as did self-reported health status (EQ-5D) and psychological well-being (DASS-21). SO SPRS-2 ratings of the person with ABI matched those of the practitioner-rated SPRS-2 at baseline and at 3 months. Similar outcomes were also observed for SO and practitioner ratings of the individual with ABI for all global function categories (MPAI-4) indicating a positive change in function.

Conclusion: ABITRS clients demonstrated statistically improved or matched outcomes at 3 months compared to the quasi-control. SOs experienced less carer strain than the quasi-control, with stable self-reported health status and psychological wellbeing. Similarity in ratings on the SPRS-2 and MPAI-4 indicate congruence in the psychosocial improvements for persons with ABI, as identified by ABITRS practitioners and SOs. These early results indicate benefit in incorporating the ABITRS program in the Queensland continuum of ABI services for both the person with a brain injury and their family members.
Online Concussion Resources for Canadian High School Aged Youth: A Systematic Search Strategy

Kylie Mallory1,2, Andrea Hickling2, Katherine Wilson3, Nick Reed1,2,3
1Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada, 2Bloorview Research Institute, Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, 3Department of Occupational Science and Occupational Therapy, University of Toronto, Toronto, Canada

Background: Concussions are common among high school aged youth and can impact their ability to engage in meaningful activities. Despite the high prevalence and unique impact of concussion on high school aged youth, there is a lack of concussion knowledge among this population. Online concussion resources have the potential to educate high school aged youth by providing them with current guidelines on concussion prevention, identification and management. Limited research to date has investigated the availability of online concussion resources, however the quality and accuracy of the information available online is largely unknown. Due to the unique concussion experience and learning needs of this population, it is critical to gain a more thorough understanding of the online concussion resources available for high school aged youth.

Objective: To identify online concussion resources that are designed for Canadian high school aged youth and are accurate according to the current International Consensus Statement on Concussion in Sport (held in Berlin, 2016).

Methods: A five-phased systematic search strategy was used to identify concussion resources for Canadian high school aged youth. This included searching six groups of key stakeholder websites, followed by expert consultation. Inclusion and exclusion criteria were then applied, and content was reviewed for accuracy according to the current International Consensus Statement on Concussion in Sport. Lastly, resources were evaluated using the Suitability Assessment of Materials for readability, usability and suitability factors.

Results: A total of 456 concussion resources were initially identified however, only 32 resources were finalized. Across all resources, 34.6% (n=109) were excluded as they were not designed primarily for a high school aged youth audience. Upon review for content accuracy, 53.1% (n=51) of resources were excluded. When evaluating resources based on readability, usability and suitability factors 28.5% (n=13) were excluded and deemed inadequate or not suitable for high school aged youth. The 32 included resources were developed by various stakeholders with the majority of resources (n=14) being developed by hospitals.

Conclusion: Most concussion resources available online are not written for youth and do not contain accurate information on pediatric concussion. It is critical that there are online concussion resources designed for high school aged youth that are continually updated to reflect emerging evidence and consensus. Access to this compilation of concussion resources is essential for clinicians, educators and researchers that interact with high school aged youth to ensure that accurate and youth-targeted resources are provided to this population.
Integrated Intensive Speech-Language Pathology Services for Persistent Symptoms of Mild Traumatic Brain Injury

Kathryn Hardin¹,², Hilary Diefenbach¹
¹University Of Colorado-Anschutz School of Medicine, Aurora, United States, ²University of Colorado-Boulder, Boulder, United States

Interdisciplinary care for persistent symptoms of mild TBI is becoming increasingly common, and care models for chronic symptomatology continue to evolve. One specialized intervention model incorporates medicine, physical therapy, behavioral health, integrative modalities, and speech-language pathology for a three-week intensive outpatient program. Speech-language pathology has three key roles within the care program. 1) At the onset of the program, speech-language pathology meets individually with each patient to facilitate broad goal planning. A conversational approach, using motivational interviewing, helps the patient identify a key need that will be followed throughout the program, and expand upon goal components to identify intervention opportunities for specific disciplines. Motivational interviewing is beneficial to allow patients to set personalized, realistic goals applicable to both this brief program and the year of follow-up care through case management. Patients may initially consider goals that are too specific for multidisciplinary care - “improve my memory” — or those that are overly broad – “be more present.” The speech-language pathologist helps to facilitate and hone this overarching goal into something applicable and targeted across disciplines, such as “be more productive at work.” Patient education underscores how each intervention activity and technique directly relate to their primary goal. In addition, speech-language pathology creates a visual representation of their goal components, thereby decreasing the verbal memory load for each patients’ care plan. Sending a primary, unified message has helped with patient buy-in during intensive intervention, and kept providers focused on key long-term needs identified by patient. 2) Patients engage in traditional, individual speech-language-cognitive therapy two to three times per week. The evidence informed treatment plan is personalized to patient need, although common areas of focus include: auditory processing/functional auditory comprehension, verbal memory, social communication, and nearly all areas of executive functioning. Surprisingly, the speech-language pathology team treats a disproportionately high number of functional disorders in both motor speech (psychogenic stuttering) and voice (functional dysphonia) compared with national prevalence rates. 3) The speech-language pathologists facilitate a weekly transdisciplinary group designed to promote strategy generalization outside the clinic. Providers from physical therapy, behavioral health, integrative modalities, and speech-language pathology are all familiar with the offsite locations visited by patients and suggest possible strategies/activities for carryover. Based on providers’ recommendations, patients select areas of focused practice for that outing. Each group member often has both overlapping and unique goals based on their care trajectory. The two-hour sessions include an initial planning time, which incorporates metacognitive strategy instruction, participation in the activity, and a follow-up debrief. These implementation sessions offer on-line therapeutic support in the real-world, beyond the clinical bubble. Overall, this three-fold model offers an evolving vision for speech-language pathologists caring for those with the persistent effects of mild TBI.
Caregiver-Reported Rehabilitation Utilization in the First 6 months following Early Childhood Traumatic Brain Injury

Amery Treble-Barna1, Laura Blackwell2, Joshua Sesenbaugh3, Brandt Ling3, Keith Yeates4, H. Gerry Taylor5, Shari Wade6

1University of Pittsburgh School of Medicine, Pittsburgh, United States, 2Children’s Healthcare of Atlanta, Atlanta, United States, 3Wright State University, Dayton, United States, 4University of Calgary, Calgary, Canada, 5Ohio State University, Columbus, United States, 6Cincinnati Children’s Hospital Medical Center, Cincinnati, United States

Background: Children sustaining complicated mild to severe traumatic brain injury (TBI) often struggle with neurobehavioral impairments that hamper their long-term functioning. Previous research shows that approximately one to two thirds of children with TBI have unmet or unrecognized physical, cognitive, socioemotional, or academic needs in both the short- and long-term following injury. Little is known about utilization rates of multidisciplinary rehabilitation services aimed at improving function following pediatric TBI. There exists no standardized or comprehensive measure of rehabilitation utilization and it is unknown how rehabilitation utilization relates to TBI outcomes. Our goal was to characterize multidisciplinary rehabilitation utilization during the first 6 months following TBI sustained in early childhood using a caregiver-report questionnaire.

Methods: Participants included 77 children who sustained complicated mild to severe TBI (median GCS 13; range 3-15) between ages 3 and 7 (5.03±1.15) years and were enrolled into a prospective longitudinal cohort study conducted across three tertiary care children’s hospitals. At approximately 6 months post-injury (0.63±0.09 years), primary caregivers completed a questionnaire asking about their child’s utilization of the following multidisciplinary rehabilitation services in or outside of school: physical therapy (PT), occupational therapy (OT), speech/language therapy (SLT), counseling, behavior modification, developmental/academic evaluation, and special education services. We calculated percentages of participants who utilized each service regardless of the setting in which each service was utilized.

Results: At 6 months post-injury, caregiver-reported rehabilitation utilization was as follows: 20.8% developmental/academic evaluation, 19.7% SLT, 15.6% special education (among school-aged children), 9.2% PT, 7.9% OT, 3.6% counseling, and 1.3% behavior modification.

Conclusions: Caregiver-reported utilization of various multidisciplinary rehabilitation services during the first 6 months following early childhood TBI ranged from 1.3-20.8%, depending on the service type. Rehabilitation services appear to be underutilized based on substantially higher previously reported percentages of children with unmet or unrecognized physical, cognitive, socioemotional, or academic needs following TBI. Future studies should determine optimal methods for assessment of rehabilitation utilization, examine barriers to rehabilitation utilization by families, and investigate whether variability in rehabilitation utilization is associated with neurobehavioral outcomes following pediatric TBI.
Recovery of Sleep Wake Cycle in Low Consciousness State after a Severe Traumatic Brain Injury in Children

Ekaterina Fufaeva

1Clinical and Research Institute of Emergency Pediatric Surgery and Trauma (criepst), Clinical and Research Institute of Emergency Pediatric Surgery and Trauma, Moscow, Russian Federation

Background and Aims: Children with severe traumatic brain injury (sTBI) have different cognitive outcomes from low consciousness state to good recovery and back to school. In case when patients having the long-lasting period of low consciousness level need a special tool for fixing minimal changes in such patients. A.R. Luria has proposed the structural–functional model of brain activity, in which the brain is regarded as a substrate for mental processes. The model separates the brain into three units: the first unit is the energy-related unit responsible for nonspecific activation; the second unit is associated with reception and processing of exteroceptive information; while the third one is responsible for programming, regulation, and control of the complex forms of mental activity, which control certain types of mental activity and execute behavioral programming. Severe traumatic brain injury with focal and diffuse brain lesions can lead to a situation when all three functional units of the brain are injured to a certain extent. Hence, a path of recovery and the contribution of each unit to consciousness recovery are the most significant issues. Normalization of the sleep—wake cycle, along with self-awakening and opening of eyes without regard to external stimuli, are typical steps in the common path of mental functions recovery. These components are supported by functions of the first unit of the brain (activation).

Objective: To follow up patterns of sleep wake cycle recovery in children (6—17 years of age) in low consciousness state at the first four months after a severe traumatic brain injury (TBI).

Material and Methods: Seventeen children with TBI (GCS ≤8) were evaluated with the Coma Recovery Scale-R (CRS). Also, the sleep and wakefulness evaluation protocol, and the stability of wakefulness were observed.

Results and Conclusion: The report contains the clinical analysis of various cases and neurobehavioral service provided. The analysis of neuropharmacological support on the sleep wake cycle is carried out.

Keywords: children, TBI, low consciousness state, neuropsychological approach, cognitive outcome.
Increased Frontal Lobe Beta Wave Activity Required for Inhibition and Inhibition Switching Tasks Post-Concussion

Maria Daly¹, Shannon Kiss¹, Avery Sicher¹, Dominique Ballinger¹, Joel Bish¹
¹Ursinus College, Collegeville, United States

In recent years there has been an increase in the amount of concussions diagnosed. Unfortunately, many of the lasting effects of this type of brain injury are not fully understood. Concussions may present obvious behavioral and cognitive deficits, such as headaches and fatigue. However, the lasting effects on the brain, specifically on the executive function network, responsible for attention and focus, often go unnoticed. Individuals who have suffered a concussion often present abnormal brain wave activity when compared to their neurotypical counterparts. There is accumulating post-concussive research that is being conducted in order to decipher the invisible symptoms that may follow an injury. For instance, research has shown a strong association between a state of wakefulness and increased EEG slow wave activity. In contrast, there are conflicting results regarding how various brain wave activity is altered in concussed individuals during a cognitive task. Specifically, beta waves, which are associated with alertness and activity, vary in concussed individuals compared to non-concussed controls while at rest. The relationship between the amount of brain power required for performance on inhibition and inhibition switching tasks, in concussed versus non-concussed individuals, was the focus of this study. The participants (n = 91, M = 19.41 years) consisted of athletic and non-athletic college students. Some of the participants (n = 26) had a history of concussion within the past 10 years (M = 12.39 months post-concussion, sd=26.85). Participants completed a color word interference (CWI) task while in a continuous EEG monitor with electrodes placed over the left and right dorsolateral frontal cortex. The CWI consisted of four conditions. First, the participants identified the color of different colored squares. Second, participants read various black and white printed names of colors aloud. The third condition was an inhibition task. This required the individual to identify the color of the text, regardless of the conflicting printed word. Lastly, the fourth and final condition demonstrates inhibition switching skills by requiring the participant to switch between two tasks. The participant would follow the same procedure as condition three, unless the word was placed in a box. If so, then the participant would read the actual word printed, despite the color of the ink. The analyzed EEG data showed a significant increase in beta wave activity in concussed participants during the two hardest conditions of the CWI task. These findings are consistent with previous research and suggest that concussed individuals require greater brain power than non-concussed individuals in tasks involving executive function of the frontal lobe. These symptoms are of particular interest due to their persistence beyond self-report of any symptoms.
Exploring Concussion Reporting and Social Support: The Validation of a Novel Concussion Survey for High School Aged Youth

Kylie Mallory\(^1,2\), Emily Kroshus\(^3,4\), Andrea Hickling\(^2\), Katherine Wilson\(^2\), Michael Hutchison\(^5\), Roger Zemek\(^6,7\), Nick Reed\(^1,2,8\)

\(^1\)Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada, \(^2\)Bloorview Research Institute, Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, \(^3\)University of Washington, Seattle, United States, \(^4\)Seattle Children’s Research Institute, Seattle, United States, \(^5\)Faculty of Kinesiology and Physical Education, University of Toronto, Toronto, Canada, \(^6\)Children’s Hospital of Eastern Ontario Research Institute, Ottawa, Canada, \(^7\)Departments of Pediatrics and Emergency Medicine, University of Ottawa, Ottawa, Canada, \(^8\)Department of Occupational Science and Occupational Therapy, University of Toronto, Toronto, Canada

Background: Concussions are a prevalent injury among youth and can occur in a range of settings (e.g. school, sport, recreation and transportation). A growing number of educational interventions aim to increase youth reporting of a suspected concussion and influence the culture of social support after concussion. However, the evaluation of such education interventions requires valid and reliable measurement tools. To date, there are no existing validated measurement tools assessing concussion-reporting behaviour, the provision of social support and cognitions (e.g. knowledge and attitudes) predictive of these behaviours that are appropriate for use in the range of settings in which these injuries may occur.

Objective: Informed by the Theory of Planned Behavior, the objective was to develop and validate a developmentally appropriate survey of theorized predictors of high school aged youth concussion reporting and the provision of social support to a peer (concussion knowledge, attitudes, subjective norms, perceived behavioural control, intent to report concussion symptoms to an adult and intent to provide social support to a peer after a concussion).

Methods: Survey development occurred in three stages. First, questions were informed by past surveys and literature. Second, cognitive interviewing took place with high school aged youth to review questions for clarity. Finally, up to 300 high school aged youth will complete a survey containing these questions along with additional questions necessary for quantitative validation. To date, \(n=95\) participants between the ages of 14-19 years (\(M=16.25, SD=1.17\)) have completed the survey, around one-fifth of whom (22.12%) have a concussion history. Measures of validity and a confirmatory factor analysis will be completed to ensure that survey questions are measuring the anticipated constructs and are representative of the two behaviours: (1) intent to report concussion symptoms to an adult; and, (2) intent to provide social support to a peer after a concussion.

Results: Cognitive interviewing provided high school aged youth perspective and resulted in updates to the wording of questions. Preliminary quantitative analyses reveal that there is limited variability in some concussion symptom knowledge and respectively, these questions will be removed from the final survey. When investigating scenarios aimed at gathering information about subjective norms, many participants have responded that their close friends would react differently than the students in their school. Questions with limited response variability will be removed from the final survey.

Conclusion: Valid and reliable measures of high school aged youth concussion reporting and the provision of social support behaviours are critical for the evaluation of concussion education programs. The survey questions resulting from the present study can be used to evaluate concussion education initiatives in the range of settings in which high school aged youth may sustain concussions.
Psychosocial Factors and Long-Term Outcomes Post Traumatic Brain Injury (TBI): The Role of Anxiety Sensitivity

Sarah Caughlin1, Mitchell Longval1, Sebastiano Failla1, Magdalena Mirkowski1, Amanda McIntyre1, Eldon Loh2, Keith Sequeira2, Robert Teasell1,2,3

1Lawson Health Research Institute, Parkwood Institute, London, Canada, 2Parkwood Institute, St. Joseph’s Health Care, London, Canada, 3Schulich School of Medicine and Dentistry, Western University, London, Canada

Background: Traumatic brain injury (TBI) is a common neurological disorder and a major public health concern that can lead to long-term disability. Non-injury factors such as demographics and psychosocial status have been reported to be consistent predictors of adjustment and the chronicity of symptoms in TBI. In particular, psychosocial traits influence adaptive or maladaptive coping responses and, in turn, predict adjustment and well-being outcomes. Anxiety sensitivity (AS) has been shown to play an important role in predicting negative outcomes in other chronic conditions such as chronic pain and rheumatoid arthritis and could be an important factor in adjustment post-TBI.

Objective: To examine the association between anxiety sensitivity and adjustment post-TBI.

Methods: AS was measured using the Anxiety Sensitivity Index (ASI), which measures total AS and includes three subscales to measure physical, mental, and social anxiety. A questionnaire booklet containing the ASI and outcome measures related to adjustment (recovery, coping, and quality of life) was given to patients attending an outpatient TBI clinic in London, ON (n = 40). Linear regression models adjusted for age and gender were used to examine the relationship between AS and all outcome measures.

Results: A significant positive association was found between ASI scores and subjective pain ratings (β = 0.461, 95% CI: 0.02 to 0.11, p = 0.006) which was also associated with pain-related disruption of various life activities. Increased ASI scores were also significantly associated with an increase in anxiety (β = 0.69, 95% CI: 0.33 to 0.69, p < 0.001), depression (β = 0.54, 95% CI: 0.21 to 0.63, p < 0.001), and stress (β = 0.61, 95% CI: 0.29 to 0.7, p < 0.001) in TBI patients. Patients with neurotic personalities were more likely to have higher ASI scores (beta = 0.653, CI: 0.24 to 0.514, p < 0.001), while traits such as agreeableness (beta = -0.361, CI: -0.309 to -0.02, p = 0.027) and conscientiousness (β = -0.58, 95% CI: -0.5 to -0.18, p < 0.001) were associated with lower ASI scores. When the three subscales of the ASI were examined separately, mental and social anxieties were found to play a larger role than physical anxiety in many of the aforementioned outcome measures.

Conclusion: The ASI was found to be strongly associated with psychological distress (anxiety, depression, stress), subjective health and pain ratings, and maladaptive personality traits. These results suggest that AS is related to adjustment post TBI and may be an important indicator of individuals who are at risk of negative long-term outcomes based on the presence of maladaptive traits.
The Impacts of an Acquired Traumatic Brain Injury on Auditory Processing Functions: A Retrospective Study

Fauve Duquette-Laplante¹, Amineh Koravand², Mira Razran³

¹University of Ottawa, Ottawa, Canada

It is estimated that more than 1.5 million Canadians are impacted by the effects of traumatic brain injury (TBI) daily. Sensory system problems are one of many common symptoms following a TBI (Kapoor & Cuiffreda, 2002) including visual processing and sensitivity which are well-documented and researched. Auditory difficulties, such as sound intolerance (Hall et al., 2005) or hearing difficulties (Musiek et al., 2004), are reported by approximately 10% of TBI survivors, although there is a lack of empirical evidence to support this claim.

The procedures regarding assessment and management of auditory processing difficulties following a TBI are not standardized. Moreover, a review regarding the measured impacts of a TBI on auditory processing indicate that research is scarce and anecdotal at best (Vander Werff, 2016). Research is still warranted to paint a clear picture of the extent of auditory function impairments following a traumatic brain injury. The objective of the present study was to identify and categorize the main impacts of a TBI on auditory processing by measuring the peripheral and central auditory performance. This investigation would advance the available knowledge on the impact of an acquired traumatic brain injury (aTBI) on auditory function and eventually would provide guidance for future testing.

A retrospective study was conducted using 26 TBI patients’ records (9 to 59 years old) who reported experiencing a multitude of auditory challenges. Data was extracted and compiled from peripheral and central audiological assessments. Several evaluations have been conducted for the peripheral assessments such as Otoscopy, Tympanometry, Conventional Audiometry, Oto-Acoustic-Emissions and Auditory Brainstem Responses. To measure central auditory processing performance like dichotic listening or temporal processing, several advanced tests have been conducted, such as Dichotic Digits, Competing Sentences Test or Random Gaps Detection Test. Moreover, several non-auditory evaluations have been used such as visual screening test, medical case history, medical files and psychological assessments.

Multiple patterns of results have been identified. For example: 62% of our sample have abnormal results on the auditory closure tests which is crucial for the understanding of degraded speech; 54% of participants have failed the dichotic listening tests which involves both ears capacity to combine or separate different stimuli presented simultaneously.

Further statistical analysis will be performed to identify possible correlations between patients’ complaints and/or performances on specific central auditory processing tests.

The study aims to identify and categorize auditory processing difficulties based on TBI patient results and performance on behavioural auditory processing tests. Ultimately, our goal is to raise awareness of auditory processing difficulties following an aTBI, meanwhile proving directions for future research regarding the assessment and management of auditory processing impairment following a traumatic brain injury.
Social Support for Youth during Concussion Recovery

Kylie Mallory1,2, Helena Kita2, Emily Kroshus3,4, Andrea Hickling2, Katherine Wilson2, Nick Reed1,2,5

1Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada, 2Bloorview Research Institute, Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, 3University of Washington, Seattle, United States, 4Seattle Children’s Research Institute, Seattle, United States, 5Department of Occupational Science and Occupational Therapy, University of Toronto, Toronto, Canada

Background: During concussion recovery, youth may experience feelings of social isolation as a result of restricted engagement in school and meaningful extracurricular activities. This social isolation may exacerbate emotional symptoms of concussion, such as anxiety and depression. Past literature has highlighted the importance of peer-based social support during concussion recovery, suggesting that the use of peer-based social support may be an effective intervention strategy during concussion recovery for youth. However, there is limited research from the perspective of youth on the nature of social support (i.e. type and source of support) that they find most useful during their concussion recovery.

Objective: To explore the lived experiences of youth receiving social support from their peers during concussion recovery.

Methods: Semi-structured interviews with up to 15 youth who have a self-reported history of sustaining a concussion are being conducted to explore their experiences with social support during concussion recovery. To date, n=4 interviews have been completed with participants aged 15 to 18 years. A descriptive qualitative approach will be used to explore: (1) the role of social support in recovery; (2) key individuals within youth social networks; (3) barriers and facilitators to social support; and, (4) youth preferences for the types of social support provided by their peers. Interviews will be analyzed using deductive thematic analysis.

Results: Preliminary findings from completed interviews with youth demonstrate four developing themes. Youth have noted a decrease in social activity during concussion recovery and challenges accessing required supports and accommodations in the school setting. Key individuals in providing social support vary based on the type of social support. Youth noted that parents were more likely to provide tangible support, whereas peers often provided emotional support. Participants emphasized the role of concussion knowledge as facilitating the provision of social support.

Conclusions: This study underscores the importance of understanding what constitutes valuable social support from the perspectives of youth recovering from concussion. Knowledge about how social support is provided by key individuals (e.g. peers and parents) and its impact on psychosocial wellbeing may be important for developing concussion education and intervention strategies that are relevant to youth social support needs. Provision of such social support may be facilitated by assessment of social support needs in clinical settings following a concussion. Future research is needed to develop and evaluate universal approaches to improve social support after a concussion.
Psychosocial Factors and Long-Term Outcomes Post Traumatic Brain Injury (TBI): The Role of Experiential Avoidance

Sarah Caughlin1, Mitchell Longval1, Sebastiano Failla3, Magdalena Mirkowski1, Amanda McIntyre1, Swati Mehta1, Eldon Loh2, Keith Sequeira2, Robert Teasell1,2,3

1Lawson Health Research Institute, London, Canada, 2Parkwood Institute, St. Joseph’s Health Care, London, Canada, 3Schulich School of Medicine and Dentistry, Western University, London, Canada

Background: Traumatic brain injury (TBI) is a common neurological disorder that can lead to long-term disabilities requiring chronic medical intervention. Psychosocial factors have been reported to be a consistent predictor of the chronicity of symptoms after TBI. In particular, personality traits influence adaptive or maladaptive coping responses that can predict adjustment and well-being outcomes. Experiential Avoidance (EA) is the unwillingness to confront aversive experiences or emotions. EA has been shown to play an important role in mediating anxiety, stress, and coping in several psychological disorders as well as in patient populations with chronic illnesses such as cancer, however, there is currently a lack of evidence with regards to the role of EA in TBI.

Objective: To examine the association between experiential avoidance and adjustment post-TBI.

Methods: EA was measured using the Acceptance and Avoidance Questionnaire 2 (AAQ-II). A questionnaire booklet containing the AAQ-II and outcome measures related to adjustment (recovery, coping, and quality of life) was given to patients attending an outpatient TBI clinic in London, ON (n = 40). Linear regression models adjusted for age and gender were used to examine the relationship between EA and all outcome measures.

Results: EA was significantly associated with negative subjective health ratings (β = -0.44, 95% CI: -1.13 to -0.24, p = 0.003) and an increase in anxiety (β = 0.79, 95% CI: 0.45 to 0.78, p < 0.001), depression (β = 0.697, 95% CI: 0.38 to 0.78, p < 0.001), and stress (β = 0.77, 95% CI: 0.47 to 0.81, p < 0.001). High EA scores were also found to be predictive of higher maladaptive perfectionism (β = 0.62, 95% CI: 0.39 to 0.84, p < 0.001), anxiety sensitivity (β = 0.81, 95% CI: 0.61 to 1.07, p < 0.001), lower self-esteem (β = 0.77, 95% CI: 0.31 to 0.54, p < 0.001), increased pessimism (β = 0.63, 95% CI: 0.17 to 0.37, p < 0.001), and a neurotic personality type (β = 0.72, 95% CI: 0.29 to 0.56, p < 0.001). Finally, EA was positively associated with the use of negative coping strategies such as venting (β = 0.37, 95% CI: 0.01 to 0.09, p = 0.016), and self-blame (β = 0.61, 95% CI: 0.06 to 0.13, p < 0.001).

Conclusion: Overall, EA was found to be associated with other maladaptive traits such as perfectionism and neuroticism. Higher EA scores were predictive of increased psychological distress (anxiety, depression, and stress), higher pain ratings, and lower subjective health ratings. These results suggest that EA may be an important contributor to adjustment post-TBI and a useful tool in identifying individuals at risk of long-term negative outcomes in the TBI outpatient population.
Sex and Gender in Chronic Traumatic Brain Injury: Patient Knowledge and Needs

Maryam Ishtiaq\textsuperscript{1,2,3}, Caterina Bordignon\textsuperscript{1,2,3}, Vanessa Amodio\textsuperscript{1,2}, Angela Colantonio\textsuperscript{1,2,3}, Tatyana Mollayeva\textsuperscript{1,2,3}

\textsuperscript{1}Toronto Rehabilitation Institute - University Health Network, Toronto, Canada, \textsuperscript{2}Acquired Brain Injury Research Lab, , , \textsuperscript{3}University of Toronto Mississauga, Toronto, Canada

Objective: Biological sex refers to the physical and physiological features of an individual, while gender refers to socially constructed roles and behaviour; both may impact short and long-term outcomes of traumatic brain injury (TBI). At the early stage of injury, when the focus is on keeping the person alive, sex and gender topics may not appear as pressing. However, as a patient moves through the recovery process and faces difficulty in resuming pre-injury roles, sex and gender topics may come to the forefront. This study aimed to understand the knowledge and needs of patients with TBI at the chronic stage of their injury.

Design: A qualitative study utilizing purposive recruitment, maximum variation type, at the largest rehabilitation research-teaching hospital in Canada.

Participants: Men and women aged 18 years or older with mild and moderate-severe TBI at the chronic stage post-injury.

Measures: Consented patients were individually interviewed using a semi-structured interview guide. Patients were asked two questions; “What is your understanding of sex and gender?” and “What are some good ways to deliver educational materials on topics of sex and gender in TBI?” The interviews were de-identified and transcribed verbatim. Thematic analysis was utilized for coding and generating themes. Two researchers independently analyzed the data to ensure accuracy and consistency. Furthermore, content analysis was applied to better understand any observable patterns.

Results: Eight men and six women (aged 30-69 and 22-69, respectively) of mild and moderate-severe injury participated in the study. When asked about their understanding of sex and gender, none of the men, but most women in the sample, were able to provide concrete definitions of the terms. With the exception of one woman, none of the participants explicitly expressed the need to be educated on the topic of sex and gender. Nonetheless, both men and women stated the need to educate the general public and clinicians on the topic, so this knowledge could be explained to a patient in an individualized manner.

Conclusions: This is the first study that illustrates men and women’s knowledge and information uptake on sex and gender at the chronic stage of TBI. The results demonstrated limited patient knowledge and willingness to be educated on the subject material within the sample, especially among men. Future research is required to understand whether it is inadequate knowledge that influences lack of educational uptake by patients as knowledge users, or if the restrictions stemming from TBI place a burden on a person’s capacity to acquire new information. The latter is highlighted by the fact that both men and women expressed the need to educate others. Factors affecting perceived education needs, including perceived norms, ethnicity, age, and education among others need to be incorporated in further analyses.
Playin' in the iBand - How a Group of Adults with Severe Cerebral Palsy Formed a Music Ensemble Based on the Use of Virtual Instruments

Aaron Lightstone¹, Shirley McNaughton²
¹Music Therapy Toronto, Vaughan, Canada, ²Bliss Symbolics Communication Institute Canada, Toronto, Canada

This presentation will give a brief overview of how and why the Bliss iBand was formed and the psychosocial, communication, and sensory-motor benefits that participants in the group have experienced.

Following this introduction, members of the group will perform selections from the repertoire of songs and improvised music techniques that they have been working on over the last few years. This presentation will expand on information presented in the 5-minute micro-documentary that was made about the group in 2018.

https://www.youtube.com/watch?v=F07j_oGbhRc&feature=youtu.be

The Bliss iBand is a group of adults with very significant motor impairments (due to cerebral palsy), who get together weekly to explore the possibilities of actively making music together with virtual instruments apps found in their iPads. (www.blissiband.com)

The Bliss i-Band is now in its fifth year (2018) of activity and has demonstrated the benefits to be enjoyed by adults with cerebral palsy (many of whom are nonspeaking and use augmentative and alternative communication (AAC) devices) in coming together to make music.

Audrey King, (psychologist) and Dr. Shirley McNaughton, (educator), came together in 2014 to launch this initiative. Shirley also served as the first, Music Director. Shirley brought her experiences in teaching Carl Orff Music for Children and i-Pad music with seniors. Funding for the activities of the iBand have been financially supported by the Lillian Meighen and Don Wright Foundation, The Ontario Arts Council, and the Canada Arts Council for the Arts.

Shirley and the group invited Aaron Lightstone to take over the role of Music Director. Aaron continues to bring his expertise as professional musician, music teacher and music therapist.

The general purposes of the Bliss i-Band at time of its formation were:

To provide learning experiences for Bliss users/alumni and their supporters through a musical program that uses virtual instrument technology to play ensemble arrangements of familiar songs, along with solo and dyad improvisation.

• To facilitate social interaction through ensemble playing and attending musical events together.
• To increase community awareness with respect to the abilities of individuals who are nonspeaking through demonstrating their musical accomplishments.
• To engage in music making as a means of experiencing functional improvements in motor function.
• As the years have progressed, we have seen all these founding objectives accomplished, and we continue to see new breakthroughs and developments each year.
Tales from the Field: How Neurologic Music Therapy Improves Cognition, Communication & Sensory Motor Skills during the Brain Injury Rehabilitation Process

Aaron Lightstone

Music Therapy Toronto, Vaughan, Canada

Many recent research initiatives across several disciplines suggest that active engagement in a wide range of music-based activities engages multiple areas of the brain and has been demonstrated to encourage neuro-plastic processes and improvements to (non-musical) functioning and behaviour in multiple domains of functioning.

This has led to the development of Neurologic Music Therapy (NMT) as formulated and taught by Dr. Michael Thaut, Dr. Coreen Hurt-Thaut and others. NMT has become an established treatment method for a range of neurological injuries and diseases.

This presentation will begin with a brief overview and introduction to the clinical practice of Neurologic Music Therapy (NMT). The effectiveness of NMT as a rehabilitation tool will be illustrated through a number of case vignettes from clinical practice. This presentation will describe and demonstrate (through the use of video examples) the use of NMT interventions in a wide range of TBI patients from prolonged disorders of consciousness such as vegetative states through to people who are returning to their pre-injury employment.

Learning Objectives:
• Examine how NMT uses music interventions to improve non-musical behaviours and functioning
• Identify the role that neurologic music therapy can play in an inter-professional treatment program for TBI rehabilitation.
• To understand through clinical examples how NMT techniques have been used to improve function in the domains of
  • sensory-motor skills
  • speech, language and communication skills
  • cognitive skills.
Quality of Life and the Needs of Persons with Acquired Brain Injury in the Context of Community-Based Rehabilitation

Yvona Angerova², Anna Krulova¹,², Olga Svestkova², Jitka Vackova¹, Martina Hartmanova¹, Katerina Pechouskova¹
¹Charles University, The First Faculty of Medicine, Prague, Czech Republic

Background: The systematic and organisational solutions to community rehabilitation for people with acquired brain injury (ABI) vary a lot between countries. In the Czech Republic, a high percentage of people with disabilities still live in institutions. Relevant evidence-based practice is needed to establish a functioning system of coordinated community rehabilitation, based on interprofessional cooperation. According to available international studies, a coordinated approach to rehabilitation is required, along with its continuity after release from hospital to the home environment, to achieve optimal quality of life for people with ABI.

Methods: We provided 3-months community interprofessional intervention for 17 persons with ABI after they returned home from hospital. Three main professions participated: occupational therapists, physiotherapists and social workers, in cooperation with the rehabilitation physician. Respondent subjective status was assessed using the standardized questionnaire WHODAS 2.0. Functional objective status was measured by the FIM system®. To identify needs of people after ABI in the home environment, we provided semi-structured interviews. Evaluation of the development of postural and balance functions was provided from a physiotherapeutic perspective using Berg Balance Scale (BBS) and the Timed Up and Go test (TUG test). The standardized assessments were performed at the first visit, after a month and after three months of intervention. These were repeated at three and six months following the end of their coordinated rehabilitation.

Results: The analysis of interviews with clients and their families showed seven needs of people with ABI following their returning to the home environment. Main needs included the desire to return to their former state before their ABI, and the need to find new systems of activities. Subjective assessment of quality of life in some cases did not correlate with their objective status measured by FIM system®, in comparable items. It points to the importance of subjective status evaluation, priorities of individuals and self-perception of disability. According to the WHODAS 2.0, quality of life was improved in 70% of the clients after 3-months of their coordinated rehabilitation, the most significant improvement was 49%. The FIM improvement is from 1 to 36 points, median 12. After a three-month intervention, 16 out of 17 clients improved in the assessment of BBS balancing functions, and 15 out of 17 clients improved in TUG test scores, although 6 clients were still at risk of falls. However, three and six months after intervention, a slight deterioration of the monitored functions was evident in one third of the cases, which may indicate the need for continuity of rehabilitation after ABI.

Conclusions: The results indicate the importance of coordinated rehabilitation provided by occupational therapists, physiotherapists and social workers. The intervention had a positive influence on self-sufficiency and quality of life of people after acquired brain injury.
Long Lasting Executive Control Deficits in Young Adults with a History of Mild Traumatic Brain Injury

Noah Yeagley1, Lindsay Taranto1, Jennifer Pastorino1, Sydney Cope1, Mikayla Cimino1, Joel Bish1
1Ursinus College, Collegeville, United States

The cognitive effects of mild traumatic brain injury (mTBI) are increasingly becoming a relevant research focus. Recent research has shown that the cognitive effects exist for a longer time than previously assumed. The major areas in which individuals who have suffered mTBI have shown lasting deficits are executive functioning and executive control. The deficits are primarily presented through behavioral assessments, such as neuropsychological batteries. Two neuropsychological assessments that focus on frontal lobe functioning are the Delis-Kaplan Executive Function System (DKEFS) and the Repeatable Battery for the Assessment of Neurological Symptoms (RBANS). Both of these batteries assess multiple aspects of executive functioning, some of which being inhibition, cognitive flexibility, impulse control, attention, and language. In this study, 91 participants, 26 concussed and 65 non-concussed undergraduate students were examined through both the RBANS and DKEFS assessment batteries. The concussed individuals were separated into two groups, those who have experienced a concussion over three years ago and those who have experienced a concussion less than three years ago. Results of this study showed significant differences in performance on multiple tasks amongst the three groups. It was found that individuals who were concussed three years ago or less performed significantly worse than individuals with concussions for over three years (n=14), and non-concussed individuals (n=14). Significant differences for the RBANS were found in the Language index (p=.037), and the Attention index (p=.018). Differences in a specific DKEFS contrast related to Executive control function was also nearly significant (p=.054). Additionally, significant differences were seen in the Category Switching condition of the Verbal Fluency task (p=.023). Results of this study suggest that concussed individuals show significant cognitive impairments, particularly in language, attention, inhibition, and cognitive flexibility, even three years after a mTBI; however, these symptoms seem to become less severe after several years. The results show that areas of cognition vital for success in an educational setting (i.e. language, attention, and cognitive flexibility), are impaired far longer than academic accommodations are provided and may be specifically related to frontal lobe dysfunction.
Pediatric Stroke and Depression: Selecting and Implementing A Clinically Relevant Screening Tool

Ashleigh Townley¹, Joanne Wincentak¹, Shauna Kingsnorth¹,²,⁴, Shannon Scratch¹,³

¹Evidence to Care, Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, ²Bloorview Research Institute, Toronto, Canada, ³University of Toronto (Pediatrics, RSI), Toronto, Canada, ⁴University of Toronto (Occupational Science and Occupational Therapy Rehabilitation Sciences Institute), Toronto, Canada

In 2015, the Canadian Heart and Stroke Foundation published a new pediatric stroke clinical practice guideline. An urban pediatric rehabilitation centre that sees approximately 300 children and youth with stroke a year, aimed to select, tailor and implement appropriate recommendations to align evidence-based stroke care across inpatient, day patient and outpatient care settings.

An integrated knowledge translation approach was used to select two recommendations for implementation in partnership with clinicians, patients, their families, hospital management and the in-house knowledge translation team.

Led by the knowledge translation team, consensus-based and prioritization methods were used to select an initial recommendation for implementation. Managing post-stroke depression was identified as the first area of need. Mood issues, such as depression, are common in children and youth who experienced a stroke. These issues are most likely to occur during times of high stress and transitional life events.

In a rehabilitation context, clinicians see patients from injury until 18 years of age and are well positioned to identify depression and initiate appropriate care. Clinical staff recognized a need for a pediatric depression screening tool relevant to a pediatric rehabilitation context to support their work. However, screening for post-stroke depression using a standardized tool was not consistent across care settings, ages, and clinical disciplines, leading to opportunities for missed identification.

This presentation will discuss our processes, decision point’s, and outputs, aligned with the Knowledge to Action Cycle. Processes include the recommendation selection and prioritization process, literature review of screening tools, tool selection process, implementation and evaluation of the pediatric stroke guideline project.

Outputs from this project include the selection of the Patient-Reported Outcomes Measurement Information Systems (PROMIS) Pediatric Depression Screening tool from 12 reviewed measures. Self-report and proxy versions were used for children between the ages of 5 – 17 across inpatient, day patient and outpatient care settings. It was decided that screening would be initiated by social work and nursing at standard time points in a patient’s care. To guide decision making for care, cut-off scores were generated by in-house psychologists. As appropriate, patients were referred for further investigation as identified through the tool and clinical expertise.

Evaluation and outcome data will be shared about the effectiveness of knowledge translation processes, implementation support, and clinical utility of the PROMIS pediatric depression screening tool. Client outcomes will be shared within the broader scope of the implementation project.
Concussion Collaborative: A Coordinated Approach to Best Practice

Louise MacRae¹, Ann Higgins¹
¹Hamilton Health Sciences, Hamilton, Canada

Background: Concussion is a significant cause of morbidity with many survivors of concussion dealing with persisting difficulties for years post-injury. About 33% of concussed patients suffer persistent symptoms that require additional assessment and support. The consequences for these individuals may include physical, cognitive, emotional and behavioural symptoms resulting in reduced functional ability, heightened emotional distress, and delayed return to work or school. While there are multiple resources available in our region, there is a lack of coordination to direct patients and caregivers to the services that are most appropriate.

Intervention: A “Concussion Collaborative” was established to enhance collaboration between existing services to optimize care. An inaugural Forum was held to introduce the most recent best practice guidelines, review existing services and identify gaps, and develop a plan to optimally utilize existing services. This Concussion Collaborative continues to meet quarterly.

Outcomes
• Improved communication and understanding of services available within the network
• Developed a comprehensive system of resources to support patients and HCPs in accessing the right care/service
• Improved standardized care across all agencies/services based on most current guidelines

Summary: Healthcare practitioners must often collaborate with stakeholders from multiple sectors to achieve the goal of providing appropriate quality care based on best evidence. Leaders can find efficiencies by leveraging existing resources and standardizing practice across the care continuum.
Walking the Research Translation Path: Reflections and Perspectives on the Implementation of a New Acquired Brain Injury Rehabilitation Service

Mandy Nielsen, Jaycie Bohan, Kerrin Watter, Areti Kennedy

The Hopkins Centre and Division of Rehabilitation, Metro South Health, Brisbane, Australia

Background and Aims: While post-discharge support is identified as crucial during the transition from hospital to home following acquired brain injury (ABI), research highlights unmet support needs of people with ABI and their families during this period. The Acquired Brain Injury Transitional Rehabilitation Service (ABITRS) is a 5-year pilot project in Queensland, Australia. The service aims to facilitate early community reintegration outcomes for individuals with ABI and their families and extend the continuum of specialist brain injury rehabilitation services (BIRS) in Queensland. Integral to the pilot project is an embedded evaluation to critically appraise process, impact and economic outcomes. This paper will discuss balancing outcome evaluation of clinical interventions with the processes of integrating the model within an existing continuum of brain injury services. Reflections on the research process will be discussed in concert with key stakeholder perspectives gained from a qualitative study involving BIRS staff, clients, family members and external referral agencies.

Method: A mixed method research design incorporating five staged components is in progress, with completion due mid-2021. Integral to this is reflexive monitoring of the evaluation design and responsiveness to ongoing service implementation. In addition, semi-structured interviews were conducted with 2 groups: 1) key stakeholders within BIRS and the National Injury Insurance Scheme Queensland; 2) consented ABITRS clients and family members between 3- and 6-months post-discharge from the ABITRS program. Interviews were digitally recorded and transcribed verbatim. Thematic analysis based on the Framework method was conducted.

Results: Key learnings from the first year of implementation include the multifaceted nature of dynamically evaluating a new service from planning to implementation, and the complexity of integrating service evaluation activities into clinical services. Key stakeholder perspectives provide additional insight into the effectiveness of the ABITRS service model in addressing unmet need within an existing continuum of care. Identified enabling factors include availability of funding, quality of management and clinical staff, and the individualised home-based rehabilitation focus.

Conclusions: Introducing a new service model within an existing service continuum serving a complex population is a challenging process. Preliminary qualitative outcomes indicate the ABITRS is negotiating this process successfully from the perspectives of other health professionals and service users, and positively impacting outcomes for clients and families.
An Environmental Scan of KT Tools About Pediatric Concussion in Canada: Protocol

Alyson Campbell1, Lisa Hartling1, Vickie Plourde1, Shannon Scott

1University of Alberta, Edmonton, Canada

Background: In North America, more than 650,000 children present to hospital emergency departments (ED), annually, for concussions. Concussion is defined as a complex pathophysiologic process affecting the brain, induced by biomechanical forces due to either a direct or indirect blow, resulting in the impairment of neurologic function with clinical symptoms. Signs and symptoms may include headache, nausea, sensitivity to light or noise, blurred vision and in some instances loss of consciousness. While most children recover quickly and spontaneously, concussions may lead to prolonged recovery, lasting several months to over a year in rare cases.

While concussion organizations in Canada do provide accurate information for health consumers about pediatric concussions, the information can be complex and difficult to understand. Lack of accurate, user-friendly, and understandable information about pediatric concussion is problematic and may result in unnecessary ED visits and poor outcomes for children. To maximize health system resources and improve patient outcomes, it is imperative that research knowledge translates into action—a process called knowledge translation (KT). KT for healthcare consumers uses tools, (e.g. pamphlets, eBooks) to present research-based information in user-friendly language and formats.

To improve KT of pediatric concussion, an environmental scan (ES) will be conducted to develop an understanding of what KT tools about pediatric concussion are currently available in Canada.

Methods: An ES will identify what information tools about pediatric concussion are currently available in Canada. The research question underpinning this ES is: What English-language information/KT tools about pediatric concussion are currently available in Canada? First, KT tools and information resources about pediatric concussion in Canada will be identified via Google search engine and Internet-based app stores (Apple and Google Play). Second, key informants at concussion organizations (e.g. Parachute Canada) will be identified and consulted to solicit known examples of relevant KT tools that are not available through our searches and to further inquire about the tools that are available. Inclusion criteria will be purposefully broad in order to ensure the full breadth of evidence is considered (e.g. no specific population, no specific type of tool).

Planned Analysis: Data tables will be developed. Content analysis will be used to extract desired information from both verbal and written sources by systematically and objectively identifying specific characteristics of the material (e.g. KT tool format, audience).

Anticipated Outcomes (expected March 2019): This ES will generate three outcomes: (i) identify and synthesize evidence about existing KT tools for pediatric concussion; (ii) identify gaps among these tools; and (iii) provide a detailed taxonomy of educational tools about pediatric concussion. These findings will be crucial to the subsequent phases of this research to develop an innovative and unique KT tool about pediatric concussion that addresses the gaps identified in this scan.
Disruption of Functional Connectivity Between Ascending Reticular Activating System and Cortex in Patients with Impaired Consciousness After a Hypoxic Brain Injury

Jorge Rudas1,2, Darwin Martínez2,5, Diana Trujillo-Rodriguez2, Cesar Enciso-Olivera6, Edgar Ordóñez-Rubiano7, Jorge Marin3, Francisco Gómez8

1Department of Biotechnology, Universidad Nacional de Colombia, Bogotá, Colombia, 2Division of Clinical Research, Fundación Universitaria de Ciencias de la Salud, Bogotá, Colombia, 3Department of Radiology, Hospital Infantil Universitario de San José, Bogotá, Colombia, 4Department of Computer Science, Universidad Nacional de Colombia, Bogotá, Colombia, 5Department of Computer Science, Universidad Central, Bogotá, Colombia, 6Department of Critical Care and Intensive Care Unit, Hospital Infantil Universitario de San José, Bogotá, Colombia, 7Department of Neurological Surgery, Hospital de San José, Bogotá, Colombia, 8Department of Mathematics, Universidad Nacional de Colombia, Bogotá, Colombia

Introduction: Estimation of the integrity of functional substrates of consciousness, including the ascending reticular activating system (ARAS) after a hypoxic brain injury, is critical in the neurological prognosis for this kind of patients. Recently, functional connectivity (FC) among ARAS nuclei and cortex nuclei showed a disruption in the functional integrity of patients with disorders of consciousness (DOC). However, these properties remain poorly understood in patients with hypoxic brain injury. This work describes a functional characterization among ARAS and cortex using resting-state functional magnetic resonance (rsfMRI) in a set of patients with any DOC secondary to a hypoxic-ischemic encephalopathy. Our results suggest a disruption of FC among ARAS and cortex, which it may be associated with a change of role (anticorrelated to correlated) for the media raphé and ventral tegmental area nuclei.

Materials and Methods: Participants and data acquisitions

15 subjects were evaluated in this study: 7 healthy controls subjects (HC) and 8 patients with a DOC admitted to the intensive care unit at Hospital Infantil Universitario de San José from Colombia (≥48h and ≤28 days after a cerebral hypoxic event). Written informed consent to participate in the study was obtained from all subjects and legal surrogates of the patients. For each subject, 180 volumes of rsfMRI and structural T1 images were acquired in a 1.5T General Electric scanner.

Functional Connectivity Estimation: After a preprocessing step using the standard pipelines for SPM8 and FSL 5, FC was estimated using Pearson's correlation among the average filtered time courses (0.05 Hz and 0.1 Hz) of nine ARAS nuclei (VTA - Ventral tegmental area, PPN - Pons - pendunculopontine nucleus, PO - pontis oralis nucleus, PBC - parabrachial complex, PAG - periaqueductal grey, MR - median raphé, MRF - mesencephalic reticular formation, LC - locus coeruleus, DR - dorsal raphé) and the forty-eight cortical nuclei from Harvard-Oxford Atlas for each one of the groups. Group analysis was performed based on a nonparametric Mann-Whitney U test and multiple comparisons were Bonferroni corrected.

Results: Our results showed that FC among the ARAS and cortical nuclei change in hypoxic patients (HP) compared to HC (see Figure 1). In particular, three functional interactions were statistically different (p < 0.001, from anticorrelated to the correlated relationships) among them (MR - Lateral Occipital Cortex, MR - Planum Temporale and VTA - Planum Temporale). MR projects extensively white matter fiber to the hippocampus, which is implicated in the formation of long-term memory and VTA is involved in dopaminergic reward circuits. This suggests that critical functions for the emergence of the consciousness (memory consolidation and motivational salience) modulate by MR and VTA nuclei may be disrupted in
these HP, however, the relationship among these changes and the outcome for these patients cannot be inferred.
Implementing an Interdisciplinary Concussion Clinic: Application of Best Practice

Michael Rathbone¹,², Gihan Perera¹,², Justine Best¹, Louise MacRae¹, Danielle Perkins¹, Barb Kubilius¹, Ann Higgins¹

¹Hamilton Health Sciences, Hamilton, Canada, ²McMaster University, Hamilton, Canada

Background: Concussion/Mild traumatic brain injury (mTBI) is a significant cause of morbidity and mortality, with many survivors dealing with persisting difficulties for years post-injury. One Canadian study examining both hospital-treated cases as well as those presenting to a family physician calculated the incidence of mTBI in Ontario to lie between 493 and 653/100,000 (Rhy, 2009). Approximately 66% of patients with mild concussion will recover in approximately 2-4 weeks with follow up from their GP or primary care giver. About 33% will experience more persistent symptoms requiring further assessment and support. Of that group, another 50% of may experience persisting symptoms beyond 3 months. The consequences for these individuals may include physical, cognitive, emotional and behavioural symptoms resulting in reduced functional ability, heightened emotional distress, and delayed return to work or school. These patients require more specialized management to assist in the returning to their pre injury activities.

Intervention: Due to an identified gap in service in the South-Central Ontario region, a comprehensive, interdisciplinary outpatient clinic was established for the assessment, diagnosis and treatment (including disposition to the appropriate follow-up resource), of patients with mild head injury/concussion. The features of the clinic and the model of care are consistent with the Ontario Neurotrauma Foundation (ONF) Standards of Post-Concussion Care (2017). The interdisciplinary care model is unique in that assessments are done collaboratively, leveraging the specific expertise of each discipline (neurology, physiatry, neuropsychology, nursing and others) in making an accurate diagnosis and determining a plan of care. Further, because this clinic is located at a regional center, consultations/referrals to neurosurgeons and trauma specialists are more easily facilitated when needed.

Outcomes: Currently, the clinic operates 1 day/week. In the first 4 months of operation, 288 referrals have been received with approximately 16-20 patients seen daily. Wait time to be seen post injury has been reduced from several weeks to 3-5 days. Expected patient outcomes include shorter/more effective recovery, hospital avoidance, less long-term symptoms/sequelae, quicker reintegration into the community, less lost time at work; increased productivity. Health system outcomes include decreased demand on ED and other acute care resources, increased skill capacity in the community as follow-up teaching and referral is completed, improved utilization of existing community resources to support patients in their recovery journey.
Use of Alcohol Among Those with a Background of Brain Injury

Francisco Ramirez1, Linda Ivy2, Neil Nedley1

1Nedley Clinic, Weimar, United States, 2Walla Walla University, Walla Walla, Australia

Background: We explore the use of alcohol among those with history of head injury that participated on an educational intervention.

Design and Methods: The educational intervention lasted 8 weeks, participants met for 2 hours once per week for 8 weeks. The meetings consisted of a presentation by a professional and a discussion of what was shared during the presentation; no doctor-patient relationship was established. The program was available in English and Spanish and the program was run in 4 continents. Among the settings were the program was run included libraries, doctor’s offices, school (after hours), churches and community centers. Participants were educated in healthy lifestyle habits including exercise, control of thoughts (recognizing cognitive distortions and correcting them), bright light therapy, abstract thinking (interpreting proverbs, puzzles), sleep hygiene, and a whole food plant-based diet among others. There was also an emphasis on the importance of abstaining from substance abuse (including alcohol consumption) and overcoming other addictions. At baseline and post-treatment, the Depression and Anxiety Assessment Test [DAAT] (registration TX 7-398-022) was used. It assessed various aspects of mental health, as well as alcohol use and history of significant brain injury among other 85 questions.

Results: From n=5397 that were accessed retrospectively, at baseline n=264 (Age = 52.57, SD = 15.61) (Gender = 191 female, 73 male) reported having suffered a significant brain injury.

At baseline head trauma was related to alcohol use. More people with head trauma use alcohol (n= 45, 17%) than would be expected from the population in the sample, $\chi^2 (1, N = 5397) = 7.597$, $p=.006$. Those with no head trauma were less likely to use alcohol (n=588, 11.5%).

Head trauma is related to post-intervention alcohol use. More people with head trauma use alcohol (n=33, 12.5%) than would be expected from the population in the sample, $\chi^2 (1, N = 5397) = 6.291$, $p=.012$. Those with no head trauma were less likely to use alcohol (n=417, 8.1%)

Discussion and Conclusions: It seems that head trauma is related to higher probability of usage of alcohol. Clinicians should be aware of this fact and provide preventive and therapeutical interventions to help decrease its usage. Some patients stopped used alcohol as a result of the intervention.
Examining the Effects of Concussion on the Autonomic Nervous System Using 24-Hour Heart Rate Variability (HRV)

Kyla Pyndiura, Alex Di Battista, Michael Hutchison

Faculty of Kinesiology and Physical Education, University of Toronto, Toronto, Canada; Defence Research and Development Canada, Toronto Research Centre, Toronto, Canada

Background: There is currently a need for an objective measure to aid in the diagnosis and clinical management of concussion. Heart rate variability (HRV) is a measure of the autonomic nervous system (ANS) that has recently been used to determine the effects of concussion. However, research examining HRV and concussion is still in the early stages and the findings remain inconsistent.

Objectives: The aims of this two-fold study include: 1) identifying differences in HRV measures between athletes with 0, 1, 2, ≤ 3 prior concussions, as well as differences between males and females, and 2) identifying any HRV differences between concussed athletes, athletes with musculoskeletal injuries, and healthy, control athletes at ≤ 7 days post-injury and at 1-month post-injury.

Methods: Healthy university athletes (n = 65) completed a 24-hour HRV collection at pre-season. Concussed athletes (n = 29) and athletes with musculoskeletal injuries (n = 24) completed a 24-hour HRV collection at ≤ 7 days post-injury and at 1-month post-injury. All participants also completed the post-concussion symptom scale and a Health and Wellness questionnaire. Between-group analyses stratified by the number of prior concussions and gender will be presented. Between-group analyses stratified by specific group (concussion, musculoskeletal, or control) and gender will also be presented.

Results: Analyses are presently underway. HRV measures [frequency (LF, HF, LF/HF ratio) and time (mean RR, SDRR, mean HR) domain], the post-concussion symptom scale scores, and the Health and Wellness questionnaire scores will be reported and presented.

Discussion: These results will contribute to the current understanding of ANS disturbances following concussion and will provide clarity in short-term and long-term HRV effects on athlete cohorts.
(Co)Constructing Concussion with Children: A Critical Qualitative Exploration of Drawings of Concussion

Katie Mah¹,², Brenda Gladstone³,⁴, Laura Hartman¹, Nick Reed¹,²,⁵
¹Bloorview Research Institute, Holland Bloorview Kids Rehabilitation Hospital, Toronto, Canada, ²Rehabilitation Sciences Institute, Faculty of Medicine, University of Toronto, Toronto, Canada, ³Dalla Lana School of Public Health, University of Toronto, Toronto, Canada, ⁴Centre for Critical Qualitative Health Research, University of Toronto, Toronto, Canada, ⁵Department of Occupational Science and Occupational Therapy, Faculty of Medicine, University of Toronto, Toronto, Canada

Objective: It is increasingly recognized that young people possess unique insights into health topics and have the capacity to share these insights. However, in the vast body of knowledge concerning childhood concussion, young people’s perspectives are rarely sought. This inadequate representation of young people’s perspectives has resulted in an incomplete knowledge base from which to inform clinical practice. Using a research orientation that values first-hand accounts and methods that encourage different knowledge than has traditionally been sought, the objective of this research is to explore how young people conceptualize concussion.

Method: In this critical qualitative arts-based study, drawing is used as an adjunct to traditional interviewing methods to generate data with young people 6-18 years of age. Those without a history of concussion completed a drawing in response to the phrase ‘when I hear the word concussion…’. Those with a history of concussion completed two drawings: the first in response to the phrase ‘before I had my concussion…’ and the second in response to the phrase ‘now I…’. Each young person participated in a semi-structured interview to explain his/her drawing (i.e., content, intended message, and intended audience). Interview data was recorded and transcribed. Analysis is guided by an adapted critical visual methodology informed by the work of Rose and Guillemin.

Results: Preliminary analysis of drawing and interview data represents varied discourses wherein concussion is understood as a widespread phenomenon with serious and sometimes fatal consequences that is indiscriminate, yet preventable. The word ‘concussion’ evokes a sense of fear in young people, even those who lack a basic understanding or experience of the injury. Concussion has an indiscriminate nature with every young person being at risk and certain ‘irresponsible’ young people being at increased risk. Analysis is framed within the work of Foucault and focuses on how risk is negotiated and resisted by young people in their everyday lives.

Conclusions: The accounts of young people are notably absent from the knowledge base concerning childhood concussion. When enabled by a research orientation that privileges first-hand accounts and methods that enable the conveyance of abstract concepts, young people are capable of contributing unique insights regarding how they understand concussion: as a sweeping phenomenon that all young people are at risk for and that should be feared. When taken seriously, such insights can enable the development of public health initiatives and clinical practices targeted to the specific educational and support needs of young people.
Peripheral Blood Neuroendocrine Hormones are Associated with Clinical Indices of Sport-Related Concussion

Alex Di Battista1, Shawn Rhind2, Doug Richards1,3, David Lawrence3, Michael Hutchison1,3

1University of Toronto, Toronto, Canada, 2Defence Research and Development Canada, Toronto, Canada, 3David L. MacIntosh Sport Medicine Clinic, Toronto, Canada

Background/Aim: The purpose of this study was to evaluate the relationship between neuroendocrine hormones and clinical recovery after sport-related concussion (SRC).

Methods: Seventy-one athletes (n = 39 male, n = 32 female) from nine interuniversity sport teams at a single institution provided blood samples. The cohort was comprised of 27 athletes with SRC (2 – 7 days post-injury), and 44 healthy athletes recruited prior to the start of their competitive season. Concentrations of 7 neuroendocrine hormones were quantitated in either plasma or serum by solid-phase chemiluminescent immunoassay. The Sport Concussion Assessment Tool version 5 (SCAT-5) was used to evaluate symptoms at the time of blood sampling in all athletes. Multivariate partial least squares (PLS) analyses were used to evaluate the relationship between blood hormone concentrations and both (1) initial symptom burden and (2) time to physician medical clearance.

Results: Results showed an inverse relationship between time to medical clearance and both dehydroepiandrosterone sulfate (DHEA-S) and progesterone; a positive relationship was found between time to medical clearance and prolactin. Somatic, cognitive and fatigue symptom clusters were inversely correlated with DHEA-S, cortisol, adrenocorticotrophic hormone and progesterone; cognitive symptoms were positively correlated with prolactin, while fatigue and symptoms of emotion were correlated with higher thyroid stimulating hormone and lower free thyroxine levels, respectively.

Conclusion: Taken together, perturbations to the neuroendocrine system in athletes with SRC may contribute to increased initial symptom burden and longer recovery times.
Are We Giving Them What They Need in Care Conferences? Perspectives from Caregivers in Inpatient Brain Injury Rehabilitation

Anna Yuen1, Edith Ng1, Debbie Hebert1
1Toronto Rehab, UHN, Toronto, Canada

Background/Aims: Care conferences, also known as family conferences, are recommended in the Ontario NeuroTrauma Foundation (INESSS-ONF) Clinical Practice Guideline to be regularly offered to individuals with traumatic brain injury in inpatient rehabilitation. Care conferences are typically offered for patients and caregivers to meet with the interprofessional teams to discuss progress, provide education, and address discharge planning. However, there is limited research to guide the delivery of care conferences with people with acquired brain injury (ABI) and their caregivers. The aims of this study are: (1) understand the needs and expectations of patients with ABI and their caregivers; (2) determine if their needs and expectations were met; and (3) identify opportunities to better shape care conferences in both format and content. Findings gathered on caregivers will be shared at this conference.

Methods: In this mixed methods study, quantitative and qualitative data was obtained through semi-structured interviews using open and closed-ended questions, which were co-designed with patient partners and the interprofessional teams. Interviews were conducted within one week after their care conferences. Qualitative data from caregiver interviews have been analyzed using a thematic analysis approach as described by Braun and Clarke (2006) to code and theme the data. Quantitative data is being analyzed using descriptive statistics.

Results: Four themes emerged to characterize caregiver needs and expectations: Feeling informed, being prepared, sharing information, and team involvement. Care conferences offer the opportunity for caregivers to ask questions and receive information to feel informed. Not only did they value the face-to-face opportunity to meet and liaise with the interprofessional teams to support their loved ones, the importance of preparing them on what to expect prior to the care conference was also expressed. All caregivers interviewed found care conference provided an effective opportunity for education, progress update, and discharge planning. Opportunities to improve their care conference experiences were also identified, including improving caregivers’ preparation prior to the care conference, providing adequate time and opportunities for questions, and ensuring all pertinent members were present for the discussion.

Conclusions: Using thematic analysis, an enriched understanding of caregiver needs and expectations emerged, and care conferences were found to play an important role in the individuals’ inpatient rehabilitation journey. Findings from this study can provide insights to guide the design of care conferences in ABI inpatient rehabilitation services to more effectively and consistently meet the needs of caregivers. Patients’ feedback will be analyzed and compared with that of the caregivers as a next step. As care conferences are regularly used to facilitate discharge planning, improving care conferences may also improve discharge transitions and community integration. Learnings may also guide the delivery of care conferences beyond the inpatient ABI rehabilitation setting.
What Do Patients with Acute Traumatic Brain Injury Know and What Do They Want to Know About Sex and Gender?

Caterina Bordignon1,2,3, Maryam Ishtiaq1,2,3, Vanessa Amodio2,3,4, Angela Colantonio2,3,4, Tatyana Mollayeva2,3,4

1Department of Biology - University of Toronto Mississauga, Mississauga, Canada, 2Acquired Brain Injury Research Lab, Toronto, Canada, 3Toronto Rehabilitation Institute - University Health Network, Toronto, Canada, 4Rehabilitation Science Institute - University of Toronto, Toronto, Canada

Background: Traumatic brain injury (TBI) is a critical injury that affects a person at multiple levels. Biological sex and gender (an amalgamation of biological, social, cultural, and behavioural elements) are interrelated concepts which are shown to impact the short- and long-term health outcomes for individuals with TBI. Knowledge of sex and gender topics is essential for educational uptake by patients as knowledge users, which has not been previously studied in TBI. Our purpose was to investigate what patients in the acute phase of recovery from TBI know and what they want to know about sex and gender influences on related topics in TBI.

Methods: A qualitative study using a purposeful sampling, a maximum variation recruitment method of patients with TBI in the acute stage after their injury, was conducted. Nine men and seven women aged 26-85 and 24-85, respectively, with mild and moderate-severe TBI were individually interviewed using a semi-structured interview guide. Data was transcribed verbatim and a thematic analysis was applied. An open-coding process was used to generate codes and discern themes, without a specific theory as a guide. Two researchers independently performed the analysis to ensure accuracy and consistency in coding. External review of coding and summaries was completed. Content analysis was followed to identify important patterns in the data and to facilitate themes interpretation.

Results: Interviewed men had more concrete knowledge about sex and gender; the majority of women interviewed did not give concrete definitions or did not know the difference. Educational needs on the topic of sex and gender were not explicitly expressed by either men or women. Men and women were equally likely to suggest that educational materials should include information on their prognosis related to their TBI and be presented in an open, supportive patient-clinician environment. In addition, only men in the sample explicitly expressed the need to educate family members. Perceived positive outcomes (e.g., reduced stress for family members and reduced biases in healthcare professionals) were cited as a motivator for education by both men and women. Strategies to convey information most effectively included learning from people who have lived experience of TBI.

Conclusions: This study is the first that describes men and women’s knowledge of sex and gender and perceived needs for education in the acute stages of TBI. The results highlight complex and diverse expectations for education by men and women, whereas topics of sex and gender were not prioritized. Therefore, a strategy is needed to better understand knowledge and needs of men and women at this stage, taking into account other factors including age, education, socioeconomic status, ethnicity, and physical and cognitive limitations preceding or arising from brain injury.
Day and Time-of-Day Activity Patterns of Patients with Recent Brain Injury During Inpatient Rehabilitation

Vincent De Paul¹,²,4, Jessica Trier²,³, Karen Smith²,³
¹Queen’s University - School of Rehabilitation Therapy, Kingston, Canada, ²Providence Care Hospital, Kingston, Canada, ³Queen’s University - Department of Physical Medicine and Rehabilitation, Kingston, Canada, ⁴Population Health Research Institute, Hamilton, Canada

Background: Acquired brain injury (ABI) is a leading cause of adult disability. Given the health benefits of physical activity (PA), including improved cognition, mood, and mobility, it is essential that rehabilitation programs enable and promote healthy PA behaviours. Identifying patterns of low and high levels of activity during the inpatient rehabilitation period should help plan activity-promotion targets in patients with moderate to severe brain injury.

Objectives: 1) To compare weekday versus weekend walking-activity patterns in individuals undergoing inpatient ABI rehabilitation; 2) To describe time-of-day activity patterns; 3) To explore the relationship between walking ability (gait speed) and day-of-week, and time-of-day activity patterns.

Design: Observational cohort study

Setting: Regional multidisciplinary inpatient ABI rehabilitation program in Southeastern Ontario

Participants: Convenience sample of 27 adults (age 56.0 [standard deviation 17.6] years; males 48%) with recent brain injury (42.8 [SD 22.0] days since injury; traumatic [48.1%]). All participants were able to walk a minimum of 10 metres without assistance (could use a gait aid). Mean gait speed 1.04 (0.33) m/s.

Procedures: Participants underwent baseline functional assessment and wore a small activity monitor (ActivPAL micro) on their mid-thigh throughout their hospital stay (24-hours/day, 7-days/week). Activity data was processed and analyzed using the ActivPAL software. Participants received usual rehabilitation care throughout the study period.

Outcomes: Daily step count; Ratio between weekday and weekend daily step count; Ratio between steps taken during core service hours (09:00 hrs to 16:00 hrs) and non-service hours (00:00 hrs – 09:00hrs, and 16:00 hrs – 11:59 hrs).

Results: Participants wore the device for an average of 18.7 days (7.8) and took 4052 (2353) steps/day. Participants tended to walk more on weekdays (4236 [2499] steps/day) than on weekend days (3378 [2134] steps/day) (p<.001). The average ratio between weekday and weekend step count was 1.71. This ratio was negatively associated with gait speed (R²=0.293; p=0.005). Participants took more steps during the seven core-service hours from 0900 to 1600 hours (2365 [1172] steps) than during the remaining 17 hours of the day (1250 [1114] steps) (p < 0.001). The average ratio between core-hours and non-core hours was 4.2. This ratio was negatively associated with baseline gait speed (R²=0.235; p=0.015.)

Conclusions: Ambulatory patients undergoing inpatient brain injury rehabilitation tend to cluster their activity during days and times when core rehabilitation staff and programs are available and are largely sedentary during other times. Brain injury rehabilitation programs should implement physical activity
promotion strategies during ‘down’ periods with specific focus on individuals with any level of walking dysfunction.
Evaluating the Feasibility of Remotely Delivered Group Therapy for Acquired Brain Injury

Mary Boulos\textsuperscript{1,2}, Brenda Colella\textsuperscript{1}, Liesel-Ann Meusel\textsuperscript{1}, Lily Miguel-Jaimes\textsuperscript{1}, Marika Dabek\textsuperscript{1}, Robin Green\textsuperscript{1,2}

\textsuperscript{1}Toronto Rehabilitation Institute, Toronto, Canada, \textsuperscript{2}Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada

Background: In Canada, acquired brain injury (ABI) is the leading cause of persisting disability. Previous research has demonstrated worsening of cognition and mood, along with neural deterioration in the chronic stages. However, long-term access to ABI support – let alone ameliorative treatments – is limited, especially for individuals experiencing mobility issues, financial hardship and/or living in remote areas. Ongoing and accessible neurorehabilitation in the chronic stages of ABI is needed to ameliorate symptoms and prevent decline.

Objectives: To evaluate the feasibility of remotely delivering cognitive and mood therapies to ABI participants across Ontario in a recently established ABI clinical-research telehealth centre.

Methods: Participants were referred from ABI programs across the province. Inclusion criteria were: (1) prior history of ABI; (2) no current cognitive/psychological therapies; (3) basic computer literacy; (4) English fluency; and (5) no active psychosis or aphasia. Referred participants were screened for eligibility, then underwent an intake interview and cognitive/psychological assessment. Following intake, participants were triaged into therapy based on their needs, deficits, and availability. Participants subsequently received any/all of the following evidence-based therapy modules adapted for ABI: cognitive behavioural therapy (CBT), goal management training (GMT), and mindfulness-based meditation and relaxation (MMR). Therapies were delivered in group format via secure videoconferencing to participants in their homes by therapists located at an urban rehabilitation hospital. Participants received 8-11 weekly group sessions lasting approximately 120 minutes with 5 group members. To assess feasibility, we examined participant recruitment, retention, and adherence. Participants were surveyed about their satisfaction with online group therapy and the technologies employed.

Results: Over a one-year period, 152 ABI participants were referred. Seventy-six were screened, of which 55 completed the intake interview and cognitive/psychological assessment. Following the intake, 44 participants began therapy. Seventeen groups were completed: four CBT (N=19), six GMT (N=30), and seven MMR (N=27). All participants completed at least 75% of therapy sessions. Attrition rates were low across all groups (CBT: n=1, GMT: n=4, and MMR: n=3). To date, over 850 clinical visits have been completed. Interventions were reported to be relevant, adequate in information density, and easy to follow. At times, technical difficulties disrupted the therapy sessions.

Discussion: Remotely delivered group therapy for ABI was feasible, with adequate recruitment, retention, and adherence for all modules. Participants anecdotally remarked on benefits of group-based therapy, and requested further opportunities for social interaction, underscoring the value of group (vs. one-to-one). Added technical support and improved communication software would improve the therapy experience. Ultimately, the establishment and refinement of mechanisms for remote therapy delivery may improve the accessibility, affordability, and scalability of ongoing rehabilitation for individuals living with the enduring effects of ABI.
Feasibility of Identifying Neurorehabilitation Intervention Candidates Living with Traumatic Brain Injury in the Criminal Justice System

Mary Boulos1,2, Brenda Colella1, Liese-Ann Meusel1, Lily Miguel-Jaimes1, Tom Worthington1, Robin Green1,2

1Toronto Rehabilitation Institute, Toronto, Canada, 2Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada

Background: Of the estimated 120,000 criminal offenders in Canada, approximately 40% have sustained traumatic brain injury (TBI). However, limited efforts have been made to provide assessment or treatment targeting TBI sequelae in this population. Neuropsychological (NP) assessment can identify cognitive and neuropsychiatric sequelae that may contribute to recidivism (e.g., aggression, impulsivity), while cognitive behaviour therapy (CBT) and goal management training (GMT) can be employed to target such sequelae. Remote delivery has the added benefit of affordability, scalability, and reducing travel and privacy concerns. Objective: To examine feasibility of providing (i) NP assessment and (ii) group-based CBT/GMT telerehabilitation to individuals with TBI and criminal charges in the Ontario Mental Health Diversion Program (OMHDP).

Methods: Participants were recruited from the OMHDP of the mental health court, which provides voluntary mental health support as an alternative to criminal justice sanctions. Approximately 100 individuals participate in diversion each year, with an estimated 20% TBI prevalence. Inclusion criteria were: >6 months post-mild-to-severe TBI; no access to neurorehabilitation; English proficiency; no substance use that may interfere with participation; and no active psychosis. Feasibility was examined using: number of referrals; number completing screening assessment; number eligible for NP; number completing NP; duration of and adherence to NP; and number eligible for treatment.

Results: Of an estimated 20 participants with TBI/year, 18 were referred (N=18). Sixteen participants were screened, with 13 eligible for the NP assessment. Of these, 8 participants completed the NP assessment and 5 withdrew prior to assessment. Assessments required 3-5 sessions, and on average, 1.3 appointments were missed across patients. One participant was deemed eligible for treatment.

Discussion: Education of frontline staff on prevalence and symptoms of TBI appeared to facilitate high referral rates. After screening, most individuals met inclusion criteria for NP assessment, with 61.5% of eligible participant completing the NP assessment. Only one individual was eligible for treatment based on clinical considerations. Impediments to eligibility, retention and adherence were nature and severity of psychiatric comorbidities (particularly substance abuse and active psychosis), difficulty attending appointments, and lack of stable housing, contact methods, and/or social support.

Clinical Implications: For individuals with TBI within diversion programs, (i) training on identification of (potential) TBI is needed, (ii) treatment format for clinical intervention (e.g., CBT, GMT) should be tailored as needed (e.g., one-on-one vs. group; modified treatment duration); and (iii) multiple appointment reminders and establishment of trust between therapist and client may facilitate participation. Importantly, patients with TBI who do not have overt psychiatric dysfunction may be overlooked for mental health diversion programs. Therefore, collaboration with additional criminal justice professionals (e.g., probation officers) may aid in the identification of patients with TBI experiencing more “invisible” injuries.
Background: Physical activity (PA) interventions seem to be increasingly used in the rehabilitation of individuals with persisting symptoms of mild traumatic brain injury (mTBI). However, recommendations from clinical practice guidelines regarding PA interventions lack clarity and specificity about important PA parameters (e.g. Frequency, Intensity, Time, Type, progression rules) that could help clinicians prescribe effective PA interventions.

Objectives: The purpose of this scoping review was to identify existing PA approaches used in the management of mTBI, critically appraise the characteristics of PA interventions, and their health-related outcomes. Methods: Our scoping review followed a 6-step framework (Levac, 2010; Arskey and O’Maley, 2005). Five databases were searched (SportDISCUSS, MEDLINE, CINHAL, PsychINFO & EMBASE), resulting in 4716 references. Documents reporting any type of PA interventions (e.g. tai chi, aerobic exercise) with at least 1 participant having a mTBI were included. Two independent reviewers selected relevant articles and extracted data using an extraction sheet based on the 16-Item Consensus of Exercise Reporting Template (CERT) and 2 additional items from the Template for intervention description and replication (TIDieR) checklist.

Results: 25 articles and 1 thesis were found reporting studies on PA interventions for individuals with mTBI. 38.5% of studies included adults only, 30.8% focused on children and 30.8% included both. Study designs were uncontrolled (n=6) and controlled (n=6) before-and-after studies, randomised controlled trials (n=5), retrospective chart reviews (n=5), case studies (n=4) and other types (n=2). Approximately 42% of studies included multiple active modalities, 30.8% reported on a sub-symptomatic threshold progressive exercise program, 11.5% evaluated a target moderate to vigorous aerobic exercise program, 11.5% reported on Tai-chi/Qigong related intervention while 3.8% studied a walking program. Stretching was used in 11.5% of studies as an intervention for the control group. On average, studies reported scores of 10.4 ± 3.8 (range 0-15) on the modified 16-item CERT. Most studies (88.5%) provided a general description of the PA intervention, and detailed information about how the exercises were prescribed (69.2%). However, few studies reported the adherence to the PA intervention (34.6%), the monitoring of adverse events (38.5%), and only 26.9% of studies reported having a motivation strategy to support the intervention. Reported outcomes were varied: 1 study reported qualitative outcomes, while others reported post-concussion symptoms (73.1%), mood (23.1%), physiological measures (e.g. heart rate, blood pressure) (23.1%) while 19% reported on return to pre-injury activities (e.g. return-to-work, return-to-sport).

Conclusions: Many different approaches have been used targeting varied outcomes, and sufficient details are provided allowing clinicians and researchers to replicate the interventions. Future studies should also better report strategies to measure adherence and include motivational strategies. This review should help clinicians select the most appropriate PA intervention on a case-by-case basis linked to desired outcomes.
TBI and Intimate Partner Violence in Women Presenting to Orthopedic Fracture Clinic

Krista Salanki
2Mcmaster University, Hamilton, Canada

Background: Victims of intimate partner violence (IPV) are at substantial risk for traumatic brain injury (TBI), as the head, neck and face are the areas most often targeted during episodes of abuse. Victims of IPV may present to health care practitioners, including orthopedic surgeons, with IPV-related injuries, but they are not routinely screened for TBI. There is increased awareness of IPV among orthopedic surgeons in Canada, and training is now available about how to address IPV in the fracture clinic. Prevalence of TBI in this group, however, is unknown. TBI-related cognitive disorders may increase risk for poor outcomes from IPV, thus knowledge about TBI prevalence in this group is critical for clinical intervention. This study aimed to determine prevalence of IPV and TBI among women presenting to orthopedic fracture clinic.

Method: We interviewed 105 women presenting at an orthopedic fracture clinic. All participants the Ohio State University TBI identification method-interview (OSU-TBI), the direct method of IPV screening questionnaire, a modified version of the HELPs questionnaire, and the neurobehavioral symptom inventory (NSI). Study variables were 12-month and lifetime prevalence of IPV, prevalence of mild and moderate-severe TBI, and prevalence of comorbid IPV and TBI.

Results: Forty-six of 105 women (43.8%) who completed the OSU-TBI reported at least one head or neck injury resulting in a TBI. Of women reporting TBI, 11 (23.9%) met criteria for moderate-severe TBI. Forty-four of 104 women who completed the IPV screening questionnaire women (42.3%) disclosed a history of IPV-related abuse within their lifetime, with 25 (24%) of these women reporting physical abuse. Twenty of these women (19.2%) reported a history of IPV-related abuse within the past twelve months, with 7 (6.7%) women reporting physical abuse. Of 104 women who completed both the OSU-TBI and the IPV screening, 23 (22.1%) had comorbid TBI (mild, moderate or severe) and lifetime history of IPV.

Significance: These preliminary results suggest that a large proportion of women attending an orthopedic fracture clinic have experienced IPV (42.3%), TBI (43.8%), or comorbid IPV and TBI (22.1%). These findings point to a need for development of regular IPV and TBI screening tools among women presenting to health clinics for physical injuries, as well as the need for further investigation of the consequences of TBI among IPV victims.
Skull Base Fractures Among Pediatric Head Trauma Patients – Trends in Incidence, Management, and Outcomes from a National Database

Anthony Asemota¹, Eric Schneider², Gary Gallia³
¹Department of Neurosurgery, Johns Hopkins Hospital, Baltimore, United States, ²Department of Surgery, University of Virginia School of Medicine, Charlottesville, United States

Introduction: Pediatric head-trauma is associated with significant morbidity and mortality in the United States. However, little is known regarding the burden and outcome of skull-base fractures (SBF) occurring in association with head-trauma.

Methods: Weighted data was analyzed from the Nationwide Inpatient Sample 2000-2014 and cases of pediatric head-trauma having a diagnosis of SBF identified. Injury severity was mapped using the Abbreviated Injury Severity (AIS) scale, categorized as mild: AIS<3, moderate: AIS=3, and severe: AIS>3. Standard descriptive statistics examined trends over time and across 5-year age-groups at significance level of P<0.05.

Results: From 2000-2014, a total of 699,173 SBF cases were diagnosed representing 23.25% of all pediatric head-trauma cases. Most cases were closed-SBF (93.14%), involved male patients (68.60%), and overall mean age was 11.25 years (SD=6.49). The median AIS-injury score was 3.0. Mild TBI was diagnosed in 1.75% of patients, moderate in 86.14% and severe TBI in 12.11%. Generally, 15-19 year-olds were more likely to present with severe TBI (P<0.001).

The leading injury cause overall were falls (28.25%), which are also the leading cause in children under-5 years (54.66%), 5-9 (32.43%), and 10-14 (21.53%) year-olds, followed by motor-vehicle accidents (25.56%) which were the leading cause among 15-19 year-olds (39.17%). Although firearm-related injury resulted in only 2.54% of SBF, the highest incidence occurred among 15-19 year-olds (4.98%) versus other age-groups (P<0.001). Firearm-related injuries were significantly more likely to result in open versus closed-SBF (30.65% vs. 0.52%, P<0.001).

Cerebrospinal fluid leaks occurred in 2.10% and were mostly managed conservatively with fewer patients requiring duraplasty (8.48%) and/or placement of lumbar-drains (9.54%). The requirement for non-conservative management including duraplasty (OR=5.53; 95%CI=1.58-19.37; P<0.001) and lumbar-drain placement (OR=2.64; 95%CI=1.06-6.60; P=0.03) was more likely among 15-19 versus under-5 year-olds. Significant intracranial hemorrhage (ICH) occurred in 40.64%, and similar to open-SBF, was likely to require craniotomy/craniectomy (P<0.001) treatment. Additional injuries including facial fractures, cervical spine fractures and cranial nerve injury occurred in 27.68%, 3.27%, and 1.53% respectively, and were all more likely to occur among 15-19 versus under-5 year-olds (P<0.001).

From 2000-2014, the overall incidence of SBF diagnosed annually increased significantly by an estimated 33% from 18.58% to 27.61% (P<0.001). Overall mortality associated with SBF was 4.68%, was higher in 15-19 versus under-5 year-olds (6.55% vs. 3.44%, P<0.001), in open versus closed-SBF (16.07% vs. 3.84%, P<0.001), and in ICH versus without-ICH (7.37% vs. 2.83%, P<0.001). Mortality decreased significantly across time from 5.09% in 2000 to 3.75% in 2014 (P<0.001). The decline in mortality seen across all age-groups was significant only in under-5 and in 15-19 year-olds (P=0.02 and 0.03 respectively).
Conclusion: Skull-base fractures occurring in association with head-trauma result in significant morbidity/mortality among pediatric patients. Older children and those with open-SBF and ICH experience worse short-term outcomes.
Longitudinal Changes in Gray Matter Volume and Gray Matter Network Architecture in Individuals with Mild Traumatic Brain Injury During the First Year after Injury

Angela Mueller, William Panenka, Rael Lange, Grant Iverson, Jeff Brubacher, Naznin Virji-Babul

Introduction: Every year, an estimated 1.7 million people sustain a traumatic brain injury in the USA. Approximately 80% of those are diagnosed with mild traumatic brain injury (mTBI). Chronic grey matter (GM) atrophy is a known consequence of moderate and severe traumatic brain injuries but has not been consistently shown in mTBI.

Objective: To examine longitudinal changes in grey matter volume (GMV) from six weeks to 12 months following uncomplicated mTBI.

Methods: 85 participants with uncomplicated mTBI (mean age=35.4 years, SD=10.6; 60% women) and 37 orthopedic controls (mean age=33.5 years, SD=9.7; 32.4% women) completed MRI scans at two time points: 6-8 weeks post injury and 12 months post injury. All MRI data were acquired on the same Philips Achieva 3T scanner equipped with Dual Nova Gradients (maximum gradient strength 80 mT/m, max. slew rate 200 mT/m/s) and an eight-channel head coil. A longitudinal voxel-based morphometry was computed using the default longitudinal preprocessing pipeline from the Computational Anatomic Toolbox that is implemented in the Statistical Parametric Mapping Toolbox. Graph theoretical analysis (GTA) using the Brain Connectivity Toolbox (BCT) was performed to evaluate how the changes in GMV affects the GM network organization in these two patient groups.

Results: There were no significant grey matter tissue volume differences between the trauma controls and the mTBI patients at six weeks or at the 12 months follow up. There was no significant overall volume change in grey matter from 6 weeks to 12 months post injury in the mTBI group or the trauma control group. Voxel-based morphometry revealed that the mTBI group showed significant grey matter volume reduction in seven clusters in lateral and medial portions of the frontal, motor, temporal, and parietal lobes, as well as in the thalamus and the basal ganglia, between 6 weeks and 12 months after injury. The results of the GTA showed that the grey matter volume decrease in the mTBI group was associated with a significant global reduction in the negative participation coefficient (nPC), a GTA measurement that quantifies the degree of segregation of a brain region in relation to other sub-networks of brain regions. The orthopedic controls showed no significant GMV change during the first year after their injury and had higher values in nPC in comparison with the mTBI group.

Conclusion: These results show that grey matter volume continues to change up to 1-year post injury in individuals with uncomplicated mTBI and this change is associated with significant changes in the architecture of the grey matter network organization.
Analyzing Head-Neck Tissue Strains During Football-Related Impacts

Kewei Bian¹, Haojie Mao¹
¹Western University, London, Canada

Introduction: Concussion due to sports-related collisions is a severe health challenge. Moreover, damage to the head and to the neck can sometimes lead to similar symptoms such as headache. Hence, to better prevent and diagnose concussion, we need to understand how helmeted impacts affect head and neck tissues.

Methods: We simulated six impact conditions mimicking real-world relevant football collisions, with an impactor hitting a helmeted player to the frontal, lateral, rear, and vertical sites of the helmet and frontal and lateral sites of the facemask. The impact velocity was 6 m/s. Based on the simulations, we examined peak maximum principal strain (MPS) in the brain as well as in the neck.

Results: For loads to the helmet, frontal impact induced peak MPS of 0.30 to the brain, 0.27 to the upper cervical spinal cord, 0.38 to the disc and 0.13 to the facet joint. Lateral impact produced peak MPS of 0.40 to the brain, 0.50 to the upper cervical spinal cord, 0.80 to the disc, and 0.25 to the facet joint. Rear impact caused peak MPS of 0.37 to the brain, 0.44 to the upper cervical spinal cord, 0.41 to the disc, but very low 0.01 to the facet joint. Vertical impact induced low strain to the brain (0.07), but it induced high strain of 0.42 to the upper spinal cord, 0.50 to the disc, and 0.35 to the facet joint. For loads to the facemask, frontal impact caused peak MPS of 0.27 to the brain, 0.42 to the upper cervical spinal cord, 0.48 to the disc, and 0.12 to the facet joint. Lateral impact to the facemask produced the highest MPS of 0.48 to the brain and 0.68 to the disc, and it caused MPS of 0.42 to the upper cervical spinal cord and 0.18 to the facet joint.

Discussion/Conclusions: Brain strains were highest during the lateral impact to facemask, followed by the lateral impact to helmet, rear impact to helmet, frontal impact to helmet, frontal impact to facemask and vertical impact to helmet. The upper cervical spinal cord experienced the highest strain among all impacts. Both the disc and facet joint experienced the high strain during lateral and vertical impacts. These heterogeneous head-neck responses can help guide future protective gear development to reduce tissue strains, as well as assist in diagnosis for identifying regions of vulnerability during various impacts.

Acknowledgements: We acknowledge NSERC Discovery and Canada Research Chairs program for support.
Concussion Knowledge in Adolescent Female Hockey Players

Mark Herceg

Phelps Hospital Northwell Health, Sleepy Hollow, United States

The majority of research examining concussions has focused on men’s sports, yet recent work has shown that female athletes have a higher prevalence of concussion and recover from the injury slower compared to male athletes. Few studies have examined knowledge about concussion in female athletes, an important factor in concussion care. This study examined how much a population of elite female youth hockey players knows about concussions, how their behavior is influenced by that knowledge, and how similar that knowledge is compared to the current state of scientific thought.

In the United States, as many as 3.8 million sports-related concussions (SRC) occur each year. This represents a serious public health problem and one which disproportionately affects those under 25 (Centers for Disease Control and Prevention). It has been shown that as much as 53% of concussions go unreported in youth sports populations, with “not thinking the injury was serious enough to report” cited as being a top reason for not reporting.

Studies on reporting behavior either do not include women or do not include questions about players knowledge about concussion. Those that do include women and assessments of concussion knowledge usually use vastly majority male populations or exclude major female contact sports like hockey.

Between the 1990 and 2017, USA Hockey reports that female youth hockey registration grew by 1300% (5,573 – 73,000; HOCKEY, 2017).

In addition to assessing general knowledge about SRCs, the study examined how the knowledge they have interacts with their self-reported behaviors. The survey included questions asking participants about their behavior, such as which sport they chose to play, if they have ever had a concussion that they did not disclose to team staff, or if they would tell someone if a teammate had a concussion. These are meant to assess how much their knowledge is applied to their behavior. It has been reported that female sex is associated with higher scores of concussion knowledge, reporting concussions at a higher level than their male counterparts, though that higher knowledge is not associated with self-reporting behaviors.

A survey was sent out to hundreds of teenage girls in upper-level hockey programs in the New England and New York Tri-State area between grades 9 and 13. 403 out of 535 possible responses were collected. The survey asked questions about things like how severe of an injury respondent thought a concussion was, whether they had ever had a concussion they did not report, and what they think constitutes a concussion. Although responses about concussion education and awareness were at expected levels, behavioral influence remained a concern. This study characterized the relationship between knowledge and action, and extent of knowledge in female hockey players, something that remains lacking in the literature.
App Design, Selection, and Research

Michelle Wild

Brain Education Strategies & Technology, Laguna Hills, United States

Memory, attention, and executive functioning impairments are commonly experienced by people with acquired brain injury (ABI). Deficits in executive functioning cause notable difficulties with planning, problem solving, self-regulation, fatigue, and goal-directed behavior, making it difficult to complete the tasks of daily life. Although there are many discipline-specific apps to help with specific post-injury challenges (e.g., SLP-related apps), well-designed apps that focus on common, persistent, everyday issues are not readily available. Furthermore, specific training on how to use the apps is seldom provided for users with brain injury, clinicians, and caregivers. Feedback from actual users with brain injury is rarely collected in order to influence the features included in the app. This presentation explores the importance of: (1) using an iterative app development process; (2) training users with brain injuries and also their clinicians and/or caregivers to use a small toolbox of apps to prevent app overload, and (3) evaluating the usability and efficacy of apps as compensatory tools to help with quality of life.

First, we'll explore the iterative process we used in the development of the BEST Suite of apps. The BEST Suite includes four integrated apps—PaceMyDay (energy management), ReachMyGoals (SMART goal creation and management), StrategizeMyLife (identification and rating of the strategies used to accomplish tasks and goals), and CompleteMyTodos (task management). The Suite is designed to provide practical solutions for common daily challenges experienced by individuals living with brain injury, including issues related to executive functioning and self-regulation.

Next, we'll explore the importance of using a limited number of apps to assist with executive function skills such as organization, concept formation, decision making, etc. Relatedly, we'll address the very specific challenges and needs associated with app training for brain injury survivors, brain injury professionals, and caregivers—training that will ensure they know how to use the apps effectively.

Lastly, the presentation will focus on specific challenges faced and lessons learned related to conducting app-related research, including sharing specific outcomes of a research project conducted with Veterans living with brain injury and/or PTSD.

(1)“Development of this application was supported in part by the Rehabilitation Engineering Research Center for Community Living, Health and Function (LiveWell RERC) funded by a grant from the National Institute on Disability, Independent Living and Rehabilitation Research (NIDILRR) in the U.S. Department of Health and Human Services under (grant no. 90RES023.”)"
A Case of Pilocytic Astrocytoma Complicated by Acute Stroke in a Young Man with Asberger's Syndrome

Ashley Kakkanatt1, Erika Trovato1,2
1Montefiore Medical Center Albert Einstein College Of Medicine, Bronx, United States, 2Burke Rehabilitation Hospital, White Plains, United States

Case Description: 20-year-old male with past medical history of Asperger syndrome and obsessive-compulsive disorder presents after surgical resection of a right temporal mass. He was enrolled in a minocycline study for treatment of Asperger syndrome in 2013, during which surveillance CT scan of the head was performed and incidentally a brain mass was found. Five years after discovery, the mass was rejected by elective stereotactic-guided right frontotemporal craniotomy with radical subtotal resection of the temporal lobe lesion. Biopsy revealed the mass to be a pilocytic astrocytoma. In the post-op period, he had seizure activity and was found to have a left middle cerebral artery (MCA) stroke. After stabilization he was transferred to acute inpatient rehabilitation. At the time of initial evaluation, he required moderate assistance for mat mobility and stand-pivot transfers, and total assistance for activities of daily living. Speech therapy noted patient to have at least a mild cognitive-linguistic impairment characterized by decreased sustained attention, delayed recall, executive functioning, insight, judgment and safety awareness.

Background: Pilocytic astrocytoma is a benign overgrowth of astrocytes, most often found in the cerebellum, the optic chiasm, or hypothalamus, at times in the cerebral hemispheres. Treatment is resection of the tumor as delaying resection can increase the chance of malignant transformation. Often the location of the tumor inhibits complete resection, at which point radiation therapy may be pursued. Benign tumors do not generally contribute to a hypercoagulable state that may increase the risk of stroke. There have been reported cases of astrocytoma and concomitant stroke.

Asperger syndrome is a communication disorder under the classification of autism spectrum disorders in which individuals have difficulty with socialization and all-consuming interest in one topic. The syndrome can also include aggression, compulsion, impulsivity, anxiety, and depression. Treatment includes communication and behavioral therapy.

Discussion: In this case the patient had significant left hemiparesis due to the location of the tumor and mass effect, and minimal right hemiparesis from a left MCA stroke. Communication deficits were intensified after the stroke. The patient was very agitated and had poor safety insight requiring an enclosed bed and ultimately medications.

Previous studies have suggested that in the pediatric population, moderate to severe brain injury often presents with symptoms similar to those of autism spectrum disorders. Individuals with autism spectrum disorders often have sensory processing disruptions, learning difficulties, impairments in social interactions. These overlap with symptoms of brain injury as well.

This leads to the importance of having a clear baseline when attempting to rehabilitate a patient with pre-morbid communication disorders. Similar tactics may be employed in autism spectrum disorders and brain injury in order to improve social interactions; the goal should be to rehabilitate to the individual’s functional baseline.
While executive function deficits are often pronounced following traumatic brain injury (TBI), memory complaints are also common and tied to medial temporal lobe vulnerability following insult. However, the extent of these memory deficits—the severity, ubiquity across domains (e.g. temporal versus spatial memory), and individual differences across patients—are still being investigated. Relational memory, or the ability to bind arbitrary information into long-lasting associations, operates across domains and time scales, and depends critically on the hippocampus. In the present study, two relational memory tasks, one spatial and one temporal, were employed to assess whether 1) patients with TBI demonstrate domain general relational memory deficits and 2) whether these deficits are evident even for small set sizes typically considered to be in the realm of working memory (i.e. 3-9 items). In the spatial relational-memory task, moderate-severe TBI patients and healthy controls (matched for age, education, and handedness) studied the locations of 2-10 abstract items on a screen for a short period of time (6-30 seconds depending on set size). The items then disappeared. After a short delay (5 seconds), the items reappeared in a line at the top of the screen and participants used the mouse to drag the items back to their original locations (reconstruction). In the temporal relational-memory task, 3-9 objects were present centrally, one at a time, during study. At test, each object was presented again in a randomized order, and participants indicated the temporal position in which that object was studied via button press on the number pad. Across both tasks, patients with TBI demonstrated relational memory deficits compared to their matched controls, and these deficits emerged beginning at set size 4, and persisted at larger set sizes as well. While there was considerable variability in performance across patients, overall performance on the spatial task correlated with performance on the temporal task, suggesting deficits on both tasks are likely related to the same hippocampally-mediated impairments, though future work incorporating both structural and functional imaging will be necessary to directly evaluate this. Overall, these data suggest that TBI results in domain-general deficits to relational memory, and that these deficits are evident both for large set sizes, but even for small set sizes typically considered to be in the range of working memory.
Yoga Therapy: A Holistic and Complementary Treatment for Individuals with a Traumatic Brain Injury

Kristina Borho¹
¹Empowering Mind and Body, Scarborough, Canada

Yoga Therapy is the prescribed application of the tools of Yoga to empower individuals in their healing journey. An individual with a traumatic brain injury (TBI) may experience physical, cognitive, communication, emotional and behavioural symptoms that can impact one’s ability to function in his or her meaningful activities. This presentation will briefly review Yoga philosophy and a Yoga Therapy model that guide a therapist to select specific tools to address the unique symptoms of the individual. These tools include physical postures, breathing techniques, meditation, sound, intention setting, visualization, oil application, yoga nidra, props, philosophy and yukti (creative tools for a desired effect). Each customized yoga practice is guided by the client’s self-identified goals. Case studies of individuals with TBI will be presented outlining the tools that were selected, how they were used and the observed and reported effect for each client. Objective and subjective improvements in the areas of motor control, strength, balance, coordination, body awareness, pain management, emotion regulation, energy levels, relaxation, mental focus, sleep, impulse control and breath control will be reported. It will be explained how specific techniques selected for each client lend themselves towards collaboration with other healthcare professionals on the client’s team to complement treatment being provided. Although almost anyone can benefit from Yoga Therapy, risks to be considered will be highlighted to inform the participants about what to look for in a qualified Yoga Therapist. Research will be infused throughout the presentation and recommendations for future research will be made. The presentation will begin and end with the participants being guided to experience first-hand, the tools of Yoga Therapy.
Plasma ADAM-10 a Potential Concussion/Traumatic Brain Injury Biomarker in Children and Adolescents

Changiz Taghibiglo, Sathiya Sekar, Douglas Fraser

1University of Saskatchewan, Saskatoon, Canada, 2Children’s Hospital, London Health Sciences Centre, Western University, London, Canada

Mild traumatic brain injury (mTBI)/concussion is a growing epidemic throughout the world. Concussion and mTBI are relatively common among children and adolescents mostly due to sport-originated incidences. In fact, according to the Centre for Disease Control (CDC), concussions are a major public health concern and they disproportionately affect youth, with more than half occurring in children and adolescents. Concussions in the adolescent patients are of particular concern as their brains are still developing and anatomically are more susceptible to injury. Moreover, compared to an adult, the concussion recovery time is longer in younger individuals. Misdiagnosis of mTBI in children and adolescents may have life-long interrupted intellectual and social development consequences. Accurate concussion diagnosis is particularly important for children and adolescents, as it would help in making decisions to stop plays and to provide rapid deployment of treatment and rehabilitation services for the patients. Concussion diagnostics still remains challenging and mostly relays on clinical evaluation of the patient as a practicing gold standard. However, in the last decade, there has been an intensive search for blood-based biomarkers of mTBI and recently FDA has approved the first blood based mTBI diagnostic kit. Here we report, plasma ADAM-10 levels as a potential diagnostic biomarker of sport-related concussion in Ontario male adolescent ice hockey athletes (aged 12–14 years). Plasma was obtained from 12 concussed and 17 non-concussed athletes and analyzed for ADAM-10 levels using ELISA method in a blinded manner. The concussion was confirmed by sport medicine physicians using neurological tests and a Sport Concussion Assessment Tool–3rd edition (SCAT3; 13–14 years of age) or a Child-SCAT3 (for children 12 years of age or younger). The estimated time from concussion occurrence to blood draw at the first clinic visit was 2.3 ± 0.7 days. Plasma ADAM-10 levels were measured at 1855.39 ± 6.76 (mean±SE) and 4039.49 ± 17.97 (mean±SE) pg/ml in non-concussed and concussed junior hockey players, respectively (p= 0.01). Our collected data suggests that ADAM-10 may be a potential useful blood-based concussion biomarker.
Playground Injuries in Bangladesh: Does the Brain Injuries Cause A Decrease in Academic Performance? A Cross-Sectional Study

Tasnim Haque Choudhury1, Ibtida Fawjia2
1Anwer Khan Modern Medical College (akmmc), Dhaka, Bangladesh, 2Rajshahi University, Rajshahi, Bangladesh

Background Information: Little is known about the rate for school playground injuries in Bangladesh. The health survey 2003, stated children (age 1-18) has the incidence rate of 1585.9 per 100, 000 children/ year (Age 1-18); this study did not state brain injury and its consequence in academic performance. Physical activity is the most important factor for childhood development as well as healthy life for future; however, when consequences of this activity can become a risk factor for their academic performance; then public health professional should step in for the solution.

Objectives: 1) to determine the relationship between playground injury and academic performance. 2) To determine the risk factors for playground injuries in school.

Study participants: Twenty-five million boys are girls are attending 120,000 schools and all types of educational institutes between ages 5-14. We have chosen to collect injury data from five schools in Dhaka and another five schools in the divisional town of Rajshahi, Bangladesh.

Methodology: We have included students reported any injuries in the last two years that resulting hospitalization or away from school activities for three days or more. We have interviewed parents as well as the teacher of that respective injured student to reconfirm the injury and related information. We have considered the fall injuries on the school playground. A retrospective data collection for brain injury and injured student’s post-injury academic performance was evaluated by collecting information from the parent as well as the teachers from that respective school.

Expected Results and Discussion: Most of the schools in Bangladesh do not have any supervised playground. Playground equipment is minimum in quantity and there are no mandated safety standards for playground surface as well as the equipment. Students play on those grounds and experience injuries; sometimes if it is not severe or no visible sign of injury then students tend to ignore those injuries; due to lack of understanding from the magnitude of the problem, or even scare to inform parent due to consequences.

Conclusion: Strategies for reducing playground injuries require saving children’s academic life as well as their life. The public health professional should provide a guideline for the playground and its equipment. A health promotion program for playground safety issue should be in place for children, parents and school teachers. The government must act on implementing strict rules for the safety of the playground and its equipment; the rules should “address design, surfacing, and maintenance”.


Nicole Coverdale1, Allen Champagne1, Matti Allen2, Don Brien1, Juan Fernandez-Ruiz3, Jessica Trier2, DJ Cook1,4
1Centre for Neuroscience Studies, Queen's University, Kingston, Canada, 2Department of Physical Medicine and Rehabilitation, Queen's University, Kingston, Canada, 3Departamento de Fisiología, Facultad de Medicina, Universidad Nacional Autónoma de México, Ciudad de México, México, 4Department of Surgery, Queen's University, Kingston, Canada

Background: A subset of mild traumatic brain injury (mTBI) patients experience prolonged symptoms that negatively affect quality of life. In particular, some patients report specific problems with vision and balance that can be termed post-trauma vision syndrome (PTVS), including binocular vision dysfunction, photophobia, balance impairment, and other visual symptoms such as objects appearing to move. PTVS is thought to be related to dysfunction relative to focal and ambient visual processing, but little is understood about its pathophysiology. In this study, we combined resting state analyses and eye tracking to characterize differences in network connectivity and eye movements between adults with mTBI and PTVS, and healthy age- and sex-matched controls.

Methods: Thirteen adults were recruited to participate in this study (n=7 mTBI, 5F, 48±13 years, 869±470 days since injury; n=6 controls, 4F, 45±14 years). Patients were included if they had a normal MRI or CT scan, and a physician had diagnosed them as having symptoms consistent with PTVS. A dual echo pseudocontinuous arterial spin labelling sequence was performed and blood oxygen level dependent (BOLD) data were extracted from the second echo for resting state analysis. Following pre-processing of the BOLD resting images, an independent component analysis was used to identify the spatial distribution of the network of interests, which were then clustered into nodes of interests (NOI). Mean regional BOLD timeseries were extracted for each node, and correlated across NOIs, and between networks. In addition to imaging data, eye tracking was performed during a pro- and anti-saccade protocol where the colour of the central fixation point indicated whether a pro- or anti-saccade should be performed. Complete eye tracking data was obtained on a subset of participants who completed the MRI (6 mTBI and 4 controls), in order to evaluate oculomotor skills, between the groups.

Results: Compared to controls, the mTBI group had increased functional connectivity between nodes in the sensorimotor, salience, visuospatial, and high visual networks. Reaction time for voluntary saccades in the anti-saccade task was also significantly increased in the mTBI group, compared to controls (350±83 ms in mTBI versus 226±24 ms in control; p=0.02).

Conclusions: Resting state network connectivity was altered in mTBI patients with a specific set of vision and balance problems, compared to healthy controls. Also, we identified behavioural changes, observable in anti-saccade reaction time, which suggests that bottom-up oculomotor processing is intact in this mTBI population, while top-down output is impaired. These results suggest that mTBI-related alterations in vision and balance affect top-down oculomotor responses, and resting state networks related to sensation, salience and high order visual processing. Further recruitment of mTBI patients will allow us to establish possible correlations between behavioral outcomes and resting state networks.
Pressure- and Hypoxia-Induced Cellular Injury: Ex Vivo Modeling of Pediatric Hydrocephalus

Michael Smith¹, Ramin Eskandari¹
¹Medical University of South Carolina, Charleston, United States

Objectives: Hydrocephalus (HCP) is a disorder of cerebrospinal fluid (CSF) physiology resulting in abnormal expansion of the cerebral ventricles and increased intracranial pressure (ICP). HCP is suggested to be a chronic ischemic condition as clinical and experimental studies have shown that HCP is associated with decreased cerebral blood flow and oxygen delivery to the brain. Given the comorbidities of elevated ICP and hypoxia in HCP, it is critical to understand how such factors contribute to the activation of secondary cellular injury mechanisms to produce neurocognitive and motor deficits in patients with pediatric HCP.

Methods: The effects of pressure and hypoxia and pressure on 3D cellular constructs containing human astrocytes and neurons were assessed using a novel pressure-controlled cell culture incubator (PC3I) capable of maintaining both elevated pressure (30cmH2O) and a hypoxic state (1% O2). We used these cocultures in 3D alginate suspensions to better simulate the human brain. Adenosine triphosphate (ATP) release was used as a biomarker to quantify the extent of cellular injury/stress. We hypothesized that as exposure time to hypoxia and pressure increased ATP release would increase, and cellular viability would decrease. The cells were subjected to pressure and hypoxia for 2, 8, 24, and 48-hour intervals. Cell viability was determined using a LIVE/DEAD assay at Days 1, 7, and 14.

Results: In treated 3D cellular constructs, ATP release was dependent on the amount of exposure. ATP levels increased 10%, and 15% following 2 and 8 hrs of exposure, respectively. With regard to cell viability, preliminary data suggest cell viability decreased as exposure time increased.

Conclusions: Using a novel ex vivo model of neonatal hydrocephalus, our data indicate that increased pressure and hypoxia produce a significant extracellular release of ATP and may be a key in the early secondary injury response during HCP progression in the developing neonatal brain. Further experiments using this model system will be valuable to determine cellular biomarkers associated with pathological ICP.
Analysing Cognitive Assistance Provided to TBI Individuals During an Ecological Evaluation: A First Step Toward Personalized Assistance Using Assistive Technology

Mireille Gagnon-Roy1,2, Nathalie Bier1,3, Stéphanie Boulé-Riley1, Guillaume Paquette2, Sylvain Giroux4, Mélanie Couture5,6, Hélène Pigot4, Guylaine Le Dorze1,2, Nadia Gosselin1, Carolina Bottari1,2

1Université De Montréal, Montreal, Canada, 2Centre for Interdisciplinary Research in Rehabilitation of Greater Montréal (CRIR), Montreal, Canada, 3Centre de recherche de l’Institut universitaire de géiatrie de Montréal, Montreal, Canada, 4DOMUS, Université de Sherbrooke, Sherbrooke, Canada, 5Center for Research and Expertise in Social Gerontology (CREGES), Montreal, Canada, 6Integrated Health and Social Services University Network (CIUSSS) for West-Central Montreal, Montreal, Canada

Introduction: Cognitive deficits due to a moderate to severe traumatic brain injury (TBI) may greatly interfere with the completion of daily activities, such as money management and meal preparation. In this context, caregivers play a major role in compensating the difficulties and deficits of their loved one (e.g. by providing cognitive assistance or completing the task altogether), thus increasing their burden overtime. Assistive technologies, such as the Cognitive Orthosis for Cooking (COOK), are a promising way to offer personalized assistance during a task, promoting maximal use of residual abilities following a TBI and reducing caregiver burden. However, better understanding how assistance could be provided according to the person’s difficulties is required to adapt the technology accordingly.

Methodology: Fifty videos of participants living with a moderate to severe TBI and evaluated using an ecological evaluation (IADL Profile) were analysed using a coding grid to identify: (1) moments of difficulty experienced by the participant (e.g. observed behavior and underlying difficulty) and (2) the type of cognitive assistance provided in response by the evaluator. As COOK focuses on meal preparation, only tasks related to this activity (e.g. grocery shopping, preparing a hot meal) were analysed. Descriptive statistics (e.g. frequencies) were completed.

Results: Of the 50 participants, 45 required cognitive assistance to progress in the task. Main difficulties experienced by TBI participants included executing the meal (28 participants, total frequency (n) = 283), formulating the goal of grocery shopping (31 participants, n = 191) and planning their meal (27 participants, n = 145). More precisely, they needed assistance to help them formulate an adequate solution (i.e. goal formulation; 34 participants, n = 235), find alternatives (i.e. planning; 25 participants, n = 110), modify their plan when in action (i.e. execution; 17 participants, n = 102) and find items in the environment (i.e. execution; 16 participants, n = 105). Main behaviors observed when confronted with a difficulty included asking for help (44 participants, n = 280) and task breakdown (24 participants, n = 159). In terms of cognitive assistance, cues (40 participants, n = 297), giving back the control of the task to the participant (40 participants, n = 187) and stimulating the participant’s thought processes (22 participants, n = 86) were the most used types of assistance overall.

Conclusion: According to these results, cueing, giving back the control of the task to the person and stimulating thought processes are three types of cognitive assistance that could be provided to TBI individuals. Considering that cues are commonly offered by assistive technologies, further steps should focus on integrating implicit assistance such as the latter two in COOK.
Using EEG to Identify Markers of Naturalistic Stimulus Processing in Patients with Disorders of Consciousness

Geoffrey Laforge, Adrian Owen, Bobby Stojanoski
1The University of Western Ontario, London, Canada

A small but significant number of those who survive acute brain injury will transition into a state of unconscious wakefulness known as the vegetative state (VS). Patients in a VS remain behaviourally non-responsive during clinical examination and, despite exhibiting clear evidence of wakefulness, do not appear to possess conscious awareness. However, recent neuroimaging research has identified a subpopulation of these patients who reliably produce neural markers indicative of covert awareness. Indeed, brain activity (e.g., EEG and fMRI) in response to motor-imagery paradigms have identified neural signatures of covert command-following ability in nearly 20% of patients tested. More recently, naturalistic movie-watching tasks in fMRI have been used successfully to index higher-order “executive” processing in patients who appear to be entirely unconscious. In this study, we demonstrate the utility of high-density EEG recorded at the bedside during two response-free naturalistic movie paradigms to detect higher-order stimulus processing in a cohort of patients diagnosed with so-called disorders of consciousness (DoC). We used a correlated component analysis (rCA) to calculate inter-subject neural synchronization—an established measure of stimulus engagement—in 27 healthy volunteers and 13 patients with DoC during a suspenseful audio-visual and an audio-only movie-watching task. Across healthy participants, we observed a remarkably consistent pattern of EEG activity during both movie types, as well as significant and reliable group-wide inter-subject neural synchronization. We then used the common pattern of neural activity from the control group and their overall inter-subject synchrony as a benchmark with which to compare to individual patients with DoC while they watched and listened to the same movie clips. In the audio-visual movie condition, we found that 25% of the patients tested were significantly synchronized to the healthy participants. Likewise, we observed significant patient-to-control group synchronization in 30% of patients during the audio-only movie. Consistent with previous findings, our results suggest that at least one-third of patients with DoC retain the capacity to process both the sensory properties of naturalistic stimuli as well as higher-order features like their plot similarly to healthy participants. Our results demonstrate the feasibility of using bedside measures of the brain’s electrophysiological activity to identify patients with intact sensory and cognitive functions who can engage with complex naturalistic stimuli in a way that closely resembles healthy controls.
Predicting Cognitive Impairment Following Traumatic Brain Injury: A Mathematical Approach

Yanir Levy, Kewei Bian, Haojie Mao

1Western University, London, Canada

Short term effects of traumatic brain injury are known to lead to changes in cognitive behavior with long term effects leading to neurodegenerative diseases. This study looks to provide a quantitative predictor for how the direction of head impact leads to a biomechanical response in the deep brain, more specifically the corpus callosum (CC) and how this affects cognitive ability. The CC has been shown through different imaging techniques to have the largest density of fibril tract connections between the cerebral hemispheres of the brain making it the primary neural connector and an important factor for human cognitive function.

Using an imaging method known as Diffusion Tensor Imaging (DTI) a computed tractography finite element model of the fibril network was created and inserted into the Global Head Body Consortium Model (GHBCM) head and brain model. Different impact loading cases (n= 4) were simulated with similar time history impact curves (5k rad/s^2 at 10 ms) to recreate an artificial rotational impact scenario. The four cases presented in this study are: flexion, extension, rotation and lateral bend. The results of these mathematical simulations were then analyzed quantitatively for both magnitude and location of greatest maximum principal strain (MPS) as well as largest Cumulative Strain Damage Measure (CSDM). The GHBCM and DTI Fibril network of the CC finite element model showed that the peak MPS was largest in the lateral bend (0.256) this was followed by extension (0.221) and flexion (0.206) and finally rotation (0.192). The Fibril networks had opposing rankings with flexion and extension having a MPS of 0.475 followed by lateral bend at 0.31 and rotation at 0.225. These results were then validated using Cumulative Strain Damage Measure (CSDM). These results help set up the quantitative assessment of the cognitive effects of brain injury. The use of computer simulation to both diagnose and identify areas of the brain injured through reverse processing the qualitative symptoms of cognitive tests is a novel approach with many clinical and industry advantages. The goal of this study is to provide the link between cognitive tests and the areas affected by traumatic brain trauma while providing a new tool for safety manufactures to quantify the effectiveness of safety equipment designed to protect the brain.
How to Adapt Smart Home Technology for People Living with a TBI: Translating Results from a Need Analysis Into Technological Recommendations

Mireille Gagnon-Roy1,2, Nathalie Bier1,3, Érika Dubuc1, Sylvain Giroux4, Mélanie Couture5,6, Hélène Pigot4, Carolina Bottari1,2

1Université De Montréal, Montreal, Canada, 2Centre for Interdisciplinary Research in Rehabilitation of Greater Montréal (CRIR), Montreal, Canada, 3Centre de recherche de l’Institut universitaire de gériatrie de Montréal, Montreal, Canada, 4DOMUS, Université de Sherbrooke, Sherbrooke, Canada, 5Center for Research and Expertise in Social Gerontology (CREGES), Montreal, Canada, 6Integrated Health and Social Services University Network (CIUSSS) for West-Central Montreal, Montreal, Canada

Introduction: Being able to prepare meals on a daily basis may become challenging following a moderate to severe traumatic brain injury (TBI). Multiple physical and cognitive impairments, such as executive function deficits, may interfere with the person’s ability to complete the task independently and safely. To alleviate this problem, a smart home technology named COOK was developed using an action design research process with 3 participants living in a residential resource. However, COOK remained personalized to these participants’ needs. Further exploration of this clientele’s needs is required to adapt COOK to the diversity of potential users’ with TBI.

Methodology: As part of a needs analysis, individual interviews with individuals living with TBI (n = 14), caregivers (n = 8) and other stakeholders supporting individuals with TBI (e.g. educators, clinical managers; n = 5), as well as two focus groups with occupational therapists (n = 7) were conducted to 1) better understand needs of individuals with TBI regarding meal preparation and 2) their opinion about the actual version of COOK, including potential obstacles and leverages to its implementation in their clinical context. These results were then discussed with the technical team to identify how COOK could be adapted accordingly.

Results: According to the needs analysis, individuals with TBI require to be guided throughout the meal preparation task while still doing what they can by themselves. Interviews with individuals living with TBI highlighted that the complexity of the task and the level of energy required is viewed as obstacles. Hence, participants tended to either avoid the task or simplify it. Furthermore, planning meals and groceries for the week was also identified as problematic. Regarding COOK, stakeholders and caregivers mentioned the complexity of the technology and the amount of resources that should be allocated to integrate the actual version in their clinical practice.

The needs analysis will guide the adaptation of COOK in five ways: 1) provide for closer and more detailed monitoring and assistance by integrating more sensitive activity recognition algorithms, 2) add recipes that can be easily simplified and take into account the level of energy of the person, 3) improve the current meal planning tool of COOK, 4) improve the grocery list by linking it to an app on the user cell phone to use it at the grocery store and 5) simplify the hardware to facilitate its implementation in the home of the person with TBI.

Conclusion: The results highlight the need to personalize COOK according to the abilities of individuals living with TBI while facilitating its use and implementation by stakeholders. Further studies should focus on implementing COOK and assess its efficacy in home environments.
Automated Cerebral Assessment with Mild TBI: An Effective Screening Tool

Frank Sparadeo¹², Andrew Karp¹, David Petrocelli³

¹Center for Community Independence, West Warwick, United States, ²Salve Regina University, Newport, United States, ³University of Massachusetts, Dartmouth, United States

The use of cognitive screening methods for determining the presence of cognitive impairment in patients with a history of recent concussion (diagnosed in the emergency department following injury) have been limited to measures of varying sensitivity. The use of standardized mental status examinations has been a poor method of screening while computer-based methods have been difficult to administer and interpret. Recently an automated cerebral assessment technique was developed for the objective detection of cognitive impairment in people above the age of 55. The measure (Cognivue) is stated to be a method of detection of cognitive impairment that may signal the early phases of progressive dementia. Cognivue was created to provide healthcare practitioners with rapid, quantitative assessments of an individual’s cerebral function. Cognivue is related to psychophysics in that it engages an individual in continuous stimulus-response paradigms that demand intervening cerebrocortical processes. Cognivue technology is a non-invasive and non-intrusive computerized assessment device. The viability of Cognivue in detection of cognitive difficulty related to dementia has been supported by a number of investigations. In view of its sensitivity with very early cognitive change in patients who eventually go on to develop dementia it was thought that Cognivue could possibly be a good screening measure of cognitive impairment in people diagnosed with concussion and post-concussion syndrome. Two groups were assessed: patients with a diagnosis of concussion within the previous year (n = 20) and healthy volunteers (n = 15). Patients had been diagnosed with concussion/mTBI according to established criteria of the American Congress Of Rehabilitation Medicine (Mild Traumatic Brain Injury Committee) in 1993, which requires the presence of at least one of the following symptoms: initial loss of consciousness <30 min; PTA lasting <24 h; a GCS score of 13–14 at time of injury; a GCS of 13–15 after 30 min; altered mental state at the time of the accident (e.g., confusion, disorientation, etc.); or a focal neurological deficit that may or may not be transient. Each subject was required to respond to 10 measures. Of the 10 measures 4 were specific measures of perceptual processing (visual discrimination) and 4 measures were memory tests. The other 2 measures were composite measures of perception and memory. Additionally, there were composite measures of motor control, visual salience and an overall average score. Analysis of variance comparing means on age was not significant with an average age for mTBI subjects at 42 and normal at 47. Analysis of Variance comparing all of the 8 cognitive variables and the composite scores was significant indicating that mTBI subjects performed significantly lower on all measures (perceptual tests and memory tests). All of the mTBI subjects were administered a comprehensive neuropsychological evaluation and all demonstrated impairment.
Academic Concerns, Requested and Received Support Among Adolescents in the Four Weeks Following a Concussion Injury: A Pilot Study

Traci Snedden, Alison Brooks, Eric Post

University of Wisconsin-Madison, Madison, United States, San Diego State University, San Diego, United States

Background: Even short-term cognitive challenges place adolescents at risk for achieving academic success and attaining career goals. Of concern, post-concussion cross-sectional studies have found alterations in cognitive ability that cause learning issues upon return to the classroom. Findings have prompted guidelines for supporting return to learn post-concussion in recent statements released by the Centers for Disease Control and Prevention, the American Academy of Pediatrics and the 5th International Conference on Concussion in Sport. However, a gap exists specific to academic concerns and needs for support using a prospective longitudinal design.

Objective: The purpose of this pilot study was to describe the scope of academic concerns, requested and received academic support among adolescents in the four weeks following a concussion injury.

Methods: Prospective longitudinal pilot study. Adolescents, aged 13-18 years, were enrolled within 7 days of diagnosed concussion injury. Academic effects requested and received support were assessed by electronic survey at 4 time points across 28 days, each one week apart. In addition, the surveys also inquired about injury history, reporting behavior, healthcare services utilized, symptoms and health-related quality of life over time.

Results: Overall, 37 adolescents (51.4% female, mean age: 16.4±1.4 years) provided sufficient data for inclusion. Preliminary analysis noted a decrease in the frequency of academic concerns over time in the 4 weeks following the concussion, with 37.8% (n=14) of subjects reporting challenges in one or more of their classes in the first week after their concussion, compared to 10.8% (n=4) reporting challenges 28 days following concussion. The classes with the largest proportion of problems at 28 days following concussion were Math and Science, respectively. A decrease in requested supports over time was also noted, with 48.6% (n=18) requesting some form of academic support in the first week following concussion compared to 13.5% (n=5) by the 28-day time point. The most commonly requested academic supports across all time points were extra time to complete work, followed by reduced homework, reduced or waived makeup work, and a shortened school day. At 28 days following concussion, 10.8% (n=4) of subjects still reported requesting extra time to complete work. Received academic support was also greatest in the first week following concussion (40.5%, n=15) and declined over time until the 28-day time point (16.2%, n=6).

Conclusions: High rates of academic concerns, requested and received supports were reported in the first week following concussion. In addition, a concerning proportion of adolescents continued to report academic concerns and needs for academic support four weeks after they sustained a concussion. These pilot findings suggest a need for greater attention to the academic effects of concussion and related support needs in the classroom. Future research should replicate this prospective pilot study in a larger scale investigation.
Comparison of Clinical and Technological Vestibular and Visual Assessments in Moderate/Severe Traumatic Brain Injury Patients

Julie Joyce1,2, Kathryn Schneider2,3,6,7, Cody VanRassel3, Mathilde Chevignard4, Michal Katz-Leurer5, Isabelle Gagnon8, Chantel Debert1,2

1Department of Clinical Neurosciences, Division of Physical Medicine and Rehabilitation, University of Calgary, Calgary, Canada, 2Hatchick Brain Institute, Calgary, Canada, 3Sport Injury Prevention Research Centre, Faculty of Kinesiology, University of Calgary, Calgary, Canada, 4Service de Rééducation des Pathologies Neurologiques de l’Enfant Pôle de Rééducation et Réadaptation de l’Enfant, Hôpitaux de Saint Maurice 14, Saint-Maurice, France, 5Department of Physical Therapy, School of Health Professions, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel, 6Alberta Children’s Hospital Research Institute, Calgary, Canada, 7Evidence Sport and Spinal Therapy, Calgary, Canada, 8Research Institute of the McGill University Health Center, School of Physical and Occupational Therapy, McGill University, Montreal, Canada

Introduction: The World Health Organization predicts that by 2020 traumatic brain injuries (TBI) will be the most common cause of death and persistent injuries worldwide. Visual and vestibular deficits are particularly prevalent following TBI. Due to limitations of current assessment techniques, these deficits often go unnoticed by clinicians. The purpose of this study was to identify alterations in oculomotor, vestibular, and dynamic visual attention that occur following TBI and to investigate whether novel technological assessments would improve clinicians’ abilities to detect these TBI-induced deficits.

Methods: A convenience sample of ten participants who had suffered a moderate or severe traumatic brain injury between the ages of 18-50 years were invited to participate. This case series, feasibility and validation study is part of a transnational collaborative research program evaluating vestibulo-ocular deficits across all ages and the TBI severity spectrum (with sites in Calgary, Montreal, Paris, and Tel-Aviv). The Quality of Life after Brain Injury (QOLIBRI), Post-Concussion Symptom Inventory (PCSI), and Dizziness Handicap Inventory (DHI) questionnaires were administered. All participants underwent a neurological and cervical exam as well as clinical and technological oculomotor, vestibular, and balance assessments. The Neurotracker was used to assess dynamic visual attention. All assessments were performed as soon as possible once medically cleared for rehabilitation. Descriptive statistics were run for demographic information and primary outcome measures.

Results: Ten inpatients (9 males; 1 female) with a median age of 37.67 years (IQR 31.71-46.90 years) with severe TBI in Calgary, Alberta, Canada have completed the assessments. The participants had a median of 14.00 years of education (IQR 13.00-15.25 years). Median time since injury was 39.12 days (IQR 25.85-56.03 days) with a median Glasgow Coma Scale score thirty minutes post-injury of 4 (IQR 3-5.5). 7/10 reported increased balance difficulties and 5/10 participants reported increased visual problems post-injury on the PCSI. 8/10 participants reported dizziness on the DHI with a median score of 22 (IQR 3-28). Cervical spine fracture, poor static visual acuity, facial fractures, skull sensitivity and orthopedic injuries limited which tests could be performed. Primary outcome measures of clinical versus technological assessments aligned in 1/6 for vestibular (clinical dynamic visual acuity test, InVision dynamic visual acuity test), 6/9 for oculomotor (clinical saccade test, Otometrics saccade test), and 7/9 for balance (Balance Error Scoring System, National Institutes of Health Toolbox Standing Balance Test). Median Neurotracker threshold score was 0.58 m/s (IQR 0.07-0.78).

Conclusion: Preliminary analyses suggest that technological evaluation of vestibulo-ocular deficits following TBI extends current clinical assessments. Limitations to testing included cervical spine fracture, poor static visual acuity, facial fractures, skull sensitivity and orthopedic injuries. Further research is required to
investigate the technological measures for assessment of vestibulo-ocular impairments in the adult moderate/severe TBI population.
More Stakeholders with Fewer Issues Instead of Fewer Issues with More Stakeholders

Chad Debison-larabie¹, Peter Athanasopoulos¹, Ruth Wilcock²
¹Ontario Neurotrauma Foundation, Toronto, Canada, ²Ontario Brain Injury Association, St. Catherines, Canada

Introduction: There is no provincial platform in Ontario to connect persons who are living with persistent symptoms of concussion. Approximately 157,000 Ontarians are diagnosed with a concussion each year and roughly 15 to 20% (23,550 – 31,440) go on to live with persistent symptoms which negatively affects their quality of life and places a significant burden on the healthcare system. By connecting existing stakeholders (caregivers, persons with lived experience and their family members) to a provincial platform, all regions within Ontario can be represented allowing common issues to be identified and prioritized for people experiencing persistent symptoms. This will help patients receive the right care, at the right time, from the right providers. This approach is based on the Ontario Spinal Cord Injury (SCI) Alliance which represents approximately the same number of stakeholders in Ontario (32,000) and has been effective in sustaining government relations and funding.

Methods: The Provincial Advisory Network has been created to not only unify the voice of persons with lived experience but to allow for a more coordinated and systematic approach when organising collective political strategy toward government relations. The Government of Ontario has divided the province (over 14 million people) into 14 health regions and the Provincial Advisory Network has established coordinators within each region to ensure equal representation of stakeholders. The Provincial Advisory Network is capitalizing on the brain injury association networks to help formulate strategies and engage people from all ages and all types of concussion incidences (falls, sports, motor vehicle collisions etc.). The Ontario SCI Alliance is a key consultant in this methodology.

Results: The feedback which is retrieved in the form of surveys, questionnaires, focus groups, telecommunication and committee meetings from each of the 14 regions is continually analyzed to determine if it has local or provincial implications and whether it needs to be consulted with the healthcare sector, social services sector and/or different levels of government. The network is also used to disseminate materials on emerging trends in policies, benefits and issues relating to concussion in addition to helping regions learn from one another on how to better approach system challenges. The Provincial Advisory Network currently has over 300 stakeholders and is projected to grow to 4000-5000 stakeholders in three years’ time.

Discussion: The Provincial Advisory Network supports the development of an articulated provincial strategy to amplify the voice of the community of people living with persistent symptoms of concussion. This provincial platform is helping identify the most important issues to address and acts a two-way communication channel between the healthcare system and community. This platform will serve as a foundation to address the full spectrum of traumatic brain injury.
A Case Report on Pediatric Anti-NMDA Receptor Encephalitis: High-Index of Suspicion Leads to Proactive Treatment Initiation and Early Diagnosis

Amy Schlegel¹, Mi Ran Shin², Melissa Fleming²
¹Edward Via College of Osteopathic Medicine, Carolinas Campus, Spartanburg, United States, ²Children’s National Medical Center, Washington D.C., United States

Objectives: Early immunotherapy has been linked to improved outcomes in cases of anti-NMDA receptor encephalitis; however, a high index of suspicion is needed to test and treat. Even within an optimal time-frame, disease management challenges persist. This case demonstrates the importance of maintaining a high index of suspicion for autoimmune encephalitis in healthy children with new neurological abnormalities.

Methods: A previously healthy 4-year-old boy presented with a focal seizure in the setting of fever with subsequent right-sided weakness, dysmetria, and ataxia. MRI was not concerning for stroke. Initial LP had negative cultures and mild pleocytosis and was found to be stable on repeat procedure one day later at which time additional autoimmune labs were sent. The patient was started on oxcarbazepine for clinical seizures unable to be captured on EEG; on clonazepam for abnormal movements of the right upper extremity, face, and tongue consistent with chorea; and on IVIG plus steroids for suspected autoimmune etiology of symptoms. Improvements with strength and coordination were noted in response to IVIG and steroid course and the patient was discharged home. Two days after discharge, the patient was readmitted for headache, vomiting, and right-hand pain. After observation, he was again discharged with symptoms attributed to acute viral gastroenteritis with dehydration. No new concerns were noted during the patient’s follow up with his pediatrician two days later. That night, however, he was unable to walk and demonstrated difficulty with speech. He was readmitted with worsening right-sided weakness, gait instability, word-finding difficulty, and paucity of speech.

Results: During third readmission, three weeks from initial presentation, the patient’s autoimmune CSF labs resulted with positive NMDA antibody. On exam, neuropsychiatric symptoms began to emerge. Imaging for a possible paraneoplastic origin including testicular teratoma was negative. Aggressive treatment with plasma exchange was initiated, along with consideration for rituximab.

Conclusions: While neuropsychiatric abnormalities are common in anti-NMDA receptor encephalitis, they may not be the presenting symptom. This case demonstrated the typical rapid and progressive course, but in a somewhat vacillating manner, emphasizing the importance of high clinical suspicion for appropriate initial work-up and preemptive treatment. Antibodies are essential to making the diagnosis but cannot feasibly be used as initial diagnostic criteria. In this case, CSF autoimmune labs were sent within 72 hours of initial presentation based on new seizure and new movement abnormality, resulting in early diagnosis. Even with the timely testing and proactive initiation of immunotherapy demonstrated in this case, determining the most effective treatment modalities to maximize patient response and subsequent outcomes remains a challenge in anti-NMDA receptor encephalitis.
Progressive Neurodegeneration Across Chronic Stages of Moderate to Severe Traumatic Brain Injury

Zorry Belchev1,2, Asaf Gilboa1,2,3, Malcolm Binns1,2, Brenda Colella3, Mark Bayley1,3, David Mikulis1,4, Robin Green1,3

1University of Toronto, Toronto, Canada, 2Rotman Research Institute at Baycrest, Toronto, Canada, 3Toronto Rehabilitation Institute, Toronto, Canada, 4Krembil Research Institute, Toronto, Canada

Conventional models of traumatic brain injury (TBI) typically assume a neurological status that stabilizes following the resolution of the acute consequences of the injury. However, recent longitudinal studies of moderate-to-severe TBI indicate that in addition to the immediate impact, there is chronic neurodegeneration of gray and white matter at least up to 3 years post-injury. This degeneration has been found to occur both cortically in frontal, temporal and occipital regions, as well as subcortically in the hippocampus, thalamus, and amygdala (Cole et al., 2018). Findings from our group show progressive integrity loss to the fornix (Adnan et al., 2013), and volumetric losses in the hippocampus, corpus callosum and whole brain (Green et al., 2014; Ng et al., 2008). We extended these findings by examining regional gray matter trajectories in the same chronic TBI group across approximately 5 to 12 to 32 months post-injury, using a segmentation protocol sensitive to lesions (MALP-EM). The extent of volume loss in patients was assessed by comparing their monthly percent change to healthy controls scanned at two time points, comparable to the delay between 5- and 12-months post-injury in patients, as well as controlling for intracranial volume differences between scans. We first examined MALP-EM subcortical regions of interest: thalamus, brainstem, hippocampus, amygdala, accumbens, whose acute volumes have previously been shown to predict long-term functional outcome (Ledig et al., 2017). We found chronic volume loss between 5- and 32-months post-injury in four of these structures (thalamus, brainstem, amygdala, accumbens) and marginally for the hippocampus. We then conducted an exploratory principal component analysis (PCA) of the trajectory across all bilateral MALP-EM gray matter regions from early-to-later chronic stages using principal component analysis on their linear slopes across the three scan times. Two components displaying significant atrophy that significantly differed from controls involved some of the ROI subcortical structures, including the thalamus, amygdala and accumbens. The full set of structures implicates subcortical and temporal atrophy, and atrophy in basal ganglia structures. This may suggest that while for cortical regions, closer to areas of impact, acute volume changes stabilize, subcortical regions may be differentially affected by protracted white matter inflammation, as well as other sustained pathology such as metabolic dysregulation. Finally, an additional PCA examined nonlinear trends across early-to-later chronic stages. It showed no significant nonlinear relationship, suggesting sustained stabilization as well as progressive decline in respective regions throughout this chronic period. Taken together, our findings indicate that although volume loss progresses across the early-to-later chronic stages post-TBI, it seems localized to subcortical regions when accounting for normal decline across time. Overall, our findings of continued neurodegeneration in chronic TBI survivors emphasizes the necessity of developing interventions to offset this progressive loss and improve long-term functional outcomes.
Social and Sexual Functioning Among Emerging Adults With Traumatic Brain Injury: Systematic Reviews From a Developmental Perspective

**Kojo Mintah**, Deborah Tang

1York University, Toronto, Canada, 2Clinical Director Mind Forward Brain Injury Services, Mississauga, Canada

Background: Emerging adulthood is associated with the highest incidence rate of traumatic brain injury (TBI; McKinlay et al., 2008). This is when most youth consolidate the requisite skills for dating and romantic relationships (Connolly et al., 2014), however the literature on social or sexual functioning after TBI fails to adequately address dating adjustment at this key developmental stage (Rosema et al., 2012; Simpson et al., 2017). Systematic reviews of the social functioning and sexuality literatures related to TBI were conducted to understand factors that might impact dating adjustment in this population.

Methods: Search terms related to TBI were crossed with terms related to social functioning (study 1) or sexuality (study 2). CINAHL, Medline, and PsycInfo databases were used in both studies. However, Cochrane Databases used in study 1 was replaced with Web of Science in study 2, to improve international reach. Quantitative articles published after 2011 that were not intervention or case studies were included in study 1. However, because study 1 articles overwhelmingly focused on young children, and TBI-sexuality studies were rare, study 2 included empirical articles of any type published after 1980, which excluded young children. We extracted each article’s objectives, sample characteristics, study design, dependent variables, and main findings.

Results: A total of 50 out of 442 articles in study 1, and 34 out of 1137 articles in study 2 met inclusion criteria. Most study 1 articles were cross-sectional (84%), did not feature emerging adults (96%), and investigated social adjustment (74%). The largest groups of study 2 articles were cross-sectional (59%), did not focus on emerging adults (88%), and investigated sexual dysfunction (47%). Research continues to associate TBI with cognitive, social-cognitive, social interaction, and social adjustment difficulties, however relatively few studies investigate the interrelations between these difficulties. Family dysfunction and low SES were risk factors, and friendship support was a protective factor, for children's social adjustment. Research associates TBI with sexual problems in terms of physiological arousal, knowledge, functioning, appropriateness, relationships, identity, and satisfaction, but investigations of sexual knowledge are rare. Little research investigates interrelations between these problems. Family functioning, health care services, and SES difficulties were risk factors for sexual problems in some of these areas.

Discussion: Research continues to consistently demonstrate social and sexual problems in the TBI population likely to compromise dating adjustment. However, research mainly confirmed social problems among young children or sexuality problems among adults in relationships, with very few studies on emerging adults. Few studies assessed interrelations between domains of social or sexual problems proposed in prominent theoretical models. Initiating and maintaining romantic relationships is a key developmental task for emerging adults and more research in this area is needed to support TBI survivors at this developmental stage.
Longer Sleep Duration Associated with Improved FIM Efficiency in Inpatient Traumatic Brain Injury Patients

Soha Sadeghikhah1, Victoria Whitehair1
1Case Western Reserve University/MetroHealth Hospital, Cleveland, United States

Background: Sleep duration and timing are critical in cognitive and physical performance, and disrupted sleep negatively affects function. Studies have linked the role of sleep to learning and memory consolidation. More recent studies have shown disturbed sleep patterns as a result of brain injury. As learning is one of the core principals of neurorehabilitation, our objective was to study the association between sleep duration and functional outcomes of brain injury patients in the acute rehabilitation setting. Since patients needing rehabilitation in the US are allotted a limited length of stay in the acute rehab setting, efficiency in functional improvement is an important outcome measure. This was the basis of our study’s outcome measure.

Methods: This retrospective study compiled data from 200 TBI patients that were admitted to the brain injury unit during a two-year period. We compared the FIM efficiency, calculated as FIM gain per day (discharge FIM score minus admission FIM score, divided by length of stay), FIM motor gain, FIM cognitive gain and total FIM gain to mean duration of sleep per night. Based on the mean sleep hours of all study patients, two different sleep-duration categories were used: one comparing patients with recorded <5.5hrs vs >=5.5hrs of sleep, and one comparing patients with recorded <6.0hrs vs >=6.0 hours of sleep per night.

Results: There was a statistically significant difference in the FIM efficiency of the >=5.5 hrs vs <5.5 hrs groups (1.13 vs 1.66, mean difference 0.46, p<0.01). We did not find such difference in the FIM gains motor (27.32 vs 24.91, mean difference 2.41, p<0.23), cognitive (6.90 vs 7.06, mean difference -0.16, p<0.81) or total (34.21 vs 31.96, mean difference 2.25, p<0.36). Similar, although less statistically significant results were found in FIM efficiency between the >=6.0 hrs vs <6.0 hrs groups (2.16 vs 1.81, mean difference 0.34, p<0.05). When compared to the <5.5 hrs sleep group (n=54), descriptive data for the >=5.5 hrs group (n=154) included younger patients (49 vs 55), more females (25.3% vs 18.5%), shorter mean length of stay in a) acute hospital (9.77 vs 16.22 days) and b) rehab hospital (17.01 vs 19.35 days) and higher admission GCS (11.49 vs 10.26).

Conclusion: The findings suggest that a longer duration of sleep in the inpatient rehabilitation setting is associated with higher FIM efficiency (total FIM gain per day). Our findings add to studies that have shown the association of sleep quality and neurorehabilitation. Further studies taking a prospective approach to better measure sleep quality and control confounders during the inpatient stay may provide better insight into the required amount and quality of sleep to achieve high functional outcome efficiency.
Correlation of Skull Deformation and Brain Biomechanics under Blunt Impacts

Hesam Moghaddam\textsuperscript{1}, Ashkan Eslaminejad\textsuperscript{2}, Mariusz Zziejewski\textsuperscript{2}, Ghodrat Karami\textsuperscript{2}

\textsuperscript{1}Northern Arizona University, Flagstaff, United States, \textsuperscript{2}North Dakota State University, Fargo, United States

Traumatic brain injury (TBI) is a major health concern as about 2.9 million people suffer TBI every year only in the United States. Fall, accidents, and sports are major causes of impact induced TBI. While many finite element (FE) head models have been developed to understand the biomechanics of TBI under impact, the majority of them have overlooked the effect of skull deformation on the biomechanical responses of brain during blunt impacts. To this end, a FE study was carried out to investigate the correlation of skull deformation with brain’s tissue responses under blunt impact. Six frontal impacts of different severities representing minor to severe impacts were simulated using LS-DYNA nonlinear FE solver. North Dakota State University Finite Element Head Model (NDSUFEHM) was impacted against a rigid cylinder at a 45º tilted orientation using six different impact velocities, namely 2, 4, 6, 8, 10, and 12 m/s. This head model includes the major anatomical components of the head including scalp, skull, brain, cerebrospinal fluid (CSF), facial bone and skin, meninges including pia and dura mater, tentorium, falx and neck bone and skin. Skull and brain tissue were considered as viscoelastic and hyper-viscoelastic materials, respectively, while the rest of the head components were considered as linear elastic. The neck was fixed to avoid rigid body motion. Maximum skull deformation (MSD), maximum shear stress (MSS), and peak intracranial pressure (ICP) were recorded in regions of interest (ROI) for all impact scenarios. ROIs were defined as a group of elements including and surrounding the element with highest value of the biomechanical parameter. Our primary results suggested a positive correlation between the MSD and ICP while little to no correlation was found between MSD and MSS. Based on our initial findings, we concluded that the maximum skull deformation could reveal useful information about the risk of concussive injuries, which are associated with ICP levels, while further investigation is needed for predicting diffuse injuries that are caused by shear stresses within the tissue. Further investigation is needed for other impact directions as well as including the maximum tissue strains in the correlative study.
Neurocognitive Side Effects of Mirabegron in a Concussion Patient

Jason Edwards1, Susan Loughlin2, Cindy Ivanhoe1,2,3

1University of Texas Health Science Center At Houston / McGovern Medical School, Houston, United States, 2TIRR Memorial Hermann, Houston, United States, 3Baylor College of Medicine, Houston, United States

A 28-year-old male with history of post-concussive syndrome due to several hockey related concussions 10 years ago, associated transient ataxia, memory loss and headaches was prescribed mirabegron by his urologist for overactive bladder. The patient noted worsening cognitive function, increased irritability, and mood changes within 4-6 weeks after starting this medication. Mirabegron was discontinued with complete resolution of patient’s symptoms.

Mirabegron, a selective beta-3 adrenergic receptor (ADRB3) agonist, is widely thought to act on beta-3 adrenoreceptors primarily in the peripheral nervous system due to poor blood brain barrier permeability. However, beta-3 adrenoreceptors are found in the human brain, and animal studies with mirabegron have shown an increase in regional brain metabolism greatest in the frontal cortex.

Caution should be exercised in the use of novel medications as patients with brain injuries may be more susceptible for potential central nervous system side effects.
A Case Report of a 47-Year Old Woman Presenting with a History of Multiple Sports-Related Concussions and Experiencing Severe Neurodegenerative Symptoms

Samuel Guay\textsuperscript{1,2}, Alex Desaultels\textsuperscript{1,2}, Louis De Beaumont\textsuperscript{1,2}

\textsuperscript{1}Research Centre, Hôpital Du Sacré-coeur De Montréal, Montreal, Canada, \textsuperscript{2}University of Montreal, Montreal, Canada

Background: With the annual prevalence of sports-related concussions reaching epidemic proportions, the long-term consequences of sports-related concussions have come to the forefront of the public conscience, with Chronic Traumatic Encephalopathy (CTE) gaining [most of] all the media attention lately. While CTE is considered the most debilitating aftereffect of exposure to head trauma, it is not the only condition that an athlete can develop during her lifetime. Other conditions during the chronic phase after sports-related concussions can alter significantly the quality of life of athletes such as persistent post-concussion syndrome or disruption of the autonomic nervous system to name a few. Yet, dysautonomia and multiple-system atrophy have been associated with exposure to traumatic brain injuries, especially in women. In parallel, sparse evidences showed comorbidity of CTE in multiple-system atrophy-confirmed cases. During this presentation, we will showcase a case report of a living patient who suffered multiple sports-related concussions during her lifetime and was given several different diagnoses before enrolling in our research program investigating the long-term of sports-related. The case report aims to highlight challenges with diagnoses and management of complications when all treatments have failed so far. Emphasis will be given to the need and the usefulness for a longitudinal multimodality assessment of all biopsychosocial aspects of the patients, from neuroimaging to polysomnography. This case study will be presented to demonstrate the complications that can worsen after multiple sports-related concussions and the difficulty to treat such complications.

In brief, it's the case of a 47-year-old former gymnast without any prior medical or psychiatric history who was diagnosed 7 sports-related concussions and exposed to many more subconcussive impacts during her athlete career. Before our baseline evaluation, she had already experienced symptoms such as transient loss of consciousness on exertion, loss of balance, sleep problems for several years. She underwent a multimodality assessment over several days as a baseline evaluation: a 4-hour long neuropsychological exam, a neurological exam, gait and strength testing, a state-of-the-art 60-minutes 3T MRI protocol, TAU and Amyloid positron-emission tomography, polysomnography as well as a lumbar puncture. Six months after our baseline evaluation, her condition worsened in that she can lose consciousness when she intensely focusses during a cognitive task. So far, her cognition appears to be normal, but not her physical evaluation. In-depth results of the baseline evaluation as well her present condition will be described during the presentation.
Charles Bonnet or Anton’s Syndrome? Overlapping Symptoms in a Young Patient with Cortical Blindness from Anoxic Brain Injury

Victoria Whitehair1, Soha Sadeghikhah1
1Case Western Reserve University/MetroHealth Hospital, Cleveland, United States

Case Diagnosis: Cortical blindness is loss of vision from damage to the geniculocalcarine pathway. Common causes include hypoxia and ischemia. Cortical blindness can be complicated by visual hallucinations (Charles Bonnet Syndrome) and by visual anosognosia and confabulations (Anton’s Syndrome).

Case Description: A 23-year-old male sustained anoxic brain injury (ABI) secondary to cardiac arrest. Initial neurologic testing in the ED including EEG and CT head showed no focal abnormalities. Further brain imaging was not performed throughout his acute hospital stay. Upon admission to inpatient rehabilitation, assessment revealed vision loss with preserved pupillary responses, suggestive of cortical blindness. This was accompanied by visual anosognosia, leading to agitation and visual hallucinations and limiting recovery. Confirmatory testing through advanced neurologic imaging was not available during rehabilitation. Psychiatry determined the patient’s hallucinations and psychosis were not due to a primary psychiatric disorder. Clinical diagnosis of cortical blindness was presumed, and the patient’s symptoms were managed with antipsychotics, dopaminergics and sleep aids. Over the course of his three-week admission, there was a decrease in agitation, visual hallucinations and confabulation.

After discharge and upon admission to an outside hospital after a fall, MRI brain confirmed our suspicion for occipital lobe damage, and explanatory finding for cortical blindness.

Discussion: Among ABI patients, cortical blindness is relatively uncommon (11% affected). Rarer still, is the association of visual hallucinations in this setting, termed Charles Bonnet Syndrome, though this syndrome is thought to be under-reported. Case reports have suggested treatment of such symptoms with SSRI’s and anti-dopaminergics. In addition to the above, our patient also showed all aspects of Anton’s syndrome, which is characterized by visual anosognosia and confabulations. Though no objective imaging studies were available during rehabilitation, our clinical suspicion for cortical blindness leading to one of these syndromes led us to use combination pharmacotherapy which decreased symptomatology and increased therapy participation.

Conclusion: Review of this challenging case demonstrates the need for a high index of suspicion for cortical blindness and its associated syndromes in ABI patients with visual impairment. Assessment for accompanying visual hallucinations, denial and confabulations will aid in making the proper diagnosis and implementing appropriate management. As in our patient, rare cases may present with overlapping symptoms of the classically taught syndromes, especially in the acute period after injury. The importance of maintaining clinical suspicion for Charles Bonnet Syndrome or Anton’s Syndrome should be further emphasized in a setting where advanced neurologic testing is not readily available, as in our case, in an acute inpatient rehabilitation hospital.
Head Injury Management in Austere Environments - A General Surgery Perspective

Aman Arora¹, Tony Rappai¹,², Eranki Sibi¹, Rishi Dhillan¹
¹Armed Forces Medical Services India, Meerut, India, ²Senior Advisor and HOD Department of Neurosurgery Base Hospital Delhi Cantt, New Delhi, India, ³Graded Specialist Surgery Department of General Trauma and Laparoscopic Surgery, Meerut, India

Background: In most developing countries access to tertiary care neurosurgical setup remains a mirage for most patients. Majority cases of trauma including Neurotrauma present to a general surgeon. This study is an attempt to highlight the importance of head injury management as a skill amongst general surgeons & also focus on the challenges in managing such cases in austere environments.

Methods: This study was a retrospective analysis of progressively collected data of trauma patients with a specific focus on head injuries in a level 2 trauma center in a semi urban area over a period of two years from August 2016 to September 2018.

Results: A total of 710 patients of trauma were analyzed out of which 392 were head injuries. Road traffic accidents accounted for nearly 77% of head injuries. Atypical trauma especially in rural setup e.g. train collision while crossing railway track, animal related causes of head trauma were also seen. Male patients accounted for majority of cases (M: F = 2.6 :1). Mean Age was 37 yrs. 104 patients had Imaging findings suggestive of severe head injury. Acute SDH was the commonest finding. 18 Patients underwent emergency neurosurgical intervention with a survival of 61%. Factors associated with poor outcome were delayed presentation (p< 0.05), SDH with Diffuse axonal injury / Multiple hemorrhagic contusion in brain parenchyma. Alcohol consumption was a significant factor in road traffic trauma.

Conclusion: Head Injury management is an essential skill for general surgeons. Management of such cases in a low resource environment in absence of modern-day facilities for imaging, ICP monitoring and powered equipment presents a significant challenge in treatment of such cases. General surgeons should be able to perform operative interventions with basic handheld instruments. Resource limitation should not hamper the operative interventions and should be carried out as and when required in order to achieve favorable outcomes in such cases.

Keywords: Head Injury, Craniocerebral trauma, rural health, Glasgow coma scale, Glasgow outcome scale, Neurosurgery.
Acceptance of a Sleep Hygiene Protocol on an Inpatient TBI Rehabilitation Unit: Patient, Family and Nursing Perspectives

**Jody Newman**, Kimberley Monden, Donald Gerber, Angie Philippus, Heidi Schneider, Jennifer Biggs, Alan Weintraub, Eric Spier, James Schraa, Lori Womeldorf, Michael Makley

1Craig Hospital, Englewood, United States, 2CNS Medical Group, Englewood, United States

Objective: This study is part of a larger project exploring the feasibility of implementing a sleep hygiene program on an inpatient TBI rehabilitation unit. Sleep disruption is common following moderate-to-severe TBI and may impact cognitive recovery and the ability to benefit from inpatient rehabilitation after traumatic brain injury. Currently, there is no gold standard for treating sleep disruption after TBI and this problem is generally not addressed in a comprehensive way for inpatients in the early phase of recovery. The objective of the current pilot study is to examine participant, family and nursing perceptions of an inpatient sleep hygiene protocol (SHP).

Methods: Twenty adults who were admitted to an acute inpatient TBI rehabilitation unit, meeting study criteria and providing consent were allocated to a 4-week SOC protocol, or a 4-week SHP. Upon completion of the protocol, participants were asked to complete a questionnaire assessing their level of satisfaction with the treatment of sleep received, and whether study participation might impact future sleep habits. A family member was asked to complete the same questionnaire, rating their own level of satisfaction with the sleep treatment received by their family member. Additionally, nursing staff involved in the participant’s care was asked to complete a survey assessing the level of difficulty implementing the treatment program to which the participant was allocated.

Results: Responses of participants, family members and nursing staff regarding an inpatient SHP indicated general acceptance of the protocol. One hundred percent of families and eighty-eight percent of patients in the SHP reported being satisfied with the sleep treatment received. Eighty percent of nurses who completed the questionnaire reported that implementing the SHP did not interfere with workflow.

Conclusions: A sleep hygiene intervention implemented on an inpatient brain injury unit was well received by patients, families and nursing staff; thus, it is both a practical and potentially nonpharmacological treatment for the common issue of disrupted sleep of individuals in the early phase of brain injury recovery.
Family Burden of Patients 10 Years or More After Traumatic Brain Injury

Shu Watanabe¹, Takatoshi Hara¹, Hideaki Akimoto¹, Ryota Fukui¹, Kumi Ikeda¹, Kazumi Kashiwabara¹, Arimasa Honda¹, Masahiro Abo¹

¹Department of Rehabilitation Medicine. The Jikei University School of Medicine, Komae-city, Japan

Objectives: Traumatic brain injury (TBI) has a substantial impact on caregivers, and the effects of moderate to severe TBI can be long-lasting or even permanent. This study describes the burden experienced by family caregivers of 344 patients who had suffered traumatic brain injury over 10 years previously.

Methods: Family caregivers of the 344 patients who suffered traumatic brain injury 10 years or more previously were asked to fill in an unpublished self-report questionnaire in order to explore their burdens and the patients’ records.

Results: In 313 patients (91.0%), loss of consciousness after injury continued for over 4 days. Of the total 344 patients (289 male and 55 females; current age: 43.6±12.3 years old; age at injury: 24.0±13.3 years old), 296 (86.0%) lived with a parent. Family burden was found to be associated with increased cognitive, emotional, and behavioral disorders of TBI patients (correlation coefficient = 0.61). Most patients (78.5%) were independent in the activities of daily living (ADL), and no statistically significant difference was found between family burden and ADL abilities of TBI patients (correlation coefficient = -0.18). Of the 344 patients, 220 were employed, including welfare employment (53.6%). The non-employment group demonstrated more considerable feeling of burden to family than the employment group (p<0.01).

Conclusions: The feeling of burden to family is immense even now, after more than 10 years since the accident. The feeling is much influenced by cognitive, emotional, and behavioral disorders as TBI sequelae that are caused by frontal damage, and psychosocial problems after injury. Furthermore, the employment situation of patients is also an important factor for the feeling of burden of long-term care. In Japan, the length of hospital stay cannot exceed more than six months after injury by law. Therefore, it is necessary to focus medical intervention for an outpatient on psychosocial problems, and if possible, vocational rehabilitation is necessary for moderate to severe TBI patients, as part of community rehabilitation.
The Minimally Conscious State Plus and Minus: Clinical Features and Functional Recovery

Aurore Thibaut¹, Yelena Bodien², Joseph Giacino²
¹University of Liège, Liege, Belgium, ²Spaulding Rehabilitation Hospital, Boston, United States

Based on previous studies, command following, and intelligible verbalization appear to be clear criteria for MCS plus (Giacino et al., 2002; Bruno et al. 2012), while intentional communication is inconsistently included as a behavior that indicates the presence of language function. The aim of the current study is to develop empirically-driven diagnostic criteria for MCS plus, and specifically to determine whether intentional communication should be included as a feature of MCS plus. We hypothesized that different behaviors suggesting preserved language function (i.e., response to command, intelligible verbalization and intentional communication), and therefore may define MCS plus, are associated with distinct levels of functional disability on the Disability Rating Scale (DRS, Rappaport et al., 1982).

We retrospectively analyzed Coma Recovery Scale-revised (CRS-R, Giacino et al., 2004) and DRS scores of inpatients admitted to a specialized Disorders of Consciousness program, at time of transition from unresponsive wakefulness syndrome (UWS) to MCS, or transition from MCS minus to MCS plus, at time of admission to the program, and at time of discharge. 120 patients diagnosed with DOC were included in our study (UWS at admission: 63, women: 46; mean age: 47+/19y; traumatic etiology: 67; mean time post-injury, 40+/23d).

DRS scores at transition were significantly different between the MCS minus group and the group showing only intentional communication, only command following, or only intelligible speech. DRS total scores did not differ between the groups demonstrating one or several MCS plus features. Presenting multiple features of MCS plus at time of transition was associated with less disability as compared to the MCS minus group, but also to the groups showing only one feature of MCS plus (command following or intelligible verbalization or intentional communication). At admission, DRS scores between groups did not differ. DRS scores differed at time of discharge; patients in MCS minus had significantly higher DRS scores at discharge than any other subgroup, while the DRS of all other groups presenting one or multiple features of MCS plus were similar.

In conclusion, level of disability (i.e., DRS total score) associated with the recovery of command following, intelligible verbalization, and/or intentional communication (i.e., MCS plus) was similar across patients with any of these behavioral profiles, but significantly lower relative to patients with no evidence of language function (i.e., MCS minus), at time of transition and at discharge. Therefore, we propose a new nosology for the MCS plus syndrome based on the association between the presence or absence of specific language-related behaviors and corresponding levels of disability. To ensure consistent application of the diagnostic term MCS plus, we recommend that the following behavioral criteria be utilized: Reproducible evidence of any one of the following behaviors: (1) command-following, (2) intelligible verbalizations or (3) intentional communication.
Diagnostic Accuracy of a CRS-R Modified Score in Patients with Disorders of Consciousness

Jitka Annen¹,², Maria Filippini¹,², Estelle Bonin¹,², Helena Cassol¹,², Charlène Aubinet¹,², Manon Carrière¹,², Olivia Gossseries¹,², Aurore Thibaut¹,², Alice Barra¹,², Audrey Wolff¹,², Leandro Sanz¹,², Charlotte Martial¹,², Steven Laureys¹,², Camille Chatelle¹,²

¹GIGA Consciousness, University of Liège, Sart Tilman, Belgium, ²Coma Science Group, University hospital of Liège, Sart Tilman, Belgium

The Coma Recovery Scale-Revised (CRS-R) is the current standard diagnostic tool for patients with disorders of consciousness (DOC; [1], [2]). Differential diagnosis includes unresponsive wakefulness syndrome (UWS; eye-opening but no evidence of awareness) [3] and minimally conscious state (MCS; inconsistent behavioral signs of awareness [4]). Items in the six subscales are hierarchically ordered (i.e. from reflex to cognitive function) and lead to diagnosis [5], [6]. Using the CRS-R total score reduces its reliability (i.e., cut-off score of 10 gives 100% specificity for UWS but false negative diagnostic error of 22% in MCS [7]). Previous studies investigating markers of consciousness, recovery and treatment have used the total CRS-R score (i.e. addition of the highest scores for each subscale) as regressor [8]– [11]. Sattin and colleagues (2015) proposed a CRS-R modified score (CRS-R MS) by disentangling reflexes and cognitive behaviors, and accounting for the number of responses obtained in every subscale to distinguish between UWS and MCS patients with 100% accuracy. The calculation of this score however requires that every item of every subscale is assessed and scored, considerably increasing the duration of the exam. We propose to adapt the CRS-R MS by only using the highest score on every subscale.

124 patients admitted to the University hospital of Liège were assessed with all CRS-R items. The CRS-R total score and two CRS-R MS were calculated. The CRS-R MS combines scores for reflexes and cognitive behavior of every CRS-R subscale which can be used to obtain the CSR-R MS from a transposition matrix. The CRS-R MS was calculated as previously described by Sattin et al., (CRS-R MS1), and using only the highest score in every subscale (i.e., assuming that lower items were successful; CRS-R MS2). Receiver Operating Characteristic (ROC) and correlation between the different CRS-R scores were calculated.

The ROC analysis for both modified scores showed an AUC of 1 (cut-off: 8.315, 100% specificity and sensitivity). The ROC analysis for the CRS-R total score showed an AUC of 0.94 (cut-off: 9, sensitivity = 100%, specificity = 67%). A strong correlation was found between the CRS-R total score and both the CRS-R MS1 (r = 0.94, p < 0.0001) and CRS-R MS2 (r = 0.96, p < 0.0001), and the between CRS-R MS1 and CRS-R MS2 (r = 0.96, p = 0.0001).

CRS-R MS2 can be calculated on the assessments performed according to the CRS-R guidelines (i.e., higher items scored only in each subscale). Its shorter assessment time may reduce patients’ fatigability. For accurate diagnosis, the CRS-R should be repeated (preferably five times [13]), therefore shorter assessments may be able to preserve the patient’s motivation, reduce the administration of nociceptive stimulation (CRS-R item 1-3 of the motor subscale), and save time resources of the assessor.
Hyaluronan-Based 3D Biodegradable Scaffold for Neural Tissue Engineering in Traumatic Brain Injury

Olga Tikhobrazova¹, Arseniy Gladkov¹,², Elina Kamenskaya¹,², Eugene Kluev¹, Olga Baskina¹, Irina Mukhina¹,²
¹Privolzhsky Research Medical University, Nizhny Novgorod, Russian Federation, ²Lobachevsky State University of Nizhny Novgorod, Nizhny Novgorod, Russian Federation

Traumatic brain injury (TBI) occurs as a result of direct mechanical insult to the brain, and induces cell degeneration and death in the central nervous system (CNS). Neuro- and cell transplantation have become widely recognized as powerful experimental tools for studying structure-function relationships, development, neuroplasticity, and regeneration in the adult central nervous system and have recently shown promise in the repair of brain injury and in the restoration of function after traumatic brain injury.

The most relevant is the development of adequate carriers for transplanted cells that would create a certain microenvironment during the long process of neural networks restoration, as well as maintain the structure of brain tissue before its recovery. Currently, it is believed that such carriers are porous hydrogels that allow cells and nutrients to penetrate the matrix, and the products of life activity are excreted in the body volume, optimal in terms of mechanical compatibility with the tissues of the brain and spinal cord.

In the presented work 3D multifunctional hydrogel scaffolds-carriers of cells produced from modified high molecular weight hyaluronic acid were formed, with the use of which a complex of tasks related both to the biocompatibility and toxicity for neural cells was solved.

During the interaction of scaffold and dissociated brain cells derived from mouse embryos (E18), the absence of toxicity for neural cells, biocompatibility and adhesive properties of the material were proved. With the help of calcium imaging and multielectrode systems in vitro, the possibility of formation of complex neural networks inside the hyaluronic scaffold was revealed.

Modified hyaluronic acid scaffolds populated with neural stem cells from nasal olfactory lamina propria improve learning and sensorimotor function, reduce the lesion volume, and provide the migration of stem cells into the lesion boundary zone after TBI in mice, reduce the formation of glial scar without activation of autoimmune processes after the reconstructive surgery.
Nociception Coma Scale Revised Allows to Identify Patients with Reserved Neural Basis for Pain Experience

Estelle Bonin1, Nicolas Lejeune1,2,3, Aurore Thibaut1, Helena Cassol1, Georgios Antanopoulos1, Sarah Wannez1, Charlotte Martial1, Caroline Schnakers4, Steven Laureys1, Camille Chatelle1

1GIGA Consciousness, Coma Science Group, University Of Liège, Liège, Belgique, 2Institute of Neuroscience, Université catholique de Louvain, Brussels, Belgium, 3Disorders of Consciousness Care Unit, Centre Hospitalier Neurologique William Lennox, Groupe Hospitalier Saint-Luc, UCL, Ottignies, Belgium, 4Department of Neurosurgery and Psychiatry, University of California Los Angeles, Los Angeles, United States

The Nociception Coma Scale-Revised (NCS-R) was developed to help assessing pain in non-communicative patients with disorders of consciousness (DOC). Several studies have shown its sensitivity in assessing responses to acute noxious stimuli. However, they failed to determine a reliable cut-off score that could be used to infer pain processing in these patients.

This retrospective cross-sectional study aimed to determine an NCS-R cut-off score supporting preserved neural basis for pain experience, based on brain metabolism as measured by fluorodeoxyglucose positron emission tomography (FDG-PET).

We included FDG-PET confirmed patient with unresponsive wakefulness syndrome (UWS) (n=13) and looked at their highest NCS-R total scores. As the highest score was 4, we determined the cut-off of 5 and compared the brain metabolism of these patients with matched DOC patients with a cut-off score ≥ 5 (i.e., potential pain) and healthy controls.

We found a higher global cerebral metabolism in healthy subjects compared with both patients’ groups and also in patients with potential pain compared with FDG-PET confirmed UWS. We observed a preserved metabolism in the left insula in patients with potential pain when compared with FDG-PET confirmed UWS. We also found a preservation of the connectivity between the left insula and the medial frontal gyrus in patients with potential pain compared with FDG-PET confirmed UWS. Our data suggest that using the cut-off score of 5 can be helpful to improve pain management in DOC patients. Future studies should focus on patients showing scores below this cut-off to better characterize their profile and improve cares.

Acknowledgments: The study was supported by the University and University Hospital of Liege, the Belgian National Funds for Scientific Research (FRS-FNRS), the Human Brain Project (EU-H2020-fetflagshipbtpsga1-ga720270), the Luminous project (EU-H2020-fetopenga686764), the Center-TBI project (FP7-HEALTH-602150), the Public Utility Foundation ‘Université Européenne du Travail’, “Fondazione Europea di Ricerca Biomedica”, the Bial Foundation, the European Space Agency, the Mind Science Foundation and the European Commission. The authors thank the whole staff from the Neurology, Radiodagnostic and Nuclear Medicine departments, University Hospital of Liege and the patient. CC is a Marie Sklodowska-Curie fellow (H2020-MSCA-IF-2016-ADOC-752686).

We are highly grateful to the members of the Liège Coma Science Group for their assistance in clinical evaluations. AT is a post-doctoral fellow, and SL is research director at FRS-FNRS.
Ecological Validity of a Novel Virtual Reality Test of Attention and Executive Functions in mTBI

Eliyas Jeffay1, Avi Orner2, Karen Seward3, Konstantine Zakzanis1
1Department of Psychology, University of Toronto, Toronto, Canada, 2Department of Surgery and Family Medicine, The Scarborough Hospital, Scarborough, Canada, 3CIRA Health, Toronto, Canada

The limited ecological validity of traditional pen-and-paper neuropsychological test measures has been acknowledged in the research literature and a call to order has been put out to researchers to address this issue. The use of technology, specifically computers in clinical neuropsychology, is long overdue. The use of Virtual Reality (VR) has the potential to present some of these neuropsychological test measures in a more ecologically valid way. Several measures have been developed that are purported to be ecologically valid. However, there have been relatively few studies looking at their clinical utility with patients who have suffered from a mild traumatic brain injury (mTBI). Thus, the aim of this study was to develop and validate two novel VR-based assessments of attention and executive functions and to compare the return to work (RTW) sensitivity and specificity with traditional pen-and-paper based tests. It was hypothesized that the VR tasks would show a statistical relationship with their traditional test counterparts demonstrating good concurrent validity. In addition, it was hypothesized that the VR test measures would be more sensitive of RTW status than ecologically-oriented tests, which would be more sensitive than traditional pen-and-paper neuropsychological tests. Participants included 50 patients in the post-acute period of mTBI who continued to report persistent symptoms at the time of assessment. Of the sample, 23 were employed to some capacity and 27 were unemployed. Traditional neuropsychological tests of attention and executive functions were administered in addition to tests that were purported to be high in ecological validity (i.e., the Behavioural Assessment of Dysexecutive Syndrome [BADS], Test of Everyday Attention [TEA]). A VR-based test of executive functions called the Office Task was administered along with a VR-based test of attention called the Conveyor Belt Task (CBT). The results indicated good concurrent validity for the VR Office Task for measuring error but not for target responses, whereas good concurrent validity was found throughout all modules of the CBT. Ecological validity was evaluated via a step-wise discriminant functions analysis and means comparison with effect size analysis. The CBT and the total speed score of the Ruff Selective Attention Test were able to predict group membership. This model predicted group membership at 82% accuracy, which was supported by a split-half cross-validation. Sensitivity of this model was found to be 82.6% and specificity was 81.5%. Effect size analysis found that the CBT was the most ecologically valid test measure. Traditional tests of executive functions and the BADS also produced null results. The conclusion drawn from these findings was that performance on tests of attention were sensitive to RTW status, but executive functioning was not. These findings provide further support to the superiority of the use of advanced technology in determining outcome defined as RTW.
Characterization of Uniaxial High-Speed Stretch as an In Vitro Model of Mild Traumatic Brain Injury on the Blood-Brain Barrier

Elvis Cuevas1, Hector Rosas-Hernandez1, Claudia Escudero-Lourdes2, Susan Lantz1, Nasya Sturdyvant1, Imam Syed1, Sumit Sarkar1, William Slikker Jr1, Kartik Balachandran3, Syed Ali1

1NCTR/FDA, Jefferson, United States, 2Facultad de Ciencias Quimicas, Universidad Autonoma de San Luis Potosi, San Luis Potosi, Mexico, 3Department of Biomedical Engineering, University of Arkansas, Fayetteville, United States

Traumatic brain injury (TBI) occurs when external mechanical forces induce brain damage as result of impact, penetration or rapid acceleration/deceleration that causes deformation of brain tissue. Depending on its severity, TBI can be classified as mild, moderate or severe and can lead to blood-brain barrier (BBB) dysfunction. In the present study, we evaluated the effects of uniaxial high-speed stretch (HSS) at 0, 5, 10 and 15% on a pure culture of primary rat brain endothelial cells as an in vitro model of TBI to the BBB. LDH release, viability and apoptosis analysis, expression of tight junction proteins and endothelial permeability were evaluated 24 h after a single stretch episode. HSS slightly increased cell death and apoptosis at 10 and 15%, while LDH release was increased only at 15% stretch. Occludin expression was increased at 10% stretch, while claudin-5 expression was increased at 5% stretch, which also decreased the endothelial permeability. In summary, 15% HSS induced low levels of cell death, consistent with mild TBI and very low percentages of HSS (5%) enhanced the BBB properties, promoting the formation of a stronger barrier. These data support the use of 15% HSS as valuable tool in the study of mild TBI to the BBB in vitro.
Statewide Acquired Brain Injury School Reintegration, Consultation, and Training Programs- Decades of Experience: A Review of Three U.S. State Programs

**Brenda Eagan-Johnson**, Janet Tyler, Melissa McCart

1BrainSTEPS Brain Injury School Consulting Program, Pittsburgh, United States, 2Colorado Department of Education, Denver, United States, 3Center for Brain Injury Research and Training, Eugene, United States

Brain Injury is considered a leading medical cause of disability in children and adolescents according to the Centers for Disease Control. Yet educationally, brain injury is considered a low incidence population. Part of the disconnect lies in the under identification and misidentification of brain injured students. Hospital to school reentry planning is key. Participants will understand the challenges and obstacles facing students who have suffered a brain injury and their families in the transition back to school and the importance of engaging and collaborating with medical, school, and family during reintegration and in an ongoing way until the student graduates.

This session will focus on Return to School following all types and severities of acquired brain injury (which includes focus on concussions) and will include a review of successful state school reintegration, consultation, and training model. The presenters will begin with a historical overview of the original TBI School Re-Entry Team Model and how other state models have evolved over the years. The presenters will identify the pathway for students entering/returning to school, including hospital and school collaboration, understanding the impact an acquired brain injury has on brain development and appropriate supports and services for these students to allow for successful school reintegration. The three programs that will be discussed include Pennsylvania’s BrainSTEPS (Strategies Teaching Educators, Parents, and Students) Brain Injury School Re-Entry Consulting Model, Colorado’s adoption of the BrainSTEPS model beginning in 2016, and Oregon’s CBIRT team model. Variations of overriding school reintegration principles and best practices will be discussed regarding how each state has implemented their models. Key themes will be addressed as well as lessons learned. Data from all three programs will be shared.
Are We Underutilizing Head ‘ache’ in Minor Traumatic Brain Injury?

Christine Perera¹, Cheryl Jayasuriya¹, Damindri Walgampaya¹, KB Galketiya¹
¹Teaching Hospital, Faculty of Medicine, Sri Lanka

Objectives: This preliminary study had two main objectives. Firstly, to find out the presence of generalized headache or localized headache at site of trauma at 2 hours of injury to head in GCS 15 patients and the possibility of having a serious head injury in patients having a significant generalized headache.

Methodology: All the Patients above 16 years of age who presented to ED with a GCS of 15 at 2 hours of head injury without any previous neurology, not on any anticlotting agents were included into the study. Patients with significant other injuries were excluded. A pre-tested questionnaire was filled by the first contact medical officer at 2 hours of injury and patient was followed up again at 24hours of injury. The questionnaire included the age, gender, mechanism of injury, criteria for Canadian CT rule. The severity of headache was assessed using visual analogue. The study was conducted in a Teaching Hospital for a period of 1 month.

Results: 52 subjects were enrolled in the study in which 17(33%) were above 60 years of age. Altogether 16(30%) had CT brain and rest of the patients were sent for 24-hour head injury observation according to local protocol. Out of 16 who had CT, nearly 60% CT findings were normal. Rest of the 36 patients who sent for 24-hour observation except 2 patients who lost follow up, rest of them had no significant complain by 24 hours.

Out of 52 subjects 48 patients complained of either localized headache (29, 55%) or generalized headache (19, 36%). In which all the patients who ended up with positive CT brain complained of significant (more than 5 in visual analogue scale) generalized headache. All Patients who complained of only a localized pain at 2 hours of injury ended up with negative findings at 24 hours.

Conclusion: Significant generalized headache at 2 hours from head injury in GCS 15 patients should be concerned seriously and can be included in adult mTBI management protocols as a reliable clinical tool. Localized headache following mTBI without generalization is a good negative clinical finding.
Supporting Wellbeing Through PEeR-Befriending (SUPERB) Trial: An Exploration of Fidelity in Peer-Befriending for People with Aphasia

Nicholas Behn¹, Katerina Hilari¹, Jane Marshall¹, Alan Simpson¹, Sarah Northcott¹, Shirley Thomas², Chris Flood¹, Kimberley Goldsmith³, Sally McVicker¹

¹City, University of London, London, United Kingdom, ²The University of Nottingham, Nottingham, United Kingdom, ³King’s College London, London, United Kingdom

Background: Treatment fidelity refers to the strategies used to enhance and monitor the reliability and validity of interventions including the replication of studies. Fidelity is rarely reported in Speech and Language Therapy intervention studies. Peer-befriending is intended to improve psychosocial wellbeing for people with stroke and aphasia. It involves people with experience of the condition (i.e. befrienders) providing social and emotional support to those who have recently had a stroke and aphasia. This paper will report on the fidelity of peer befriending for people with aphasia post-stroke as part of a feasibility trial (SUPERB) underway. Aims are: (1) to investigate the adherence to protocol of peer befriending visits, and training and supervision of peer befrienders; and (2) to explore the inter-rater and intra-rater reliability of checklists designed to examine fidelity of peer befriending.

Methods & Procedures: The current study is a feasibility single-blinded, mixed-methods, parallel group phase II RCT comparing peer-befriending (n=30) vs. usual care (n=30) for people with aphasia post-stroke. Ten befrienders with mild-moderate aphasia at least one-year post stroke are recruited from the community. Befrienders will attend 5-6 hours of training (across 2-3 days) and monthly group supervision sessions with other befrienders and a facilitator. The 30 participants randomised to the peer-befriending arm of the trial will be befriended by a trained befriender. Each participant will get 6-visits (over 3-months) soon after discharge from hospital. To measure fidelity, three checklists were created for the intervention visits, training and supervision, based on the Health Behaviour Change Competency Framework (HBCCF) and Kagan’s supported conversation measures. All training and supervision sessions and one (of six) visits for each befriender-befriended pair were videotaped and rated for adherence to protocol using the checklists. Adherence is evaluated by calculating a per-cent fidelity score. Inter-rater and intra-rater reliability are calculated using Kappa statistics.

Outcomes & Results: Preliminary results are positive with high treatment fidelity scores for 2 training workshops (93.8%), 10 group supervision sessions (92.9%-100%) and 8 intervention visits (87.5%-100%). Inter- and intra-rater reliability could not be calculated on the training sessions as there was no variability in the data. Inter-rater reliability for the supervision sessions was excellent (k = 0.76-1.0) and fair-to-excellent for the intervention visits (k = 0.45-0.77). Intra-rater reliability was good-to-excellent for the supervision sessions (k = 0.61-1.0) and intervention visits (k = 0.60 – 1.00).

Conclusions: Early fidelity results demonstrate that training and supervision of befrienders is being delivered as intended in the SUPERB trial. Variation in the reliability of the checklists to detect the presence (or absence) of behaviours suggest that further training and/or refinement of the checklists may be warranted. Calculating fidelity is an important element of intervention research to improve the validity of the study and future replication.
Introduction: The state of consciousness reflects both the level of wakefulness and the sum of cognitive and affective functions. The acquired brain injury (ABI) may be of traumatic (TBI) or non-traumatic (non-TBI) origin. The loss of consciousness implies the abolition of the capacities of perception and reaction. Within the disorders of consciousness (DOC) we can find coma, vegetative state (VS) and minimally conscious state (MCS).

The emergence from the MCS is defined by the ability to communicate or functional use of objects. The Rancho Los Amigos Levels of Cognitive Functioning Scale (ERLA): one of the most used scales to evaluate cognitive function in post-comatose patients.

The Revised JFK Coma Recovery Scale (CRS-R) measures auditory, visual, motor, oromotor, communication and arousal functions.

The Western Neuro Sensory Stimulation Profile (WNSSP) is designed to measure cognitive sensory function in consciousness disorders.

Objective: Compare the sensitivity of both scales to measure changes in the state of consciousness during emergence.

Identify possible predictive signs of emergence in subjects with level IV (confused agitated) or more according to the ERLA.

Materials and Methods: Descriptive, retrospective, cross-sectional study of review of medical records. 19 subjects between 1 and 18 years of age with ABI, who entered the "Sensory Stimulation Program" between the years 2005 and 2017 with DOC and that managed to emerge from the disorder were included. Patients assessed with the CRS-R and WNSSP scales were included. For the WNSSP, only the items of Expressive Communication and Object Manipulation were taken into account.

Results: The CRS-R was able to detect changes before the WNSSP in 11 patients. In 15 patients, the first function to improve was the motor function being the object manipulation item the one that prevailed. 3 patients showed changes in verbal-oromotor and 1 in visual.

In the WNSSP, 12 subjects showed changes in Object Manipulation (6: Inappropriate use, 3: Spontaneous use, 2: Reach / withdraw, 1: Use indications) and 7 in Communicative Function (5: Yes / No: both, 2: Yes or no)

Conclusions: It was seen that the CRS-R was more sensitive to measure changes in the state of consciousness in early stages at the same time it is a possible predictor of emergence of the DOC, the Motor Function- Object Manipulation.

It is recommended to carry out future studies that support the results obtained.
Key words: acquired brain injury; Revised JFK Coma Recovery Scale; Western Neuro Sensory Stimulation Profile; predictors; altered states of consciousness; Rancho Los Amigos
Gender Differences Preceding Work-Related Traumatic Brain Injury: A Person-Environment-Occupation Lens

Chung Hyun (Esther) Yong1, Sarah Trick1, Tatyana Mollayeva1, Angela Colantonio1
1University of Toronto, Toronto, Canada

Background: Most of the injuries experienced by workers are multifactorial, involving personal, environmental, and occupational risk factors, but little is known about work-related traumatic brain injuries (wrTBI) and how risk factors differ between men and women.

Objectives: To investigate the factors related to wrTBI in men and women using the Person-Environment-Occupation (PEO) model.

Methods: One-hundred and two Ontario workers (52% men, 48% women, aged 15-69 years) with wrTBI were studied. Personal, environmental, and occupational data were collected, and chi-square tests were conducted to identify differences between men and women.

Results: Within Person-related factors, both men and women were comparable in terms of age at the time of injury and history of depression (p values ≥0.05), but substance use disorder was more frequently observed in men compared to women (χ²=4.95, p=0.026). Gender differences were observed in Environmental factors, with more women reporting support at the workplace compared to men (χ²=4.10, p=0.043). Within Occupation-related factors, the most striking differences were observed in job security, with men perceiving their jobs as less secure compared to women (χ²=7.84, p=0.005). Other differences were observed in physical and mental workloads, with men perceiving greater physical load than women (χ²=5.11, p=0.024), and women perceiving greater mental load than men (χ²=7.11, p=0.008) at the time preceding wrTBI.

Conclusion: Observed gender differences in all components of the PEO model preceding a critical injury at the workplace should not be ignored. Implementation of gender-responsive approaches will actively promote occupational health and safety initiatives.
The PINK Concussions Panel of Women and Girls with Brain Injury

**Katherine Snedaker**

1Pink Concussions, Norwalk, United States

TBI is not the same in women as in men. And yet decades ago, when research began to identify significant sex differences, due to the higher overall male TBI numbers and the effect of reproductive cycles of female lab animals, TBI research almost solely focused on males with findings applied to women. Females of all ages suffer brain injury from sports, domestic violence/assaults, accidents and military service. And when seeking care, the lack of sex/gendered information seriously inhibits diagnosis and appropriate intervention across the care continuum and affects the development and provision of appropriate healthcare service.

This symposium will intersperse scientific findings with women’s lived experience to translate research into actionable-change in clinical practice. The PINK Concussions Symposium will be a panel presentation of key #pinkTBI differences in female vs male brain injury interspersed with sound bites from our panel of women patients who will share of their lived experience of brain injury to illustrate these differences. The goal of blending the scientific findings with the patient’s perspective is to truly help translate data in research paper into actionable-change in the clinical practice of participants. Female veterans will also be included in the panel.

Even today, most woman and medical providers are unaware of the #pinkTBI - sex and gender differences - in how women and girls experience in brain injury. This lack of sex and gendered information seriously inhibits diagnosis and appropriate intervention across the care continuum and affects the development and provision of appropriate healthcare service. Women and girls are rarely educated about these #pinkTBI differences which can lead to unrealistic expectations of their recovery time and an underestimation of the need for family and school/work support.

**Presenter**

Katherine Snedaker will summarize female differences (such as recovery time, fatigue, depression, hormone issues) and the panel of women with brain injury will share their lived experience of brain injury in short responses). The purpose to make the research come alive via the voices of women to translate the research into everyday experience. Our hope is clinicians to retain and apply the #pinkTBI science in their everyday interactions with their female patients.

**The Panel**

The all-female panel will consist of a cross-section of brain injuries from sports, domestic violence, work-related injuries, accidents, and military service. The panel will also represent a range of ages from teens to older women.
Playing the Game or Gaming the System: Are US Private High School Student-Athletes Reporting, Hiding or Faking Concussions?

Katherine Snedaker1, Jason Bouton
1Pink Concussions, Norwalk, United States

Background: Concussions are a common youth injury, affecting up to 20% of adolescents. A major cause of concussions is due to sports- and recreation-related activities. However, most research on sports- and recreation-related concussions have been conducted among public school students. Private schools have been shown to be qualitatively different in terms of location, socioeconomic status, and even types of sports played. A survey was conducted in order to explore the concussion experience of a large group of private high school students.

Methods: Over 1,900 private high school students from New England were surveyed in 2018. Students were asked what sports they played, if they had ever experienced a concussion, age at first concussion, whether their concussions were sports- or recreation-related, among other topics. Descriptive, bivariate, and multivariate statistics are presented.

Results: Of the students who reported engaging in a sport- or recreation-related activity, 32.7% reported having experienced a concussion. Males, students who played contact or limited contact sports, and those who played multiple seasons of school sports had an increased odd of having reported a previous concussion. Sex contact level of primary sport played, and number of seasons and type of sport played were also significantly associated with age of first concussion and whether any concussions were sports- or school sports-related.

Conclusions: A sizeable proportion of private high school students reported have had a previous concussion, with certain factors placing students at higher risk. Concussion prevention strategies unique to the private high school setting may be needed.
From Paper to Practice: Developing and Implementing Sports Injury Prevention Interventions that Make a Difference - 4 Year Update

Katherine Snedaker¹, Alex Donaldson²
¹Pink Concussions, Norwalk, United States, ²La Trobe University, Melbourne, Australia

There has been much written in the last 5 years, in science publications and in the press, on the importance of reducing the number of youth sports concussions and finding ways to manage concussion recovery better in children. And for all the clamour to create or change school and youth sport concussion policies, there are very few examples of how to take theory laid out in these scientific papers and implement low-cost programmes in children’s day-to-day lives across an entire city.

This presentation will highlight an ongoing 3-year project in Norwalk, Connecticut, USA, where RE-AIM Sports Setting Matrix (RE-AIM SSM), a health promotion planning and evaluation framework, was used to develop and implement a city-wide concussion education and management policy targeted at the 11,000 children in all schools and all city youth recreation sports programmes. In 2014, researchers were concerned the newly updated CT State Concussion Law only applied to 1145 high school students participating in official high school teams. The project launched in the 2014 – 2015 school year to investigate how many of the 9855 non-children not covered by the state law were having concussions and how many student-athletes were having concussions.

For the last 4 years, all concussions reported to the school nurses and athletic trainers in all the Norwalk Public School were recorded by age, sex, mechanism of injury and where the injury occurred. All children, aged kindergarten to 12th grade, could be considered involved in sports if sports are considered in a range from peer-organized games at recess, school gym class, official sports teams and also solo sports outside of school. Specific data were also captured on the ratio of sports to non-sports injuries, and if concussions happened at school or home.

Researchers then used the RE-AIM Sports Setting Matrix (RE-AIM SSM) to guide the development, implementation and evaluation of sports injury prevention interventions across this entire city by involving the schools, the city hospital, city government, youth sports organizations and the city parks and recreation department.

The proposed presentation on this project will discuss how to use RE-AIM SSM to develop interventions and accompanying implementation plans targeted at a multi-layered implementation context to maximize the adoption and overall impact of sports injury prevention interventions. The presentation will also provide a unique opportunity for participants to share the challenges they face and explore practical solutions in planning and implementing sports injury prevention interventions in complex settings.

NOTE: While the RE-AIM SSM used in this case was modified to be specific to the community sports setting context, this framework could be used to optimize the impact of future sports safety and other health promotion, interventions in complex real-world settings.
Challenges in Rehabilitation of Traumatic Brain Injury in India

Shiv Lal Yadav¹
¹All India Institute of Medical Sciences, New Delhi, New Delhi, India

Traumatic brain injury (TBI) is a leading cause of death and disability worldwide. It often kills or leads to hospitalization of approximately 10 million people every year with low and middle-income countries disproportionately affected. With just a handful of centres across India offering neuro-rehabilitation, the needs of such patients cannot be met. There exists a paucity of rehabilitation specialists and infrastructure coupled with lack of awareness among healthcare professionals which often leads to TBI patients being discharged without addressing their rehabilitation needs. It is therefore important to ensure stakeholders understand that rehabilitation following TBI represents a continuum of management rather than an add-on or optional facility.

A good way to begin improving rehabilitation care on the ground in a vast country like India would be to identify centres in all the districts that could work as nodal rehabilitation centres and initiating referral of all TBI patients to these centres. Human resource development including training of medical professionals in neuro-rehabilitation needs to run parallel so that rehabilitation needs can be more easily met. Could rehabilitation be a cost-effective measure by getting people back to work, equipping new rehabilitation centres, training staff to run them, and extending a whole new layer of care to a nation of over 1.3 billion people will come with a huge price tag? Maybe! But what is the price of doing nothing? Preventing TBIs occurring in the first place requires making of better roads, introduction and enforcement of new road safety laws, and the development of other injury related legislations.

The main challenges encountered by a rehabilitation specialist in India are lack of a registry, psychological and cognitive issues, memory deficit or recall, uncontrolled Spasticity, Swallowing dysfunction, Respiratory issues, Nutritional & Dietary issues, Disorders of consciousness, difficulty in achieving functional independence in Activities of Daily Living, Problems of cardio-respiratory capacity and Return to work will be discussed in detail during the presentation.
Attention Deficit Hyperactivity Disorder is Associated with Increased Anxiety and Depression in Concussed College Athletes

Brett Gunn\textsuperscript{1}, Jacob Kay\textsuperscript{1}, Torres-McGehee Toni\textsuperscript{1}, Davis Moore\textsuperscript{1}
\textsuperscript{1}University of South Carolina, Columbia, United States

Objective: The purpose of this study was to compare anxiety and depression in athletes with attention deficit hyperactivity disorder (ADHD), a history of concussion, ADHD with a history of concussion, and controls. We hypothesized collegiate athletes with ADHD who experienced a concussion would report higher levels of anxiety and depression than other athletes.

Design/Methods: Nine hundred seventy-nine NCAA Division-I college athletes at the University of South Carolina (USC) were surveyed as part of a larger performance health and wellness management program at USC. We acquired ADHD diagnoses, history of concussion, physician diagnosed concussions, State-Trait Anxiety Inventory (STA-I), and Center of Epidemiological Studies Depression Scale (CES-D). Athletes were divided into four groups 1) ADHD with Concussion, 2) ADHD no concussion, 3) ADHD no concussion, and 4) No ADHD no concussion for comparison.

Results: State Anxiety scores were significantly higher in the ADHD with concussion group (42.1 ± 14.2) compared to all other groups (33.4 ± 8.9). Depression scores were also significantly higher for ADHD with concussion group (25.5 ± 10.2) than all other groups (16.3 ± 5.7).

Conclusions: These findings suggest that ADHD and concussion may have a cumulative effect on anxiety and depression beyond that of either ADHD or concussion alone. Therefore, athletes with ADHD should receive extra care and monitoring, as they will likely experience more severe symptoms after a concussion than others.
Encouraging Early Screening and Diagnosis of mild TBI in Two At-Risk Montana Populations: A Community-Based Approach to Identify Barriers and Culturally-Effective Interventions

Cindi Laukes1,2, Jera Stewart3, Solomon Harrar4,5, LeeAnna Muzquiz3,7, Shawn Grove6, Ann Miller8, Roy Savage9, Miles Wetzel15, Brenda Morton17, Margaret Bowman11, Leonid Kalachev4, Tony Incashola12, Lisa Shourds13, Michele Rutherford15, Matt Gangloff14

1 Neural Injury Center, University of Montana, Missoula, United States, 2 University of Washington, Seattle, United States, 3 Missoula VA Community Based Outpatient Clinic, Missoula, United States, 4 University of Montana Statistics and Applied Math, Missoula, United States, 5 University of Kentucky, Lexington, United States, 6 University of Montana Vets Office, Missoula, United States, 7 CSKT Tribal Health Department, Polson, United States, 8 CSKT Tribal Defenders Office, Pablo, United States, 9 Heroes Therapeutic Outreach Program, Missoula, United States, 10 Montana Military Order of the Purple Heart, Statewide, United States, 11 S&K Technologies, Polson, United States, 12 Salish-Pend d’Oreille Culture Committee, St. Ignatius, United States, 13 CSKT Legal Dept., Pablo, United States, 14 Enlyten Lab, Missoula, United States, 15 University of Montana, Missoula, United States

Background: Montana ranks amongst the highest in the nation for both brain injury and suicide incidence. It also has one of the highest per capita veterans’ populations and is home to seven Indian reservations. Both American Indian and veteran populations are at increased risk for both brain injuries and suicide. Both groups are characterized by unique social and cultural factors presenting specific challenges and barriers to health screenings, including concussion. These factors can also influence the success of brain injury interventions. Both groups share similar barriers, such as reliance on and mistrust of government-based systems (Indian Health Service and Veterans Administration), stigma related to brain injury, financial barriers, transportation issues, homelessness and other factors. Conversely, each community is characterized by unique cultural factors that may be of key importance in developing culturally effective interventions.

Objectives: (1) To engage a Montana tribal community (Confederated Salish & Kootenai Tribes--CSKT) and a student veterans community (at the University of Montana) in understanding the problem of concussion; (2) To identify prevalence, existing barriers, and culturally effective interventions targeting early screening and diagnosis of concussion, and; (3) To compare results of the two groups to better understand and describe any common and distinct factors between groups that may impact successful interventions.

Research Description: This study used a mixed method, community-engaged survey approach, with extensive input from two community advisory groups and other stakeholders. Advisors helped to define unique social and cultural issues, design survey questions and language to be culturally appropriate, identify best survey collection sites; work with the PI at survey collection sites; review survey results, and; recommend methods for dissemination of findings and future applications. 100 enrolled members or descendants of the Confederated Salish and Kootenai Tribes were surveyed, along with 80 student veterans at the University of Montana, Missoula, all in public locations. The survey included 17 questions related to current knowledge, demographics, and barriers. Participants were paid $10. Results were analyzed to detect differences and similarities between groups, incidence, barriers to screening, and other factors.

Results/Discussion: Results of this study show a high incidence of both diagnosed and “probable” lifetime history of concussion. Strikingly similar results were seen across groups. There is a clear need for more community-based, culturally effective education and awareness in both communities. More study in this area and how best to address barriers is needed. In both groups, community suggestions were made for
future modes/locations for providing effective awareness and educational interventions for future implementation.
Concussion Knowledge and Awareness Among Canadian Medical Students and Residents: A Research Proposal

Shannon Hart, Scott Bray, Ryan Patrick Kelly, Jared Ryan, Roger Avery

1Faculty of Medicine, Memorial University, St. John’s, Canada, 2Division of Neurosurgery, Eastern Health, St. John’s, Canada

Recently the CDC has classified concussions as an epidemic, resulting in a growing body of medical literature surrounding their severity, management, and diagnosis. The financial burden of traumatic brain injury (TBI) as a whole costs the Canadian government upwards of $10 billion. With mild TBIs comprising 80% of all TBIs, concussions may account for a large portion of this financial impact. A concussion has been previously defined as a TBI induced by biomechanical forces being transmitted to the head by a blow to the head, face, neck or elsewhere on the body, and are considered the mildest form of diffuse axonal injury. Therefore, it is important to recognize that concussive injuries occur via a complex mechanism and should be treated as complex injuries. Various screening tools, such as the Sport Concussion Assessment Tool 5 (SCAT5), have been developed and intended for use by healthcare professionals in evaluation of individuals that are 13 years or older. In conjunction with screening tools, guidelines for the management of concussions in the setting of returning to sport, better known as return-to-play (RTP), and returning to the classroom, known as return-to-learn (RTL), should be used by all healthcare professionals. That being said, a proportion of Canadian medical schools have been identified as offering little to no education on the topic. Furthermore, residency programs of specialties identified as being a first point of contact for concussion management have been observed to have discrepancies and gaps in knowledge between specialties regarding important elements of injury care. The present study proposes to analyze the longitudinal learning of Canadian medical students and residents regarding concussion awareness and management. From this, Canadian medical students’ education regarding concussion awareness and management will be evaluated to determine whether or not it is enhanced throughout medical school training. Using a modified version of the concussion knowledge survey developed by Boggild and Tator (2012), our group will compare knowledge scores regarding concussion awareness and management between pre-clerk medical students and family, emergency, and pediatric residents across Canada. Our study aims to identify discrepancies existing with regard to concussion-related teaching between the various levels of medical education. Moreover, the present study looks to contribute to the field of concussion management and research by increasing awareness of knowledge translation gaps in medical school training in Canada.

OSABI: Optimized Sleep after Brain Injury, A Pilot Study of Sleep Hygiene Intervention for Patients with Moderate to Severe Brain Injury

Michael Makley\textsuperscript{1,2,3}, Donald Gerber\textsuperscript{1}, Jody Newman\textsuperscript{1}, Angela Phillipus\textsuperscript{1}, Kimberley Monden\textsuperscript{1}, Eric Spier\textsuperscript{1,2,3}, Patrick Tarwater\textsuperscript{4}, Alan Weintraub\textsuperscript{1,2,3}

\textsuperscript{1}Craig Hospital, Englewood, United States, \textsuperscript{2}CNS Medical Group, Englewood, United States, \textsuperscript{3}University of Colorado Department of Physical Medicine and Rehabilitation, Aurora, United States, \textsuperscript{4}University of Texas Health Science Center, Houston, United States

Background: Disrupted sleep is common after traumatic brain injury (TBI) particularly in the rehabilitation setting where it may impact participation in therapy and outcomes. Treatment of this disorder is varied and largely unexamined.

Objective: To study the feasibility of instituting a sleep hygiene intervention compared to standard TBI care in a cohort of patients on an inpatient rehabilitation unit.

Methods: Prospective screening of 386 consecutive admissions to a brain injury unit with allocation to a sleep hygiene protocol (SHP) or standard of care (SOC) by minimization. All patients wore actigraphs and underwent serial cognitive testing for four weeks. Light monitors were placed in subjects’ rooms. SHP patients received 30-minutes of blue light therapy with morning ADLs, had no caffeine after noon and were limited to 30-minute naps during the day. SHP patients had night time sleep rest intervals set according to pre-injury sleep time preference. Both groups were treated with the same restricted formulary of centrally acting medications.

Results: Of the patients screened, 27 met criteria. Twenty-two patients were enrolled, of which nine in each group were retained for final analysis. The protocol was rated favorably by participants, families, and staff. Actigraph sleep metrics improved in both groups during the four-week intervention; however, only in the SHP was the magnitude of change significant.

Conclusions: Sleep hygiene is both a practical and feasible non-pharmacologic intervention to treat disrupted sleep in a TBI inpatient rehabilitation setting. A larger study is warranted to examine treatment efficacy in this population.

Amy Robinson1, Jacob Shelley1, Jeffrey Holmes1, Jacqueline Specht1, Leila Mackay1, Andrew Johnson1
1The University of Western Ontario, London, Canada

Introduction: In March 2014, the Ontario Ministry of Education was the first ministry in Canada to institute a formal concussion policy. The ministry stipulates that student long-term health and safety are essential preconditions for learning, and that concussions can negatively impact cognitive, physical, emotional, and social development. Policy/Program Memorandum (PPM) No. 158 requires all school boards and school authorities to establish a policy on concussions. Each school board in Ontario developed a concussion policy within their local context to address concussion awareness, prevention, identification, management, and training. Multiple stakeholders including administrators, teachers, staff, students, parents/guardians, volunteers, and community-based organizations were encouraged to participate in policy development as stated in PPM No. 158.

Objectives: To understand how school boards in Ontario interpreted PPM No. 158 in the development and implementation of board concussion policies and administrative procedures.

Methods: An interpretive policy analysis was conducted on English-language, publicly available concussion policy documents and related administrative procedures from 64 Ontario school boards and school authorities. Semi-structured interviews were conducted with four key informants from a large school board in Ontario to further contextualize this analysis. Informants included two elementary school Principals, one secondary school Vice Principal, and one secondary school Health and Physical Education Department Head. Informants were directly involved in the development of their school board’s concussion policy and administrative procedures, as well as the daily implementation of these policies in their respective schools as part of their leadership roles in the school community.

Results: School boards in Ontario relied on partnerships across the domains of education, health, and safety in order to fulfill the requirements of PPM No. 158. Within each domain, collaboration between students, parents/guardians, teachers, administrators, coaches, and health care providers was essential for the development and implementation of school board concussion policies. Multiple stakeholder groups frequently share responsibility for student education, health, and safety.

Conclusions: Effective collaborative partnerships require strong communication and a shared understanding of concussion prevention, identification, and management strategies. As a result of PPM No. 158, teachers and school administrators have increasingly taken on a leadership role in this regard. Findings highlight the need for policy makers and legislators to consider local context, community needs, professional practices of multiple stakeholder groups, and available resources when developing concussion policy and legislation.
Elevated Circulating Syndecan-1 Levels, A Marker of Endothelial Glycocalyx Degradation, in CAF Military Breachers with Repeated Occupational Blast Exposure

Shawn Rhind¹, Oshin Vartanian¹, Alex Di Battista¹, Katherine Moes¹, Maria Shiu¹, Ingrid Smith¹, Doug Saunders¹, Ann Nakashima¹, Catherine Tenn², Rakesh Jetly³

¹DRDC - Toronto Research Centre, Toronto, Canada, ²DRDC - Suffield Research Centre, Medicine Hat, Canada, ³Canadian Forces Health Services, Ottawa, Canada

Background: Blast-induced neurotrauma has received much attention due to its incidence in recent military conflicts. Explosive blast exerts a variety of effects on the nervous system, including deleterious vascular and inflammatory responses that can be observed with even low-level exposures. Indeed, mounting evidence suggests that repeated exposure to occupational levels of blast overpressure may lead to persistent and progressive neurological deficits that are reflected by alterations in fluid biomarkers. Syndecan (SDC)-1 is a heparan sulfate proteoglycan that forms a dynamic layer of macromolecules at the luminal surface of the vascular endothelium. As such, SDC-1 plays a key role in vascular integrity and is considered a specific marker of endothelial glycocalyx damage after trauma. No human studies have evaluated the potential long-term consequences of repeated occupational blast exposure on SDC-1 and it remains unknown if endothelial degradation occurs with chronic exposure to subconcussive blast waves.

Objectives: This cross-sectional study compared plasma levels of SDC-1 in a subset of Canadian Armed Forces (CAF) School of Military Engineering tactical breaching instructors and range staff (n=18) with a history of occupational exposure to repetitive blast, to a group of healthy CAF non-breacher controls (n=18).

Methods: SDC-1 concentrations (ng/ml) were measured by ELISA in citrated plasma collected from breachers with a mean(±SD) of 7.2±4.4 years’ experience (range, 1.5-20 y) and compared to age- and sex-matched CAF controls. Group differences were evaluated by Mann-Whitney U-test and Spearman’s correlation coefficient to assess relationships between SDC-1 and years of blast exposure. Results. CAF breachers displayed significantly higher (p <0.001) plasma SDC-1 levels (median, IQR) in breachers (45, 26-150 ng/ml) compared to those (18, 9-26 ng/ml) in CAF controls. The number of years of breaching and/or explosive training was positively correlated with increased SDC-1 levels.

Conclusions: Repetitive occupational exposure to low-level blast is associated with enhanced systemic release of SDC-1 in CAF breachers, suggesting persistent vascular endothelial glycocalyx activation/degradation. These findings provide new insight into the intrinsic neuropathological sequelae of chronic low-level blast on microcirculatory glycocalyx integrity, which may translate into clinically relevant diagnostic and/or therapeutic biomarkers.
Age Differences in Long-Term Recovery of Brain Function After Traumatic Brain Injury

Nicola de Souza¹, Rachel Parker², Jennifer Ryan²³, Carrie Esopenko¹
¹Rutgers University, Newark, United States, ²Rotman Research Institute, Baycrest, Toronto, Canada, ³Department of Psychology, University of Toronto, Toronto, Canada

Background: There is growing support for the use of resting state functional connectivity (rsFC) as a tool to monitor impairment and recovery of brain function after traumatic brain injury (TBI; Hayes et al., 2016). Altered connectivity has been shown in key functional networks, such as the default mode network (DMN), in the acute (Iraji et al., 2015) and chronic phase after injury (Mayer et al., 2011; Rigon et al., 2016). However, few studies have assessed long-term recovery of brain function using rsFC following TBI (Venkatesan et al., 2015). Thus, the time frame of functional brain recovery is unknown. To better understand recovery of brain function after TBI, we examined changes in whole-brain functional connectivity from anterior and posterior seeds in the DMN in the sub-acute and long-term phases post-TBI. We also examined the effect of age of injury on rsFC long-term recovery patterns.

Method: Resting-state functional magnetic resonance imaging scans (fMRI) were obtained from the controlled access datasets distributed from the DOD- and NIH-supported Federal Interagency Traumatic Brain Injury Research (FITBIR) Informatics Systems [DOI: 10.23718/FITBIR/1503293]. Thirty-nine patients (25.6% female, age mean=42.30) completed two resting-state fMRI scans after sustaining a mild to severe TBI at approximately 10 days (sub-acute; Glasgow Outcome Scale Extended [GOS-E]=6.03, SD=1.77) and 18 months (long-term; GOS-E=6.87, SD=1.56) post-injury. Seed-to-voxel analyses assessed rsFC from anterior medial prefrontal cortex (aMPFC) and posterior cingulate cortex (PCC) seeds in the DMN. Effect of age on functional recovery was compared between younger (age 18-45; n=20; GOS-E=6.69, SD=1.70) and older (age 46+; n=19; GOS-E=5.53, SD=1.70) patients.

Results: Differences in DMN rsFC were found between the sub-acute and long-term phases. Eighteen months post-injury, increased rsFC from the aMPFC seed to cortical and subcortical regions, as well as increased rsFC from the PCC seed to frontal and temporal regions was shown. In addition, different patterns of rsFC were shown dependent on age at 18 months post-injury. Specifically, younger patients showed widespread increases in rsFC from the aMPFC and increased rsFC from the PCC to frontal regions. However, older patients demonstrated limited recovery of rsFC at 18-months post-injury. Importantly, no age differences in GOS-E were noted at 10 days and 18-months post-injury suggesting that age differences in rsFC were not due to injury severity.

Conclusion: Our results demonstrate that age at time of injury significantly impacts long-term recovery of brain function following TBI. Furthermore, our results suggest that rsFC is a sensitive tool that can be used to monitor recovery of brain function; however, factors such as age of injury must be considered. Future studies should also examine the association between rsFC with cognitive and behavioral symptoms.
Acute and Long-Term Effects of Sodium Pyruvate on Blood Chemistry in Rats with Blast TBI

Pushpa Sharma

*Uniformed Services University of The Health Sciences, Gaithersburg, United States*

Background: During modern wars and terrorist attacks, the improvised explosive devices (IEDs) and roadside bombs are the main causes of blast traumatic brain injuries (bTBI), death and disabilities. Blast exposure effects the whole body and causes secondary effects mainly on brain, lungs and intestine. The ineffective treatment of bTBI is mainly due to the lack of biomarkers of brain injury severity and multi-organ failure affected by blast. Our goal was to identify if any of the parameters in the blood chemistry can be used as a biomarker of blast TBI and examine the effects of pyruvate treatment on blood chemistry, brain and lung injury severity.

Method: Sprague dawley male rats were exposed to three repeat blasts 11psi at 5 min interval. Pyruvate (1g/Kg orally) or vehicle (similar volume) treatment was started immediately for 7 days or 28 days following blast+/− treatment. Femoral arterial blood for blood chemistry was collected at baseline, and at the time of sacrifice. Brain was examined for gliosis by GFAP+ cells.

Results: Compared with sham animals, 7 day bTBI had higher Lactate/Pyruvate (l/p) ratios; pyruvate treatment didn’t seem to help during the short-term period. In contrast long-term bTBI animals treated with pyruvate had higher values of pCO₂, pO₂, HCO₃, eTCO₂, and SPO₂%. Indicating better buffering and oxygen delivery with pyruvate treatment. Also, calculation of lung alveolar dead space from pCO₂ and eTCO₂ (en tidal CO₂) as a physiological marker of lung function showed that animals undergoing blast had higher alveolar dead space in lungs, and this was slightly improved by pyruvate treatment. Brain injury severity following blast confirmed by increased gliosis (GFAP+) in brain compared with sham animals.

Conclusions: Increased l/p ratio and dead alveolar space can be used as a systemic biomarker of bTBI and lung injury following blast exposure and pyruvate improves these blast effects.
Extending the Proportional Recovery Rule of the Upper Paretic Limb Early After Stroke

Rick van der Vliet, Ruud Selles, Eleni-Rosalina Andrinopoulou, Rinske Nijland, Maarten Frens, Carel Meskers, Gerard Ribbers, Gert Kwakkel

1Erasmus MC, Rotterdam, Netherlands, 2Amsterdam University Medical Centre, location VU University Medical Center, Amsterdam, Netherlands, 3Rijndam Rehabilitation Center, Rotterdam, Netherlands, 4Reade Rehabilitation Center, Amsterdam, Netherlands

Objective: Spontaneous recovery is an important determinant of upper extremity recovery after stroke, which has been described with the 70%-proportional recovery rule for the Fugl-Meyer motor upper extremity scale. However, this rule is increasingly criticized for overestimating predictability of FM-UE recovery. Our objectives were to (1) develop a longitudinal mixture model of proportional recovery, (2) identify FM-UE recovery subgroups, and (3) cross-validate the model predictions.

Methods: We developed an exponential recovery function with parameters: subgroup assignment probability, proportional recovery coefficient, time constant in weeks and the distribution of the initial FM-UE scores. We fitted the model to FM-UE measurements of 385 first-ever ischemic hemispheric stroke patients and cross-validated the endpoint predictions and cluster assignment.

Results: The model discerns five subgroups with different recovery parameters. Endpoint FM-UE can be predicted with a median absolute error of 5.8 IQR=[1.6 13.5] 1 week after stroke and 4.6 IQR=[1.4 10.1] 2 weeks after stroke. Overall accuracy of assignment to the poor (subgroup 1), moderate (subgroups 2 and 3) and excellent (subgroups 4 and 5) recovery cluster was 0.77 95%ETI=[0.76 0.79] after 1 week and 0.82 95%ETI=[0.81 0.83] after 2 weeks.

Interpretation: Spontaneous recovery following FM-UE reflects different subgroups, each with its own recovery profile. Cross-validation of our mixture model indicates that FM-UE endpoints and cluster assignment can be well predicted. These findings will have major implications for the identification of prognostic biomarkers and the stratification of stroke trials.
Co-administration of TiO2-Nanowired DL-3-n-butylphthalide (DL-NBP) with Mesenchymal Stem Cells Enhanced Neuroprotection in Parkinson’s Disease After Concussive Head Injury

Feng Niu1, Aruna Sharma2, Hari Shanker Sharma2, Lianyuan Feng3

1CSPC NBP Pharmaceutical Medicine, Zhongshan Road (West), Shijiazhuang, Hebei Province, Shijiazhuang, China, 2Uppsala University, Uppsala, Sweden, 3Bethune Int. Peace Hospital, Shijiazhuang, China

DL-3-n-butylphthalide (DL-NBP) is one of the constituents of Chinese celery extract that is used to treat stroke, dementia and ischemic diseases. Since NBP has powerful antioxidative effects, the compound has shown powerful neuroprotective effects in Alzheimer’s disease (AD), Amyolateral sclerosis (ALS) and other neurodegenerative diseases. However, role of NBP in Parkinson’s disease (PD) is not well known. Few studies in cell culture showed neuroprotective effects of NBP in PD. Thus, efforts should be made to understand the role of NBP in PD in great details. Recent research shows that traumatic brain injury (TBI) is one of the key factors inducing PD like symptoms in human populations and particularly in military personnel who are prone to TBI. There are many similarities in AD and PD cases as both exhibit deposition of amyloid beta peptide (AbP), tau phosphorylation (p-tau) as well as alpha synuclein (ASNC) disturbances. Previous reports from our laboratory showed that nanowired-NBP are capable to induce profound neuroprotection following concussive head injury (CHI). Thus, it would be interesting to explore the possible neuroprotective effects of NBP in PD following CHI in a rat model. It has been shown that a combination of NBP and mesenchymal stem cells (MSCs) reduces brain pathology following carbon monoxide poisoning in human cases. Thus, we also examined a combination of MSCs and NBP in our model of PD with CHI. PD like symptoms was induced in naive or CHI rats by administration of 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridin (MPTP, 20 mg/kg) daily within 2-h intervals for 5 days. CHI was inflicted under anesthesia by dropping a weight of 114.6 g from a height of 20 cm inducing an impact of 0.224 N on right parietal skull. PD symptoms e.g., loss of tyrosine hydroxylase (TH) activity in substantia niagra pars compacta (SNpc) and striatum (STr) and decrease in dopamine (DA) and dopamine decarboxylase (DOPAC) levels were exacerbated by CHI. The p-tau in the cerebrospinal fluid (CSF) showed greater enhancement in CHI with PD. Treatment with TiO2-nanowired delivery of NBP (40 mg/kg, i.p.) together with MSCs (106) 4 h after CHI in PD significantly reduced the p-tau levels in the cerebrospinal fluid (CSF) and restored the TH immunoreactivity in SNpc and STr. The levels of DA and DOPAC were also significantly elevated in CHI rats with PD as compared to the untreated group. Neuronal damages were also significantly reduced in PD after CHI by a combination of NBP and MSCs. These observations are the first to show that a combination of NBP with MSCs when delivered using nanowired technology has superior neuroprotective effects in PD exacerbated by CHI, not reported earlier.
Falling by the Wayside: Women-Specific Resources for Traumatic Brain Injury

Mijal Vonderwalde¹, Lindsay Rideout¹

¹University of Toronto, Toronto, Canada

Introduction: Despite the growing body of literature about traumatic brain injury, women remain underrepresented in research due to the higher prevalence of this injury among men. Male findings are often inappropriately generalized to women and educational resources lack specificity about unique gendered experiences. Women are at risk of not receiving the appropriate education and support required for rehabilitation.

Objectives: This study will draw attention to current knowledge translation resources available that are specific to women who have sustained a traumatic brain injury and identify potential knowledge gaps.

Methods: A grey literature search plan, based on a recently published methodological search strategy, was developed to incorporate two searching strategies: (1) a targeted Google search, and (2) consultation with contact experts. Websites were identified and screened for relevance based on predetermined criteria by two researchers independently. Data including organization, year published, intended audience, objective of the document, evidence cited, and recommendations was extracted into an Excel spreadsheet for analysis of gaps.

Practice Implications: Gender differences exist in recovery from traumatic brain injury and present findings demonstrated there is a lack of gender-specific educational resources addressing the unique needs of women. Women therefore may be at a greater risk of experiencing anxiety, isolation, and other vulnerabilities beyond the common sequelae of traumatic brain injury.

Conclusions: The identified knowledge translation gap highlights the need for the creation of gendered knowledge translation materials and resources to ensure that women receive appropriate education and support for optimal recovery and rehabilitation.

Keywords: Traumatic brain injury, women, gender, knowledge translation, resources, education
Sex Differences in Executive Functions following Pediatric Concussive Brain Injury

**Jacob Kay**, Colt Coffman¹, Alexander Wagner², Jeffrey Holloway², R. Davis Moore³

¹University of South Carolina, Columbia, United States, ²University of South Carolina -- School of Medicine, Columbia, United States

Introduction: Children with concussive brain injuries often exhibit impaired executive functioning that can lessen quality of life and impede cognitive development. Research also demonstrates that there may be important sex-based differences in outcomes following concussion. However, few studies have sought to go beyond symptom reports, leaving our understanding of sex differences in executive functioning unknown in this population. Therefore, we sought to not only evaluate clinical symptoms but also executive functioning in a multi-faceted manner through computerized testing and parental reports of cognitive-behavioral functioning in daily life. We hypothesized that females would exhibit more severe clinical symptoms and greater executive dysfunction following concussion compared to males.

Methods: During the 2017-2019 academic years, data were collected from a local pediatric sports medicine clinic. Thirty males (M = 15.00, SD = 1.44 years) and twenty females (M = 15.30; SD = 1.38 years) who sustained concussions were examined. All participants were evaluated at two timepoints, an average of 2- and 5-weeks post-concussion. Clinical symptoms were measured using the Rivermead Post-Concussion Symptoms Questionnaire (RPQ). Executive function was measured using the parent-reported Behavioral Rating Inventory of Executive Function (BRIEF), as well as a modified CogState Brain Injury Test Battery.

Results: Females reported a greater number of somatic and cognitive symptoms on the RPQ at 2 weeks and 5 weeks post-injury (p’s < .05). In addition, a significantly greater proportion of females (16 of 20) reported persistent clinical symptoms at 5-week follow-up when compared to males (5 of 30; p < .05). Further, parents of female participants reported significantly greater difficulties with their child’s behavioral regulation than parents of male participants (p’s < .05). Females also performed more slowly on the One Back Condition of the CogState Brain Injury Test Battery relative to males (p < 0.05). No correlations between injury characteristics (time since injury, concussion history) and clinical symptoms or executive functions were observed.

Conclusions: Our findings corroborate evidence that females report greater clinical symptoms following concussion than males. In addition, females not only demonstrated slower cognitive performance, but their parents also reported greater impairment in executive functioning. Thus, our findings indicate that females may exhibit significantly poorer cognitive outcomes than males. Future longitudinal research incorporating baseline evaluations is necessary to gain a more accurate understanding of sex differences before-and-after concussion.
Perivascular Parasympathetic and Sensory Nerves Mediate Axo-Axonal Interactions in Neurogenic Vasodilation in Middle Cerebral Arteries

Kuo-Feng Huang1,2, Hsi-Hsien Chang1,2
1Taipei Tzu Chi General Hospital, Buddhist Tzu Chi Medical Foundation, New Taipei City, Republic of China, 2School of Medicine, Buddhist Tzu Chi University, Hualien, Republic of China

Background: It is well known that cerebral arterial vessels receive dense perivascular autonomic and sensory nerve innervations, and sympathetic-parasympathetic (axo-axonal) interactions have been found to regulate nitric oxide-mediated neurogenic vasodilation in rat basilar arteries (BAs). However, it is unknown whether axo-axonal interactions lead to neurogenic vasodilation in middle cerebral arteries (MCA). The aim of this study was to investigate whether axo-axonal interactions modulate neurogenic vasomotor responses in isolated rat endothelium-denuded MCAs.

Method: Blood vessel myography was used to measure relaxation and contraction responses of isolated MCA rings, and immunohistochemistry was used to determine that calcitonin-gene related peptide (CGRP)-immunoreactive (I) and vasoactive intestinal polypeptide (VIP)-I, colocalized with the tyrosine hydroxylase (TH)-I fibers, was present in the MCA from male Wistar-Kyoto rats.

Results: The vasorelaxation of endothelium-denuded MCA rings was induced by nicotine and transmural nerve stimulation (TNS), which was abolished by TTX (a neurotoxin). Nicotine induced relaxation of MCAs and drastically reduced levels of guanethidine (an adrenergic neuronal blocker) and NG-nitro-L-arginine (a nitric oxide synthase inhibitor). This nicotine-induced relaxation was not sensitive to propranolol. In the MCAs, nicotine- and TNS-induced vasorelaxation was significantly inhibited by pretreatment with CGRP8-37 (a CGRP-receptor antagonist) and VIP6-28 (a VIP-receptor antagonist). Immunohistochemical analysis further demonstrated the close association of CGRP-I with TH-I fibers, and VIP-I with TH-I fibers.

Conclusion: Nicotine-induced neurogenic vasorelaxation may depend on the activation of perivascular sympathetic nerves, which then leads to activation of CGRPergic, VIPergic, and nitriergic nerves causing neurogenic vasorelaxation. Nicotine-induced neurogenic vasorelaxation in MCAs was more complex than in BAs.
Comparison of Prescribed Rest to Aerobic Exercise as A Treatment Recommendation for Adolescents with Sports Related Concussion

Barry Willer¹, John Leddy¹, Mohammad Haider¹
¹University at Buffalo, Buffalo, United States

In previously published research we demonstrated that concussions cause significant alteration of the patient’s autonomic nervous system (ANS). Prior research has also demonstrated that the best way to regain control of the ANS is through aerobic exercise. However, as part of the ANS response, concussed athletes demonstrate exercise intolerance. We designed an exercise program that is individualised to the patient and is based on the heart rate (HR) threshold at which the patient becomes symptomatic during exercise. We recently completed a Randomised Clinical Trial (RCT) with adolescents where they were randomly assigned to a sub-threshold aerobic exercise program or a placebo-like stretching exercise program. The RCT demonstrated that sub-threshold aerobic exercise significantly reduced the days to recovery for these adolescents with sports related concussion. Our study will be published in JAMA Pediatrics in February 2019. In this presentation we will describe the recovery of those who received aerobic exercise (N=52) along with a third group of adolescents (N=48) who were given instructions to rest until asymptomatic (until recently the standard of care for concussion). Adolescents in the rest only group took significantly longer to recover, much like the placebo like control group in the RCT. Interestingly, female adolescents appeared to do worse with prescribed rest than their male counterparts. The conclusion from this research is that adolescents who are prescribed sub-threshold exercise will recover faster than those prescribed stretching (placebo group) or relative rest. There was also a decrease in the number of adolescents who had delayed recovery in the aerobic exercise group. Limitations of the research will also be presented.
Participatory Action Research with Individuals Who Have A Moderate to Severe Traumatic Brain Injury: The Process of Co-Creating A Peer-Run Physical Activity Program in the Community

Enrico Quilico¹, Bonnie Swaine², Shane Sweet³, Lindsay Duncan³, Shawn Wilkinson⁴, Frédérique Poncet⁴, Christophe Alarie⁵, Angela Colantonio¹

¹University of Toronto, Toronto, Canada, ²University of Montreal, Montreal, Canada, ³McGill University, Montreal, Canada, ⁴Concordia University, Montreal, Canada

Background: Physical activity (PA) and sport are suggested as a non-stigmatizing approach to address long-term problems following moderate and severe traumatic brain injury (TBI) and can positively influence community integration, mood, and quality of life. However, promoting PA and sport participation for people with TBI is challenging due to long-term sequelae associated with their injuries. Consequently, PA and sport programs must be appropriately designed. This project aims to pursue the co-creation of a community-based PA and sport program for persons with TBI and stems from a pilot program that began in January 2017 in collaboration with multiple organizational partners. The program consists of three phases (i.e., learning how to train safely, independently and for a triathlon event). Four individuals with TBI from the pilot program are currently peer mentors and share their perspectives, motivate new members and assist with the development of the project as key stakeholders. To facilitate the implementation, evaluation and sustainability of the program, formal procedures and toolkits must be co-created with researchers and stakeholders to ensure the content is tailored to the program users’ needs.

Objectives: 1) explore the impact of the current program on mentors, participants, and administration to inform the creation process of the new program; 2) co-construct the program’s logic model while identifying strategies to ensure program sustainability with the community fitness center; 3) co-create a set of clearly-defined protocols for the new peer mentor program.

Design: An embedded mixed-method design will be used in which supplemental qualitative data will be collected to enhance the development of the program protocol. This design incorporates participant perceptions and experiences of the program before, during and after primary measures are administered to support aspects of the overall application and evaluation of the program.

Participants: A heterogeneous convenience sample of 20 community-dwelling, adult participants (4 peer mentors, 16 active participants) with severe TBI in Eastern Canada have been purposely recruited based on their suitability for the program.

Methods: In line with the participatory action research approach, there will be equitable collaboration among organizational representatives (n=3), a team of multidisciplinary researchers (n=5) and community members (mentors, n=4) in every aspect of the research process. Through an iterative process, regular scheduled sessions will take place with working group teams to clearly inform a logic model describing the necessary inputs, key components, and expected outputs of the program to facilitate the development of the program’s protocols.

Significance: Recently approved, this presentation will share the process of co-creating a study protocol for this innovative community-based research program with multiple stakeholders. The results will further our
understanding about the factors that promote PA and sport participation for adults with moderate to severe TBI and make recommendations about working with this community.
Apomorphine for the Treatment of Chronic Disorders of Consciousness: A Case Report with Multimodal Assessments

Leandro Sanz1,2, Nicolas Lejeune1,2,3,4, Séverine Blandiaux1,2, Estelle Bonin1,2, Federico Raimondo1,2,5, Rajanikant Panda1,2, Helena Cassol1,2, Neal Farber5, Steven Laureys1,2, Olivia Gosseries1,2

1GIGA Consciousness, University of Liège, Liège, Belgium, 2Coma Science Group, University Hospital of Liège, Liège, Belgium, 3CHN William Lennox, Groupe Hospitalier Saint-Luc, Ottignies, Belgium, 4Institute of Neurosciences, UCLouvain, Brussels, Belgium, 5Institut du Cerveau et de la Moelle épinière, Sorbonne Université, Paris, France, 6NeuroHealing Pharmaceuticals Inc., Waban, United States

Background: There are few available therapeutic options to promote recovery among patients with disorders of consciousness (DOC). Among pharmacological treatments, apomorphine, a dopamine agonist, has exhibited promising behavioral effects in traumatic brain injury. Its efficacy among patients with non-traumatic brain injury has never been documented and its action on brain activity remains unknown. We report the case of a patient with DOC following intracranial hemorrhage, who was treated with apomorphine in a prospective open-label study.

Methods/Design: A 47-year-old woman with chronic DOC (minimally conscious state; MCS) following spontaneous rupture of a left carotid aneurysm (132 days since onset), was treated with apomorphine for 30 days. The drug was administered via subcutaneous infusions 12 hours per day, with escalating doses up to 6 mg/h. The patient was monitored 30 days before initiation of therapy, during treatment and 30 days after withdrawal, using the Coma Recovery Scale–Revised (CRS-R). High-density electroencephalography (hdEEG) and fluorodeoxyglucose positron emission tomography (FDG-PET) were acquired before and after treatment. Outcome measures included CRS-R diagnosis, FDG-PET standardized uptake values, a multivariate classifier integrating 68 individual hdEEG markers and hdEEG functional connectivity using debiased weighted phase lag index.

Results: Before treatment, CRS-R scores were compatible with a diagnosis of unresponsive wakefulness syndrome (UWS) in 8/9 evaluations, and with a MCS- only once. During treatment, the patient was diagnosed as UWS in 2/8 evaluations, MCS- in 5/8 evaluations and MCS+ once, characterized by the presence of reproducible response to command. After treatment withdrawal, she was diagnosed UWS once and MCS- in 4/5 evaluations. Compared to 54 healthy controls, FDG-PET whole brain metabolism revealed a 59% metabolic drop before treatment and 51% after treatment, with increases in right temporal, parietal and frontal cortical areas. The multivariate classifier using resting-state hdEEG data was in favor of a UWS before treatment, while it indicated a MCS after treatment. Most of the individual markers increased after treatment, including alpha and beta spectral power, spectral entropy, Kolmogorov complexity and permutation entropy. Functional connectivity analyses also indicated an increase in network centrality predominant in the alpha frequency band after treatment compared to before treatment.

Discussion: After treatment with apomorphine, this patient showed improvements both at the clinical and neuroimaging levels. While signs of consciousness were only observed once at baseline, most of the assessments performed during and after treatment led to a diagnosis of MCS. Notably, a reproducible response to command was observed once during treatment, leading to a change of diagnosis. Brain activity measures all increased after treatment compared to before treatment. These multimodal improvements suggest that apomorphine may be efficient to promote the recovery of non-traumatic DOC patients, and that its action can be measured through different changes in brain imaging markers.
Clinicaltrials.gov identifier: NCT03623828
Impact of Remote Ischemic Conditioning on Neurological Biomarker Profiles in Posttraumatic Hemorrhagic Shock Patients with or without Brain Injury

Chung Ho Leung1,2, Shawn Rhind1, Zahra Khan1,2, Sandro Rizoli1,2, Andrew Baker1,2, Markus Ziesmann1, Alex Di Battista2,3, Maria Shiu3, Andrew Beckett4, Christopher Caldarone5, Ori D Rotstein1,2
1St. Michael's Hospital, Toronto, Canada, 2University of Toronto, Toronto, Canada, 3Defence Research and Development Canada, Toronto, Canada, 4Royal Canadian Medical Services, Ottawa, Canada, 5Texas Children’s Hospital, Houston, United States

Background: The extent of secondary organ damage/dysfunction after trauma is determined by the severity of primary mechanical injury and resultant intensity of endogenous secondary injury cascades (e.g. excitotoxicity, oxidant injury, inflammation), which may be worsened by systemic distress (e.g. hypotension, hypoxemia, ischemia). Collectively these posttraumatic insults contribute to brain damage via neural cell death (neurons, axons, glia) and tissue-level pathologies (cerebral edema and progressive neurological impairment). Remote ischemic conditioning (RIC) is a noninvasive intervention produced by alternating cycles of limb ischemia/reperfusion that has been shown to mitigate distant organ injury in animal models of resuscitated hemorrhagic shock (HS) and brain injury (TBI).

Objectives: The aim of this randomized controlled trial was to examine the potential neuroprotective effects of RIC on peripheral blood neurological injury biomarker profiles in a cohort of severely injured trauma patients in HS (median ISS = 17) with or without concomitant TBI (AIS head ≥1).

Methods: Healthy controls (n=10) and patients sustaining blunt or penetrating trauma in HS (systolic BP<90mmHg), with (n=8) or without TBI (n=25), were randomized 1:1 to receive either Sham (0mmHg) or RIC intervention (4 cycles of 5-min thigh cuff inflation at 250mmHg followed by 5-min deflation via pneumatic tourniquet). Circulating concentrations of neuroproteomic biomarkers, selected on the basis of their relative brain-specificities and potentials to reflect distinct injury mechanisms, including (1) neuronal cell damage [neuron-specific enolase (NSE), neurogranin, visinin-like protein]; (2) astroglial damage [S100B, glial fibrillary acidic protein (GFAP)]; (3) cerebral ischemia/oxidative stress [creatine kinase (CK)-BB, peroxiredoxin]; (4) neuroinflammation [monocyte chemoattractant protein-1, matrix metalloproteinase (MMP)-9]; (5) neural repair/plasticity [brain derived neurotrophic factor]; and (6) neurodegeneration [total Tau (T-tau)], were quantified on admission (pre-intervention) and 24-h post-RIC by ELISA. Differences between controls, HS, and HS+TBI on Admission were compared by ANOVA; Sham versus RIC treated trauma patients were evaluated by mixed model analysis.

Results: Compared to healthy control values, HS alone elevated levels of CK-BB (P<0.01), MMP-9 (P<0.01), S100B (P<0.01), and T-Tau (P<0.05) on Admission. Relative to HS alone, patients sustaining HS+TBI exhibited significantly increased levels of GFAP (P<0.01), CK-BB (P<0.05), S100B (P<0.05), T-Tau (P<0.05), and NSE (P<0.05). Overall treatment with RIC in pooled HS patients with or without TBI resulted in reduced NSE levels at 24-h in comparison to Sham patients (P<0.05) but did not alter other biomarker levels.

Conclusions: HS, in the absence of TBI, induced alterations in circulating neurological injury biomarkers. Concomitant hemorrhage and brain injury further exacerbated neurological injury biomarker release. These findings suggest post-injury application of RIC in HS patients has potential to reduce neuronal cell damage as evidenced by reduced NSE levels. Future RIC studies in isolated TBI patients, examining specific
neurological injury biomarkers in association with neuroimaging and neurocognitive outcome assessments may also demonstrate neuroprotective effects.
Post-Recovery Cognitive Decline in Adults with Traumatic Brain Injury

Alana Changoor¹, Marika Dabek¹, Brenda Colella¹, Robin Green¹,²,³
¹Toronto Rehabilitation Institute, University Health Network, Toronto, Canada, ²Department of Psychiatry, University of Toronto, Toronto, Canada, ³Rehabilitation Sciences Institute, University of Toronto, Toronto, Canada

Background: An estimated 1.1% of patients live with enduring disability from traumatic brain injury (TBI) (Zaloshnja, 2008), with persisting cognitive impairment being one of the most consequential factors impeding return to pre-injury productivity (Colantonio et al, 2004; Benedictus et al, 2010) and psychosocial reintegration (Ponsford et al, 2014). However, the ability to prognosticate recovery remains limited to date. This limitation is due to a large part to heterogeneity across patients of pre-injury factors (e.g., neural, cognitive, personality factors), to heterogeneity in the nature and severity of brain injuries (Millis et al., 2001; Doppenberg et al, 2004, Maas et al, 2008), and to variations in post-injury factors (e.g., mood, family support, therapy and enrichment of environment) (Frasca et al., 2013). As a result, traditional approaches to study recovery by comparing grouped means over time, may underestimate long term decline in this population.

Objectives: To replicate and extend our team’s 2008 findings of “post-recovery cognitive decline”, which refers to cognitive deterioration that may occur following an initial period of recovery post-injury (Till et al, 2008). The specific aims were to: (1) Assess prospectively the degree and pattern of post-recovery cognitive decline in individuals with moderate to severe TBI; (2) Characterize the cognitive domains that are most vulnerable to post-recovery decline; and (3) Identify the correlates of decline, including pre and post-injury factors.

Research Design: The current study was a longitudinal prospective observational cohort design in a sample of N=48 adults with moderate to severe TBI. Recovery of functioning was ascertained through repeat neuropsychological assessments at 2, 5, 12, and 24+ months post-injury. Change was calculated using the Reliable Change Index (RCI) to ascertain clinically and statistically significant decline at the individual level, across 12 neuropsychological tests commonly used in the assessment of TBI.

Results: Statistically significant cognitive decline was observed on at least 2 neuropsychological measures in 33.3% of study participants, and the proportion of participants experiencing cognitive decline steadily increased across the 2-24 months post injury time window. The most implicated cognitive domain was verbal recall for unorganized information, as captured by performance on the Rey Auditory Verbal Learning Test (RAVLT), for which there was the greatest number of decliners (39% of study participants) between 12-24 months post injury. Acute care length of stay, a proxy for injury severity, significantly predicted cognitive decline (p<0.05).

Conclusions: A quarter to a third of patients experience substantive cognitive declines from 1 to 2+ years post-injury. Further research is needed to identify early risk factors to enable prognosis at the single case level and to support the development of preventative treatments.

References: https://docs.google.com/document/d/1rmjO-etufq8uuUpilMjg8RLVT8ul8xwB6UIM43oySW0/edit?usp=sharing
Effects of Human Umbilical Cord Perivascular Cell-Conditioned Media in A Model of Traumatic Brain Injury in Adult Zebrafish

Xiao Yu Liu1, Eugene Park2, Tanya Barretto1, Elaine Liu2, Graham Ferrier3, Jahan Tavakkoli3, Andrew Baker1,2,4
1University of Toronto, Toronto, Canada, 2Keenan Research Centre, Toronto, Canada, 3Ryerson University, Toronto, Canada, 4St, Michael’s Hospital, Toronto, Canada

Background: The greatest impact on survival and outcome after a traumatic brain injury (TBI) attributes to future mitigation of the progression of secondary injury. Mesenchymal stem cells (MSCs) are promising therapeutic candidates as cumulative evidence shows both the multipotency of MSCs and their capability to exert a neuroprotective effect after CNS injury through the paracrine production of mitogenic, anti-apoptotic, and trophic factors. The secretome of MSC derived from human umbilical cord perivascular cells (HUCPVCs) have the potential anti-apoptotic, anti-oxidative and anti-excitotoxic functions; as well as regulation proteasome degradation, neurogenesis and neurodifferentiation. Here, we hypothesized that the secretome of HUCPVCs can improve outcome for TBI and modulate some known secondary injury mechanisms. More specifically, we examined the effect of the HUCPVC-conditioned media (CM) in a zebrafish TBI model using pulse, high intensity focused ultrasound (pHIFU).

Methods: All experiments were approved by the St. Michael’s Hospital Research Ethics Board and complied with the guidelines established by the St. Michael’s Hospital Animal Care Committee and Canadian Council on Animal Care. The zebrafish were grouped into sham, injured, injury treated with vehicle (basal media), and injury treated with HUCPVC-CM. Behaviour recordings were performed 6- and 24-hours post-injury (hpi). Whole brain dissection was performed 24-hpi to be further analyzed.

Results: At 6- and 24-hpi, there was a significant improvement in the total distance travelled (p<0.001), mean velocity (p<0.001), mean meander (p<0.001), and percent time immobile (p<0.001) for zebrafish treated with HUCPVC-CM when compared to the injured group without treatment and zebrafish treated with the vehicle. At 24-hpi, there was a significant increase in reactive astrogliosis observed in the brain tissue after injury when compared to the controls, as demonstrated by an increase in both GFAP protein expression and astrocyte processes. This alteration was modulated after treating the zebrafish with HUCPVC-CM. Furthermore, at 24-hpi, there was a significant increase in TUNEL-positive signals observed in the brain tissue after injury when compared to the control group, representing the presence of cellular apoptosis. However, this alteration was modulated by both the vehicle and HUCPVC-CM.

Conclusions: We present the first examination of the effect of the secretome of HUCPVC in a zebrafish TBI model. Positive modulation of known secondary injury mechanisms by the secretome of HUCPVCs may be a promising therapeutic strategy alternative to stem cell therapy.
Effect of Marijuana on Individuals with Significant Hit to the Head

Francisco Ramirez, Lance Hofer-Draper, John Hartman, Elijah Ramjattan

1Nedley Clinic, Weimar, United States

Background: Practitioners and patients are seeking effective treatments to help with mental disorders. Treatments must be assessed before their use because they may potentially worsen symptoms instead of ameliorating them. Some practitioners use marijuana to treat depression and anxiety, mainly due to marijuana’s effects on mood.

Purpose: To ascertain the effect of marijuana on levels of depression and anxiety in individuals suffering from brain injury.

Methods: Individuals participating in a depression recovery program were separated by those that had a history of significant hit to the head. Further those with a history of traumatic brain injury were separated into two groups based on their self-reported usage or abstinence of marijuana. Depression and anxiety scores were measured using a standard test for depression and anxiety called the Depression and Anxiety Assessment Test (registration TX 7-398-022). It assessed depression level based on DSM-5 [The Diagnostic and Statistical Manual of Mental Disorders Volume 5] criteria into 4 categories as none (0-6), mild (7-10), moderate (11-19) or severe (20 or more).

Results: Average age of those with a significant hit to the head was 47.2 ST Dev 16.6. The group abstaining from marijuana contained n=1237 individuals, and those using it numbered n=100. The mean depression score among those not using marijuana was 11.9 (SD: 8), while the mean depression score of those using marijuana was 16.8 (SD: 6.4).

The mean anxiety score among those not using marijuana was 6.5 (SD: 4.7), while the mean anxiety score of those using marijuana was 9.5 (SD: 3.9). Incidence of self-reported suicidal thoughts was also higher among the group using marijuana, with 57% of marijuana users reporting they had experienced suicidal thoughts in the past, compared with 29.4% of non-users of marijuana.

Conclusion: Marijuana users seem to have increased depression, anxiety, and suicidal thoughts. This effect may negate the potential benefits of its relaxing and euphoric effects for users, especially for those with a history of traumatic brain injury.
Characterizing the Longitudinal Course of Depression after Moderate-Severe Traumatic Brain Injury: A Trajectory Analysis from 2 to 5 to 12 to 24+ Months Post-Injury.

Pavel Tselichtchev¹, Jennifer Tomaszczyk²,³, Brenda Colella², Robin Green¹,²
¹University of Toronto, Toronto, Canada, ²Toronto Rehabilitation Institute, Toronto, Canada, ³University of Waterloo, Waterloo, Canada

Background: Depression can compound the already devastating effects of moderate-severe traumatic brain injury (TBI). Depression after TBI has been correlated with decreased quality of life, poorer community re-integration, and lowered rates of return to productivity. While the persistence and impact of depressive symptoms have been well-documented in patients with moderate-severe TBI, less is known about the course of depression from the sub-acute to chronic stages of injury.

Objective: To examine the magnitude, frequency, and trajectories of depressive symptoms from the sub-acute to the chronic stages of moderate to severe TBI.

Methods: N=77 patients prospectively completed the Beck Depression Inventory I (BDI) at 2, 5, 12, and 24+ months post-injury as part of the Toronto Rehab TBI Recovery Study. The proportion of patients with at least moderate-severe depressive symptoms was examined at each time point. A trajectory analysis was performed to identify recovery sub-groups within the study sample.

Results: Mean BDI score significantly increased across time, and the proportion of those meeting the cutoff for moderate or greater symptoms of depression more than doubled from 2 months to 24+ months post-injury. Trajectory analysis modelling revealed 4 subgroups within the sample: a “low stable” group (i.e., minimal depression across time; 67.9%), an “improvement” group (i.e., those whose initial depression resolved across time; 15.5%), a “high early increasing” group (i.e., rapidly increasing symptoms of depression across time; 10.9%), and a “delayed increasing” group (i.e., those starting without depression who became depressed in the later stages of injury; 5.7%).

Conclusions: Overall, the proportion of patients with moderate or greater symptoms of depression increased across time, with more than 15% showing either an early or a later rise in depressive symptoms based on trajectory analysis. Establishing factors underlying trajectory membership, especially those sub-groups likely to have poor long-term outcomes, can help to target patients for early prophylactic treatment.
Race and Psychological Distress Among Adults with Traumatic Brain Injury

Danielle Burlie1, Lauren Marcus1, Angela Colantonio1,2, Robert Mann3, Vincy Chan1
1University of Toronto, Toronto, Canada, 2Toronto Rehabilitation Institute-UHN, Toronto, Canada, 3Centre for Addiction and Mental Health, Toronto, Canada

Introduction: Traumatic brain injury (TBI) has been defined as “an alteration in brain function, or other evidence of brain pathology, caused by an external force”. It is a leading cause of disability in Canada and is disproportionately prevalent among certain racial minority groups. TBI can negatively affect every domain of an individual’s life, including increasing risk of psychological distress.

Objectives: To determine the prevalence of psychological distress among survivors of TBI by sex and explore the relationship between race and psychological distress within this population, controlling for sociodemographic factors, such as income, rurality, education, and age.

Methods: Data from 2014-2017 CAMH Monitor surveys will be presented. Psychological distress will be measured using the validated Kessler Psychological Distress Scale, which has been used with individuals of varying race and cognitive challenges (including TBI). Sex-specific descriptive and logistic regression analyses will be used to examine the association between race and psychological distress in individuals with a TBI.

Conclusions: Identifying racial groups with TBI that are vulnerable to psychological distress provides an opportunity for targeted intervention. Findings will encourage in-depth research on the specific barriers and risk factors associated with race and the impact that these have on health outcomes among survivors of TBI to support equitable and appropriate care to maximize quality of life after TBI.
Moderate Exercise Can Be Used to Detect Sub-Clinical Changes in Alpha Activity Related to Cumulative Soccer Heading

Alexandra Harriss1, Andrew Johnson2, James Thompson5, David Walton2,3, James Dickey4
1Health and Rehabilitation Sciences, The University of Western Ontario, London, Canada, 2School of Health Studies, The University of Western Ontario, London, Canada, 3School of Physical Therapy, The University of Western Ontario, London, Canada, 4School of Kinesiology, The University of Western Ontario, London, Canada, 5Evoke Neuroscience Inc., New York, United States

Background: Cumulative soccer heading may lead to negative changes in neurological functioning in youth soccer players. Electroencephalogram (EEG) recordings show abnormal brain functioning in people diagnosed with a concussion that had otherwise cleared all clinical concussion outcome measures [2]. Some type of compensatory brain mechanism may be occurring to achieve what appears to be normal functioning. It is unknown whether the cumulative effects of soccer heading show similar EEG findings, in that participants are able to perform a continuous performance test (CPT) successfully; however, require additional brain resources to compensate for the inability to produce the necessary power.

Objectives: Our primary objective evaluates EEG activity during a CPT to determine changes in brain function that may be related to cumulative soccer heading, both at rest and during exercise. It is expected that potential abnormalities will become amplified and more easily identified when in the context of increased task complexity [1].

Methods: This study documented the number of headers that 24 female youth soccer players (13.1 (SD 0.8) years old) performed during their six-month soccer season (22 matches total). They completed a CPT during rest and moderate exercise while recording EEG at four time points: baseline, two-mid season measures and post-season. Omission and commission errors were assessed for each CPT. EEG frequency bandwidths were divided into, theta (4-8Hz), low alpha (8-10Hz), high alpha (11-12Hz), low beta (12-18Hz), and high beta (19-30Hz). Electrode sites at the frontal, mid-frontal, lateral-frontal, and central locations were assessed.

Results: The average cumulative number of headers at follow-ups one, two and post-season was 6.4 (range: 0-29), 15.4 (range: 1-49), and 23.5 (range: 6-61), respectively. Omission errors significantly increased during exercise, compared to rest (p<0.05) but not commission errors. Linear mixed effects models revealed a statistically significant increase in alpha power during exercise (p<0.05), and the number of cumulative headers exacerbated this difference (p<0.05).

Conclusion: EEG recordings during exercise combined with additional cognitive load were adequately sensitive to detect sub-clinical neurocognitive dysfunction related to cumulative soccer heading. The number of headers a player performed resulted in increased alpha activity with increasing task complexity (moderate exercise and CPT). Increasing cumulative headers revealed negative changes in sustained attention as measured by an increase in omission errors (inattention), but no change in commission errors (impulsivity).

Cranial Nerve Noninvasive Neuromodulation Using Translingual Stimulation with the Portable Neuromodulation Stimulator (PoNS®) for the Treatment of Chronic Balance Deficit Due to Mild-to-Moderate Traumatic Brain Injury

Kim Skinner3, Linda Papa1, Alain Ptito2

1Orlando Health, Orlando, United States, 2Montreal Neurological Institute and Hospital, Montreal, Canada, 3Department of Kinesiology, University of Wisconsin, Madison, United States

Introduction: Portable Neuromodulation Stimulator (PoNS®) treatment involves a novel translingual neurostimulation (TLNS) device that applies sequenced electrotactile stimulation to the tongue. When combined with targeted exercise, TLNS improves outcomes for patients with chronic balance and gait deficits due to neurotrauma or neurodegenerative disease.

Methods: This 5-week, double-blind, randomized controlled trial was carried out to determine whether TLNS training combined with targeted exercise (PoNS® treatment) with normal stimulation (active) is more effective than training using a very low but perceivable stimulation (control) in patients with balance and gait deficits due to mild-to-moderate traumatic brain injury (mTBI). Patients had experienced their most recent mTBI ≥1 year prior to enrollment in the trial and had received previous physical therapy for their balance disorder, been deemed to have reached a plateau by their healthcare provider, and still had significantly impaired balance. All participants also had a NeuroCom® Sensory Organization Test (SOT) composite score ≥16 points below normal after adjustment for age. Patients participated in a 5-week course of standard physical therapy focusing on balance and gait, together with breathing and awareness (mindfulness) training, as per the PoNS® treatment protocol. Success was defined as an increase in SOT score by ≥15 points at 5 weeks (primary endpoint), with a secondary endpoint at 2 weeks. The analysis plan permitted combining results from the two groups if there was no significant difference between the groups for the primary endpoint.

Results: A total of 122 patients were enrolled and randomized 1:1; an improvement in the SOT score of ≥15 points occurred in 71.2% in the active group compared with 63.5% in the control group (P = 0.081). Pooling of results from the two groups indicated a responder rate of 67.2%. For the combined group, the mean change in SOT score from baseline was 24.6 (P < 0.0005) at week 5 and 18.3 (P < 0.0005) at week 2. Treatment also resulted in reductions in falls and headaches and improved sleep and quality of life.

Conclusions: The results of this controlled clinical trial indicate that PoNS® treatment (TLNS plus physical therapy) with either high- or low-frequency stimulation produced significant improvements in balance, as indicated by changes in the composite SOT scores, and also helped to decrease the number of falls.
<table>
<thead>
<tr>
<th>Name</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aabid, Hend</td>
<td>349</td>
</tr>
<tr>
<td>Abegunde, Naomi</td>
<td>596</td>
</tr>
<tr>
<td>Abelleira-Hervas, Laura</td>
<td>575</td>
</tr>
<tr>
<td>Abildskov, Tracy</td>
<td>321, 388</td>
</tr>
<tr>
<td>Abo, Masahiro</td>
<td>740</td>
</tr>
<tr>
<td>Abraham, Lesley</td>
<td>401</td>
</tr>
<tr>
<td>Acher, Rose</td>
<td>364</td>
</tr>
<tr>
<td>Adams, Deana</td>
<td>39</td>
</tr>
<tr>
<td>Adams, Rachel</td>
<td>272</td>
</tr>
<tr>
<td>Adamson, Maheen</td>
<td>321</td>
</tr>
<tr>
<td>Aegerter, Philippe</td>
<td>428</td>
</tr>
<tr>
<td>Agrawal, Niruj</td>
<td>633</td>
</tr>
<tr>
<td>Ahonniska-Assa, Jaana</td>
<td>484</td>
</tr>
<tr>
<td>Aida, Tamami</td>
<td>218</td>
</tr>
<tr>
<td>Aiello, Marco</td>
<td>638</td>
</tr>
<tr>
<td>Aitken, Phillip</td>
<td>575</td>
</tr>
<tr>
<td>Akimoto, Hideaki</td>
<td>740</td>
</tr>
<tr>
<td>Akkidas, James</td>
<td>400</td>
</tr>
<tr>
<td>Akobirshoev, Ilhom</td>
<td>272</td>
</tr>
<tr>
<td>Alarie, Christophe</td>
<td>702, 789</td>
</tr>
<tr>
<td>Ala-Seppälä, Henna</td>
<td>134, 432, 512</td>
</tr>
<tr>
<td>Alavinia, Mohammad</td>
<td>200</td>
</tr>
<tr>
<td>Albakri, Ghalia</td>
<td>407</td>
</tr>
<tr>
<td>Alcañiz, Mariano</td>
<td>477</td>
</tr>
<tr>
<td>Aldhoun, Jitka</td>
<td>575</td>
</tr>
<tr>
<td>Alexander Chronik, Blaine</td>
<td>638</td>
</tr>
<tr>
<td>Alfonso, Ejessie</td>
<td>113</td>
</tr>
<tr>
<td>Algird, Almunder</td>
<td>573</td>
</tr>
<tr>
<td>Ali, Syed</td>
<td>244, 513, 749</td>
</tr>
<tr>
<td>Allen, Kelly</td>
<td>97</td>
</tr>
<tr>
<td>Allen, Matti</td>
<td>716</td>
</tr>
<tr>
<td>Allgar, Victoria</td>
<td>229, 230</td>
</tr>
<tr>
<td>Alm Andreassen, Tone</td>
<td>461, 479</td>
</tr>
<tr>
<td>Aloisi, Marta</td>
<td>260, 261, 453</td>
</tr>
<tr>
<td>Alvarán, Liliana</td>
<td>48</td>
</tr>
<tr>
<td>Alvarez, Gabrielle</td>
<td>506</td>
</tr>
<tr>
<td>Alvarez, Liliana</td>
<td>201</td>
</tr>
<tr>
<td>Alves de Sousa, Ricardo</td>
<td>110</td>
</tr>
<tr>
<td>Amodio, Vanessa</td>
<td>165, 166, 167, 682, 698</td>
</tr>
<tr>
<td>Amoozegar, Farnaz</td>
<td>417</td>
</tr>
<tr>
<td>Analytis, Penelope</td>
<td>418</td>
</tr>
<tr>
<td>Andelic, Nada</td>
<td>311, 339, 350, 367, 373, 374, 488, 511, 620</td>
</tr>
<tr>
<td>Anderson, Adam</td>
<td>445</td>
</tr>
<tr>
<td>Anderson, Dustin</td>
<td>169</td>
</tr>
<tr>
<td>Anderson, John</td>
<td>537</td>
</tr>
<tr>
<td>Anderson, Malcolm</td>
<td>319</td>
</tr>
<tr>
<td>Anderson, Nicholas</td>
<td>155</td>
</tr>
<tr>
<td>Anderson, Vicki</td>
<td>148, 155, 197, 249, 250, 380</td>
</tr>
<tr>
<td>Andersson, Stein</td>
<td>367</td>
</tr>
<tr>
<td>Andrinopoulou, Eleni-Rosalina</td>
<td>782</td>
</tr>
<tr>
<td>Angerova, Yvona</td>
<td>158, 234, 685</td>
</tr>
<tr>
<td>Annen, Jitka</td>
<td>504, 744</td>
</tr>
<tr>
<td>Anochina, Nadia</td>
<td>547</td>
</tr>
<tr>
<td>Antanopoulos, Georgios</td>
<td>747</td>
</tr>
<tr>
<td>Antenucci, Roberto</td>
<td>349</td>
</tr>
<tr>
<td>Aoki, Kazuya</td>
<td>326</td>
</tr>
<tr>
<td>Arakal, Alan</td>
<td>387, 434</td>
</tr>
<tr>
<td>Arango-Lasprilla, Juan Carlos</td>
<td>620</td>
</tr>
<tr>
<td>Arbabi, Mohammad</td>
<td>633</td>
</tr>
<tr>
<td>Arbogast, Katherine</td>
<td>344, 615, 635</td>
</tr>
<tr>
<td>Arbogast, Kristy</td>
<td>405</td>
</tr>
<tr>
<td>Arichi, Tomoki</td>
<td>391</td>
</tr>
<tr>
<td>Armstrong, Kelly</td>
<td>88</td>
</tr>
<tr>
<td>Arora, Aman</td>
<td>736</td>
</tr>
<tr>
<td>Asemota, Anthony</td>
<td>704</td>
</tr>
<tr>
<td>Ashford, Stephen</td>
<td>121, 247, 508</td>
</tr>
<tr>
<td>Aslam, Hira</td>
<td>446, 447, 448</td>
</tr>
<tr>
<td>Astolfi, Laura</td>
<td>453, 457</td>
</tr>
<tr>
<td>Astrand, Ramona</td>
<td>427</td>
</tr>
<tr>
<td>Athanasopoulos, Peter</td>
<td>726</td>
</tr>
<tr>
<td>Aubinet, Charlène</td>
<td>257, 421, 504, 744</td>
</tr>
<tr>
<td>Audrit, Hélène</td>
<td>264</td>
</tr>
<tr>
<td>Avery, Roger</td>
<td>767</td>
</tr>
<tr>
<td>Avesani, Renato</td>
<td>349</td>
</tr>
<tr>
<td>Awasthi, Vibhudutta</td>
<td>351, 561</td>
</tr>
<tr>
<td>Awwad, Hibah</td>
<td>351</td>
</tr>
<tr>
<td>Azouvi, Philippe</td>
<td>290, 315, 428</td>
</tr>
<tr>
<td>Azurmendi, Leire</td>
<td>176, 199, 485, 512</td>
</tr>
<tr>
<td>Babl, Franz</td>
<td>155, 250, 380</td>
</tr>
<tr>
<td>Babul, Shelina</td>
<td>499</td>
</tr>
<tr>
<td>Bagnato, Sergio</td>
<td>348</td>
</tr>
<tr>
<td>Bailey, Kristi</td>
<td>665</td>
</tr>
<tr>
<td>Biscardi, Melissa</td>
<td>567, 668</td>
</tr>
<tr>
<td>Bish, Joel</td>
<td>676, 686</td>
</tr>
<tr>
<td>Bittencourt-Villalpando, Mayra</td>
<td>460</td>
</tr>
<tr>
<td>Bjarkam, Carsten Reidies</td>
<td>463</td>
</tr>
<tr>
<td>Name</td>
<td>Pages</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Baker, Andrew</td>
<td>233, 235, 237, 791, 793</td>
</tr>
<tr>
<td>Bakushkina, Nadja</td>
<td>208</td>
</tr>
<tr>
<td>Balachandran, Kartik</td>
<td>749</td>
</tr>
<tr>
<td>Balachandran, Peraveena</td>
<td>358</td>
</tr>
<tr>
<td>Balaet, Maria</td>
<td>575</td>
</tr>
<tr>
<td>Baldwin, Bristol</td>
<td>408</td>
</tr>
<tr>
<td>Ballinger, Dominique</td>
<td>676</td>
</tr>
<tr>
<td>Balogh, Robert</td>
<td>390, 556, 627</td>
</tr>
<tr>
<td>Bamborschke, Stephan</td>
<td>496</td>
</tr>
<tr>
<td>Banks, Russell</td>
<td>27, 36</td>
</tr>
<tr>
<td>Banky, Megan</td>
<td>300</td>
</tr>
<tr>
<td>Banville, Catherine</td>
<td>284</td>
</tr>
<tr>
<td>Bar, Orly</td>
<td>647</td>
</tr>
<tr>
<td>Barner, Christine</td>
<td>611</td>
</tr>
<tr>
<td>Barnett, Peter</td>
<td>155, 250, 380</td>
</tr>
<tr>
<td>Barr, Alasdair</td>
<td>377</td>
</tr>
<tr>
<td>Barra, Alice</td>
<td>129, 333, 424, 504, 744</td>
</tr>
<tr>
<td>Barrett, Carrie</td>
<td>483, 501</td>
</tr>
<tr>
<td>Barretto, Tanya</td>
<td>793</td>
</tr>
<tr>
<td>Bartfai, Aniko</td>
<td>168, 429</td>
</tr>
<tr>
<td>Bartolo, Michelangelo</td>
<td>348, 349</td>
</tr>
<tr>
<td>Basaglia, Nino</td>
<td>362, 365</td>
</tr>
<tr>
<td>Baskina, Olga</td>
<td>745</td>
</tr>
<tr>
<td>Basso, Luca</td>
<td>638</td>
</tr>
<tr>
<td>Bateman, E. Ali</td>
<td>338</td>
</tr>
<tr>
<td>Batey, Heather</td>
<td>478</td>
</tr>
<tr>
<td>Batty, Rachel</td>
<td>58, 60</td>
</tr>
<tr>
<td>Bauser, Nancy</td>
<td>86</td>
</tr>
<tr>
<td>Bavishi, Sheital</td>
<td>661</td>
</tr>
<tr>
<td>Bayen, Eleonore</td>
<td>428</td>
</tr>
<tr>
<td>Bayley, Mark</td>
<td>130, 189, 200, 233, 492, 729</td>
</tr>
<tr>
<td>Beal, Deryk</td>
<td>151</td>
</tr>
<tr>
<td>Beaumont, Emily</td>
<td>635</td>
</tr>
<tr>
<td>Beauchamp, Miriam</td>
<td>74, 148, 197, 277, 598</td>
</tr>
<tr>
<td>Beaujuge, Christine</td>
<td>293, 294, 309</td>
</tr>
<tr>
<td>Beaujuge-Bonneau, Simon</td>
<td>284, 290, 310, 320, 384</td>
</tr>
<tr>
<td>Beckett, Andrew</td>
<td>791</td>
</tr>
<tr>
<td>Beech, Sandra</td>
<td>236</td>
</tr>
<tr>
<td>Befus, Deanna</td>
<td>618</td>
</tr>
<tr>
<td>Behn, Nicholas</td>
<td>454, 455, 752</td>
</tr>
<tr>
<td>Belanger, Heather</td>
<td>321, 388</td>
</tr>
<tr>
<td>Belchev, Zorry</td>
<td>729</td>
</tr>
<tr>
<td>Belisle, Arielle</td>
<td>490</td>
</tr>
<tr>
<td>Bell, Fiona</td>
<td>441</td>
</tr>
<tr>
<td>Bell, Kathleen</td>
<td>401, 510, 566</td>
</tr>
<tr>
<td>Bellerose, Jenny</td>
<td>74</td>
</tr>
<tr>
<td>Belousovy, Michael</td>
<td>123</td>
</tr>
<tr>
<td>Name</td>
<td>Page Numbers</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Benetti, Nalía</td>
<td>753</td>
</tr>
<tr>
<td>Benton, Brooke</td>
<td>464, 505, 548</td>
</tr>
<tr>
<td>Ben-Zeev, Bruria</td>
<td>484, 609</td>
</tr>
<tr>
<td>Berardi, Mark</td>
<td>27, 36</td>
</tr>
<tr>
<td>Berghem, Ksenia</td>
<td>669</td>
</tr>
<tr>
<td>Bergin, Michael</td>
<td>341</td>
</tr>
<tr>
<td>Bergquist, Thomas</td>
<td>246</td>
</tr>
<tr>
<td>Berkner, Paul</td>
<td>239, 331</td>
</tr>
<tr>
<td>Berlusconi, Marta</td>
<td>349</td>
</tr>
<tr>
<td>Bernier, Annie</td>
<td>74, 277</td>
</tr>
<tr>
<td>Berntsen, Svein</td>
<td>311, 373</td>
</tr>
<tr>
<td>Beros, Katie</td>
<td>251</td>
</tr>
<tr>
<td>Bertoni, Michele</td>
<td>349</td>
</tr>
<tr>
<td>Best, Justine</td>
<td>692</td>
</tr>
<tr>
<td>Best, Krista</td>
<td>193</td>
</tr>
<tr>
<td>Beyea, Jason</td>
<td>202</td>
</tr>
<tr>
<td>Bhalarao, Shree</td>
<td>71, 72, 235, 237</td>
</tr>
<tr>
<td>Biacchi, Daniela</td>
<td>349</td>
</tr>
<tr>
<td>Bialas, Dale</td>
<td>573</td>
</tr>
<tr>
<td>Bian, Kewei</td>
<td>706, 720</td>
</tr>
<tr>
<td>Biddiss, Elaine</td>
<td>475, 526</td>
</tr>
<tr>
<td>Biegon, Anat</td>
<td>572</td>
</tr>
<tr>
<td>Bier, Nathalie</td>
<td>718, 721</td>
</tr>
<tr>
<td>Biering-Soerensen, Fin</td>
<td>271</td>
</tr>
<tr>
<td>Biernacki, Kathryn</td>
<td>304</td>
</tr>
<tr>
<td>Biggs, Jennifer</td>
<td>738</td>
</tr>
<tr>
<td>Bigler, Erin</td>
<td>321, 388</td>
</tr>
<tr>
<td>Bill, Alan</td>
<td>99</td>
</tr>
<tr>
<td>Binda Fossati, Mariachiara</td>
<td>333, 424</td>
</tr>
<tr>
<td>Luisella</td>
<td></td>
</tr>
<tr>
<td>Bines, Ann</td>
<td>177</td>
</tr>
<tr>
<td>Binns, Malcolm</td>
<td>729</td>
</tr>
</tbody>
</table>

C

<table>
<thead>
<tr>
<th>Name</th>
<th>Page Numbers</th>
<th>Name</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caldarone, Christopher</td>
<td>791</td>
<td>Chung, Hannah</td>
<td>390</td>
</tr>
<tr>
<td>Calero, Karel</td>
<td>100</td>
<td>Ciarrochi, Joseph</td>
<td>412</td>
</tr>
<tr>
<td>Calle, Esteban</td>
<td>48</td>
<td>Cimino, Mikayla</td>
<td>686</td>
</tr>
<tr>
<td>Callo, Andrej</td>
<td>621</td>
<td>Cincotti, Febo</td>
<td>453, 457</td>
</tr>
<tr>
<td>Calvo, Dayana</td>
<td>209</td>
<td>Ciscar, Regina</td>
<td>477</td>
</tr>
<tr>
<td>Campbell, Alyson</td>
<td>690</td>
<td>Cisneros, Eduardo</td>
<td>187, 188, 217</td>
</tr>
<tr>
<td>Campos-Pires, Rita</td>
<td>568, 571, 575</td>
<td>Ciurli, Paola</td>
<td>361, 453</td>
</tr>
<tr>
<td>Candaras, Jacquelyn</td>
<td>282</td>
<td>Clark, Ross</td>
<td>298, 300</td>
</tr>
<tr>
<td>Cannizzaro, Me</td>
<td>243</td>
<td>Clarke, Cathriona</td>
<td>155, 250, 380</td>
</tr>
<tr>
<td>Caraza, Ricardo</td>
<td>383</td>
<td>Clay, Fiona</td>
<td>58, 60</td>
</tr>
<tr>
<td>Carboncini, Maria Chiara</td>
<td>349</td>
<td>Clifton, Patrick</td>
<td>250, 380</td>
</tr>
<tr>
<td>Cardona, Annabel</td>
<td>113</td>
<td>Cnossen, Maryse</td>
<td>143, 470</td>
</tr>
<tr>
<td>CARE Consortium,</td>
<td>291</td>
<td>Coelho, Carl</td>
<td>123</td>
</tr>
<tr>
<td>Investigators,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carleton, Alexandra</td>
<td>636</td>
<td>Coffman, Colt</td>
<td>785</td>
</tr>
<tr>
<td>Carmichael, Jason</td>
<td>80</td>
<td>Cogné, Mélanie</td>
<td>315</td>
</tr>
<tr>
<td>Caron, Gabriel</td>
<td>600</td>
<td>Cohen, Neal</td>
<td>337, 360, 710</td>
</tr>
<tr>
<td>Name</td>
<td>Pages</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpenter, Jessica</td>
<td>64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colantonio, Angela</td>
<td>46, 51, 165, 166, 167, 358, 408, 492, 507, 522, 538, 552, 556, 567, 585, 627, 634, 636, 641, 663, 668, 670, 682, 698, 755, 789, 796</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrière, Manon</td>
<td>129, 333, 421, 424, 504, 744</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colella, Brenda</td>
<td>700, 701, 729, 792, 795</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carroll, Kevin</td>
<td>163</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collins, Kathleen</td>
<td>152</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carullo, Paulina</td>
<td>267</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colomer, Carolina</td>
<td>477</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Casa, Douglas</td>
<td>584</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colquhoun, Heather</td>
<td>216</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Casanova, Emanuela</td>
<td>349</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colwell, Kathi</td>
<td>274</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cassol, Helena</td>
<td>348, 421, 504, 625, 744, 747</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combs, Patricia</td>
<td>387</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Castellani, Rudolph</td>
<td>212, 654, 665</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comper, Paul</td>
<td>492</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catroppa, Cathy</td>
<td>148, 197</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comstock, R. Dawn</td>
<td>387, 434</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caughlan, Jan</td>
<td>648</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conder, Robert</td>
<td>615</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caughlin, Sarah</td>
<td>678, 681</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conforto, Adriana</td>
<td>451, 452</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cavaliere, Carlo</td>
<td>638</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connolly, Eric</td>
<td>81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cecchini, Amy</td>
<td>544, 563</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contrada, Marianna</td>
<td>260, 261, 453</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceniti, Amanda</td>
<td>586</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cook, Anna</td>
<td>643, 652, 659</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ceregra, Gabi</td>
<td>250, 380</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cook, DJ</td>
<td>716</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cermak, Carly</td>
<td>151</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cope, Sydney</td>
<td>686</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chaleckas, Edvinas</td>
<td>437</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copeland, Paige</td>
<td>153, 409, 410</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamberland, Cindy</td>
<td>555</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copley, Anna</td>
<td>78, 83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Champagne, Allen</td>
<td>716</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copstick, Sue</td>
<td>536</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chan, Albert</td>
<td>419</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corbin-Berrigan, Laurie-Ann</td>
<td>392</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chan, Nicole</td>
<td>77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cornwell, Petrea</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chan, Tasha</td>
<td>377</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correa, José</td>
<td>180</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chan, Vincy</td>
<td>390, 538, 552, 556, 585, 627, 634, 796</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrigan, John</td>
<td>628</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chandran, Avinash</td>
<td>162, 387, 434</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cortés, Roberto</td>
<td>383</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chang, Hsi-Hsien</td>
<td>786</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corwin, Daniel</td>
<td>405</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changooor, Alana</td>
<td>792</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cousins, Jacqueline</td>
<td>416</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chao, Yin-Cheng</td>
<td>415</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Couture, Mélanie</td>
<td>718, 721</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chapa-Montemayor, Ana</td>
<td>383</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coverdale, Nicole</td>
<td>716</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charanton, James</td>
<td>428</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Covington, Natalie</td>
<td>710</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charbonney, Emmanuel</td>
<td>385</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cowle, Stephanie</td>
<td>486, 499</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charles, Latchoumane</td>
<td>102</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Craighero, Laila</td>
<td>362</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charlfue, Susan</td>
<td>152</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crampton, Adrienne</td>
<td>309</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charvat, Mylea</td>
<td>163</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crawley, Adrian</td>
<td>636</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chatelle, Camille</td>
<td>348, 421, 424, 503, 504, 625, 744, 747</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credieu, Daniel</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chau, Tom</td>
<td>554</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crichton, Alison</td>
<td>155, 250, 380</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chauny, Jean-Marc</td>
<td>264</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crilly, Sarah</td>
<td>355</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chaves, Marisa</td>
<td>305</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crooks, Samantha</td>
<td>403</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chen, Chin-Wei</td>
<td>415</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Croteau, Carolane</td>
<td>555</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chen, Chi-Shuo</td>
<td>195</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cruse, Nicole</td>
<td>123</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chen, Peii</td>
<td>462</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cruz, Luz María</td>
<td>539</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheng, Alex</td>
<td>377</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crylen, Anne</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheng, Chia Hsin (Jasmine)</td>
<td>535</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuadrado-Godia, Elisa</td>
<td>516</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chevignard, Mathilde</td>
<td>724</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuevas, Elvis</td>
<td>244, 513, 749</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Page</td>
<td>Name</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------</td>
<td>---------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Chmelova, Irina</td>
<td>234</td>
<td>Cullen, Nora</td>
<td>507, 522, 531, 538, 567, 585, 596, 634, 663</td>
</tr>
<tr>
<td>Chou, Yi-Pin</td>
<td>105</td>
<td>Cullum, Munro</td>
<td>401</td>
</tr>
<tr>
<td>Choudhari, Kishor</td>
<td>287</td>
<td>Curkovic, Anna</td>
<td>573</td>
</tr>
<tr>
<td>Choudhury, Tasnim Haque</td>
<td>714</td>
<td>Curtin, Mariah</td>
<td>101</td>
</tr>
<tr>
<td>Christie, Brian</td>
<td>392</td>
<td>Cusimano, Michael</td>
<td>98, 379</td>
</tr>
<tr>
<td>Chui, Adora</td>
<td>216</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dabaghian, Laurie</td>
<td>399</td>
<td>Dhillan, Rishi</td>
<td>736</td>
</tr>
<tr>
<td>Dabek, Marika</td>
<td>700, 792</td>
<td>Di Battista, Alex</td>
<td>694, 696, 775, 791</td>
</tr>
<tr>
<td>Daher, Maysaa</td>
<td>319</td>
<td>Diana, Anna Rita</td>
<td>349</td>
</tr>
<tr>
<td>Dahl, Hilde Margrete</td>
<td>339</td>
<td>Diaz-Acevedo, Neishaliz</td>
<td>629</td>
</tr>
<tr>
<td>Dales, Eden</td>
<td>476</td>
<td>Dickens, Alex</td>
<td>134</td>
</tr>
<tr>
<td>Daly, Maria</td>
<td>676</td>
<td>Dickey, James</td>
<td>201, 797</td>
</tr>
<tr>
<td>Dams-O'Connor, Kristen</td>
<td>137, 139</td>
<td>Dickinson, Robert</td>
<td>568, 571, 575</td>
</tr>
<tr>
<td>Darling, Simone</td>
<td>250, 380</td>
<td>Diefenbach, Hilary</td>
<td>673</td>
</tr>
<tr>
<td>Davenport, Elizabeth</td>
<td>401</td>
<td>Diekelmann, Susanne</td>
<td>611</td>
</tr>
<tr>
<td>Davis, Gavin</td>
<td>155, 250, 380</td>
<td>Diener, Ed</td>
<td>89</td>
</tr>
<tr>
<td>Davis, John</td>
<td>96, 514, 596</td>
<td>Dijkland, Simone</td>
<td>470</td>
</tr>
<tr>
<td>Davis, Robert</td>
<td>597</td>
<td>Disabito, Susan</td>
<td>573</td>
</tr>
<tr>
<td>Davis, Taron</td>
<td>245</td>
<td>Divine, James</td>
<td>546</td>
</tr>
<tr>
<td>Davis Moore, Robert</td>
<td>550, 551</td>
<td>Dlamini, Nomazulu</td>
<td>541</td>
</tr>
<tr>
<td>Dawson, Deirdre</td>
<td>216</td>
<td>Dolbow, David</td>
<td>50</td>
</tr>
<tr>
<td>Dawson, Jeremy</td>
<td>119, 120, 287</td>
<td>Dolbow, James</td>
<td>50</td>
</tr>
<tr>
<td>De Beaumont, Louis</td>
<td>734</td>
<td>Donaldson, Alex</td>
<td>761</td>
</tr>
<tr>
<td>De Bellis, Francesco</td>
<td>353</td>
<td>Donnelly, Erin</td>
<td>282</td>
</tr>
<tr>
<td>De Maio, Carren</td>
<td>330</td>
<td>Doran, Tony</td>
<td>29, 35, 226</td>
</tr>
<tr>
<td>De Paul, Vincent</td>
<td>699</td>
<td>Dornonville de la Cour, Frederik</td>
<td>124</td>
</tr>
<tr>
<td>De Tanti, Antonio</td>
<td>349</td>
<td>Dorrego, Maria Flavia</td>
<td>267</td>
</tr>
<tr>
<td>Dean, Jackie</td>
<td>227</td>
<td>Dougherty III, John</td>
<td>553</td>
</tr>
<tr>
<td>Dean, Phil JA</td>
<td>451, 452</td>
<td>Douglas, Jacinta</td>
<td>330</td>
</tr>
<tr>
<td>Deane, Frank</td>
<td>412</td>
<td>Downey, Dawn</td>
<td>274</td>
</tr>
<tr>
<td>Debert, Chantel</td>
<td>204, 417, 630, 724</td>
<td>Downing, Marina</td>
<td>304</td>
</tr>
<tr>
<td>Debison-larabie, Chad</td>
<td>726</td>
<td>Dr., Adrian</td>
<td>641</td>
</tr>
<tr>
<td>Decq, Philippe</td>
<td>315</td>
<td>Drennon, Ann Marie</td>
<td>321</td>
</tr>
<tr>
<td>Defferrière, Hélène</td>
<td>315</td>
<td>D'Souza, Andrea</td>
<td>46, 165, 166, 167</td>
</tr>
<tr>
<td>Dégeilh, Fanny</td>
<td>148, 197, 598</td>
<td>D'Souza, Natasha</td>
<td>643</td>
</tr>
<tr>
<td>Dehaes, Mathieu</td>
<td>598</td>
<td>Dubé, Archana</td>
<td>236</td>
</tr>
<tr>
<td>Dejong, Joyce</td>
<td>665</td>
<td>Dubuc, Érika</td>
<td>721</td>
</tr>
<tr>
<td>Delhalle, Sabrina</td>
<td>257</td>
<td>Duff, Melissa</td>
<td>170, 241, 337, 359, 360, 366, 403, 623, 646, 710</td>
</tr>
<tr>
<td>DeMatteo, Carol</td>
<td>77, 280</td>
<td>Duffy, Tristan</td>
<td>464</td>
</tr>
<tr>
<td>Deng, Zhihui</td>
<td>389, 514</td>
<td>Dukelow, Sean</td>
<td>417</td>
</tr>
<tr>
<td>Dennis, Emily</td>
<td>321</td>
<td>Dulas, Michael</td>
<td>337, 710</td>
</tr>
<tr>
<td>Department, Parisa</td>
<td>104</td>
<td>Dunbar, Tricia</td>
<td>603</td>
</tr>
<tr>
<td>Dertinger, Stacie</td>
<td>559</td>
<td>Duncan, Lindsay</td>
<td>789</td>
</tr>
<tr>
<td>Dery, Julien</td>
<td>82</td>
<td>Dunne, Kevin</td>
<td>155</td>
</tr>
<tr>
<td>Desaultels, Alex</td>
<td>734</td>
<td>Dupont, Dominique</td>
<td>74</td>
</tr>
<tr>
<td>Name</td>
<td>Page(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Descoteaux, Maxime</td>
<td>404</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Devanaboyina, Monika</td>
<td>619</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duquette-Laplante, Fauve</td>
<td>679</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Durant, Benoit</td>
<td>649</td>
<td></td>
<td></td>
</tr>
<tr>
<td>de Guise, Elaine</td>
<td>82, 180, 264, 310, 384, 490</td>
<td></td>
<td></td>
</tr>
<tr>
<td>de Souza, Nicola</td>
<td>497, 778</td>
<td></td>
<td></td>
</tr>
<tr>
<td>de Koning, Myrthe</td>
<td>444</td>
<td></td>
<td></td>
</tr>
<tr>
<td>de Vries, Lianne</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>de Pasquale, Francesco</td>
<td>361</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**E**

<table>
<thead>
<tr>
<th>Name</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eagan-Johnson, Brenda</td>
<td>288, 750</td>
</tr>
<tr>
<td>Eapen, Blessen</td>
<td>321, 388</td>
</tr>
<tr>
<td>Ebad Fardzadeh, Haghish</td>
<td>459</td>
</tr>
<tr>
<td>Echlin, Holly</td>
<td>285</td>
</tr>
<tr>
<td>Edge, Christopher</td>
<td>568, 571, 575</td>
</tr>
<tr>
<td>Edgell, Heather</td>
<td>285</td>
</tr>
<tr>
<td>Edlinger, Günter</td>
<td>605</td>
</tr>
<tr>
<td>Edlow, Brian</td>
<td>348</td>
</tr>
<tr>
<td>Edvardsen, Espen</td>
<td>489</td>
</tr>
<tr>
<td>Edwards, Jason</td>
<td>357, 733</td>
</tr>
<tr>
<td>Edwards, Malcolm</td>
<td>646</td>
</tr>
<tr>
<td>Efthymios, Angelakis</td>
<td>348</td>
</tr>
<tr>
<td>Egea-Guerrero, Juan José</td>
<td>175</td>
</tr>
<tr>
<td>Egerod, Ingrid</td>
<td>461</td>
</tr>
<tr>
<td>Eggertsen, Kathrine</td>
<td>79</td>
</tr>
<tr>
<td>Eichler, Sandra</td>
<td>339</td>
</tr>
<tr>
<td>Eide, Line</td>
<td>256, 489</td>
</tr>
<tr>
<td>Eilander, Henk</td>
<td>601</td>
</tr>
<tr>
<td>Einstein, Gillian</td>
<td>567</td>
</tr>
<tr>
<td>Elazhary, Nicolas</td>
<td>264</td>
</tr>
<tr>
<td>Elg, Mattias</td>
<td>168</td>
</tr>
<tr>
<td>El-Jalbout, Ramy</td>
<td>598</td>
</tr>
<tr>
<td>Ellemberg, Dave</td>
<td>172, 569, 597, 600</td>
</tr>
<tr>
<td>Elmér, Eskil</td>
<td>427</td>
</tr>
<tr>
<td>Eman Abdulle, Amaal</td>
<td>354, 356</td>
</tr>
<tr>
<td>Emond, Marcel</td>
<td>310</td>
</tr>
<tr>
<td>Enciso-Olivera, Cesar</td>
<td>691</td>
</tr>
<tr>
<td>Enghaug, Heidi</td>
<td>488, 511</td>
</tr>
<tr>
<td>Enright, Sara</td>
<td>661</td>
</tr>
<tr>
<td>Epker, Jelle</td>
<td>433</td>
</tr>
<tr>
<td>Erez, Jonathan</td>
<td>562</td>
</tr>
<tr>
<td>Erskine, Brittany</td>
<td>665</td>
</tr>
<tr>
<td>Escobar, Michael</td>
<td>552</td>
</tr>
<tr>
<td>Escorcia, Clara</td>
<td>48</td>
</tr>
<tr>
<td>Escudero-Lourdes, Claudia</td>
<td>749</td>
</tr>
<tr>
<td>Eskandari, Ramin</td>
<td>717</td>
</tr>
<tr>
<td>Eskildsen, Marianne</td>
<td>142</td>
</tr>
<tr>
<td>Eslamijeiaj, Ashkan</td>
<td>732</td>
</tr>
<tr>
<td>Eslampanah Sendi, Mohammad</td>
<td>102</td>
</tr>
<tr>
<td>Esopenko, Carrie</td>
<td>497, 778</td>
</tr>
<tr>
<td>Esterov, Dmitry</td>
<td>246</td>
</tr>
<tr>
<td>Estraneo, Anna</td>
<td>348, 349, 353, 504, 638</td>
</tr>
</tbody>
</table>

**F**

<table>
<thead>
<tr>
<th>Name</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabbri, Andrea</td>
<td>229, 231</td>
</tr>
<tr>
<td>Fabricius, Alexis</td>
<td>165, 166, 167</td>
</tr>
<tr>
<td>Failla, Sebastiano</td>
<td>678, 681</td>
</tr>
<tr>
<td>Falco, Christopher</td>
<td>580</td>
</tr>
<tr>
<td>Falletta Caravasso, Chiara</td>
<td>361, 453</td>
</tr>
<tr>
<td>Faltynek, Pavlina</td>
<td>464, 505, 548</td>
</tr>
<tr>
<td>Fang, Chung-An</td>
<td>415</td>
</tr>
<tr>
<td>Fleming, Jenny</td>
<td>78</td>
</tr>
<tr>
<td>Fleming, Melissa</td>
<td>727</td>
</tr>
<tr>
<td>Flood, Chris</td>
<td>455, 752</td>
</tr>
<tr>
<td>Floyd, Tracy</td>
<td>393</td>
</tr>
<tr>
<td>Fonge, Humphrey</td>
<td>578</td>
</tr>
<tr>
<td>Forchhammer, Birgitte</td>
<td>124</td>
</tr>
<tr>
<td>Formisano, Rita</td>
<td>260, 261, 348, 349, 361, 453, 457, 504</td>
</tr>
<tr>
<td>Forslund, Marit</td>
<td>311, 373, 374, 435</td>
</tr>
<tr>
<td>Forster, Jeri</td>
<td>169, 219, 279</td>
</tr>
<tr>
<td>Fortier, Catherine</td>
<td>491, 664</td>
</tr>
<tr>
<td>Fortin, Sylvie</td>
<td>557</td>
</tr>
<tr>
<td>Foussias, George</td>
<td>586</td>
</tr>
<tr>
<td>Francis, Jill</td>
<td>454</td>
</tr>
<tr>
<td>Franks, Nicholas</td>
<td>568, 571, 575</td>
</tr>
<tr>
<td>Frantzén, Janek</td>
<td>134</td>
</tr>
<tr>
<td>Fawjia, Ibtida</td>
<td>714</td>
</tr>
<tr>
<td>Name</td>
<td>Page Numbers</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Fedele, Bianca</td>
<td>364</td>
</tr>
<tr>
<td>Fedoruk, Andrea</td>
<td>386</td>
</tr>
<tr>
<td>Feinberg, Debby</td>
<td>115</td>
</tr>
<tr>
<td>Feldbaek Nielsen, Joergen</td>
<td>587</td>
</tr>
<tr>
<td>Feng, Lianyuan</td>
<td>783</td>
</tr>
<tr>
<td>Ferdosi, Hamid</td>
<td>61, 62</td>
</tr>
<tr>
<td>Fernandes, Fabio</td>
<td>110</td>
</tr>
<tr>
<td>Fernandez-Ruiz, Juan</td>
<td>716</td>
</tr>
<tr>
<td>Ferrea, Mónica</td>
<td>267, 753</td>
</tr>
<tr>
<td>Ferri, Giulia</td>
<td>260, 261</td>
</tr>
<tr>
<td>Ferri, Joan</td>
<td>477, 481, 504, 617</td>
</tr>
<tr>
<td>Ferrier, Graham</td>
<td>793</td>
</tr>
<tr>
<td>Feyz, Mitra</td>
<td>180, 264</td>
</tr>
<tr>
<td>Rheodoroff, Klemens</td>
<td>508</td>
</tr>
<tr>
<td>Filippini, Maria</td>
<td>744</td>
</tr>
<tr>
<td>Finch, Emma</td>
<td>78, 83</td>
</tr>
<tr>
<td>Fink, Anna</td>
<td>394</td>
</tr>
<tr>
<td>Fiorenza, Salvatore</td>
<td>348, 353, 638</td>
</tr>
<tr>
<td>Fischer, Lisa</td>
<td>233</td>
</tr>
<tr>
<td>Fjellheim Elseth, Marthe</td>
<td>339</td>
</tr>
<tr>
<td>Flaherty, Patti</td>
<td>577</td>
</tr>
<tr>
<td><strong>G</strong></td>
<td></td>
</tr>
<tr>
<td>Gabrielsen Hjelle, Ellen</td>
<td>579</td>
</tr>
<tr>
<td>Gagnon, Isabelle</td>
<td>114, 264, 293, 294,</td>
</tr>
<tr>
<td></td>
<td>309, 392, 702, 724</td>
</tr>
<tr>
<td>Gagnon, Marie-Ève</td>
<td>562</td>
</tr>
<tr>
<td>Gagnon-Roy, Mireille</td>
<td>718, 721</td>
</tr>
<tr>
<td>Gainforth, Heather</td>
<td>653</td>
</tr>
<tr>
<td>Galang, Gary</td>
<td>118</td>
</tr>
<tr>
<td>Galketiya, KB</td>
<td>751</td>
</tr>
<tr>
<td>Gallant, Caitlyn</td>
<td>656</td>
</tr>
<tr>
<td>Gallia, Gary</td>
<td>704</td>
</tr>
<tr>
<td>Gallucci, M.</td>
<td>543</td>
</tr>
<tr>
<td>Galvaio, Alejandro</td>
<td>617</td>
</tr>
<tr>
<td>Gambarin, Mattia</td>
<td>349</td>
</tr>
<tr>
<td>Gan, Caron</td>
<td>108, 358</td>
</tr>
<tr>
<td>Gan, Liu Shi</td>
<td>417</td>
</tr>
<tr>
<td>Gangloff, Matt</td>
<td>766</td>
</tr>
<tr>
<td>Garcia, Amanda</td>
<td>164</td>
</tr>
<tr>
<td>García, Carmen</td>
<td>617</td>
</tr>
<tr>
<td>García-Berrocoso, Teresa</td>
<td>539</td>
</tr>
<tr>
<td>Gardiner, Shelley</td>
<td>521</td>
</tr>
<tr>
<td>Gardner, Andrew</td>
<td>518, 519, 520, 537,</td>
</tr>
<tr>
<td></td>
<td>667</td>
</tr>
<tr>
<td>Garduño-Ortega, Olga</td>
<td>278, 576</td>
</tr>
<tr>
<td>Gargaro, Judy</td>
<td>274, 606, 643, 657</td>
</tr>
<tr>
<td>Garneau, Christian</td>
<td>264</td>
</tr>
<tr>
<td>Gaspich, John</td>
<td>370</td>
</tr>
<tr>
<td>Gatineau-Saillant, Maryame</td>
<td>315</td>
</tr>
<tr>
<td>Gazdzinski, Lisa</td>
<td>210, 266</td>
</tr>
<tr>
<td>Name</td>
<td>Page Numbers</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Gelaye, Bizu</td>
<td>50</td>
</tr>
<tr>
<td>Gelberg, Lillian</td>
<td>648</td>
</tr>
<tr>
<td>Gentile, Simona</td>
<td>349</td>
</tr>
<tr>
<td>Gerber, Donald</td>
<td>154, 738, 769</td>
</tr>
<tr>
<td>Gerritsen, Debby</td>
<td>133</td>
</tr>
<tr>
<td>Geva, Ronny</td>
<td>609</td>
</tr>
<tr>
<td>Ghasemzadeh, Hamzeh</td>
<td>27, 36</td>
</tr>
<tr>
<td>Giacino, Joseph</td>
<td>117, 324, 333, 341</td>
</tr>
<tr>
<td>Gicas, Kristina</td>
<td>377</td>
</tr>
<tr>
<td>Gilbert, Kim</td>
<td>385</td>
</tr>
<tr>
<td>Gilboa, Asaf</td>
<td>729</td>
</tr>
<tr>
<td>Gilchrist, Julie</td>
<td>147</td>
</tr>
<tr>
<td>Gildner, Paula</td>
<td>162</td>
</tr>
<tr>
<td>Gill, Jessica</td>
<td>134, 512</td>
</tr>
<tr>
<td>Gill, Natalia</td>
<td>516</td>
</tr>
<tr>
<td>Gillenkirck, Aleah</td>
<td>529</td>
</tr>
<tr>
<td>Giraldo, Yessica</td>
<td>48</td>
</tr>
<tr>
<td>Girard, Todd</td>
<td>379</td>
</tr>
<tr>
<td>Giroux, Sylvain</td>
<td>718, 721</td>
</tr>
<tr>
<td>Girs, David</td>
<td>621</td>
</tr>
<tr>
<td>Giulietti, Giovanni</td>
<td>361</td>
</tr>
<tr>
<td>Gladkov, Arseniy</td>
<td>745</td>
</tr>
<tr>
<td>Gladstone, Brenda</td>
<td>695</td>
</tr>
<tr>
<td>Godin, Maryse</td>
<td>264</td>
</tr>
<tr>
<td>Gofer-Levi, Moran</td>
<td>647</td>
</tr>
<tr>
<td>Hall, Eric</td>
<td>344, 615, 635</td>
</tr>
<tr>
<td>Hall, Margaret</td>
<td>285</td>
</tr>
<tr>
<td>Halsey, Shelby</td>
<td>21</td>
</tr>
<tr>
<td>Hamblin, Michael</td>
<td>396</td>
</tr>
<tr>
<td>Haninec, Pavel</td>
<td>621</td>
</tr>
<tr>
<td>Hänninen, Timo</td>
<td>645</td>
</tr>
<tr>
<td>Hansen, Christian Pilebæk</td>
<td>420</td>
</tr>
<tr>
<td>Hansen, Colby</td>
<td>322</td>
</tr>
<tr>
<td>Hansson, Magnus</td>
<td>427</td>
</tr>
<tr>
<td>Hara, Takatoshi</td>
<td>740</td>
</tr>
<tr>
<td>Harcourt, Peter</td>
<td>250, 380</td>
</tr>
<tr>
<td>Hardin, Kathryn</td>
<td>673</td>
</tr>
<tr>
<td>Harnof, Sagi</td>
<td>572</td>
</tr>
<tr>
<td>Harrar, Solomon</td>
<td>766</td>
</tr>
<tr>
<td>Harris, Katie</td>
<td>568</td>
</tr>
<tr>
<td>Name</td>
<td>Pages</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Harrison, Adam</td>
<td>550, 551</td>
</tr>
<tr>
<td>Harrison-Felix, Cynthia</td>
<td>89, 154, 530</td>
</tr>
<tr>
<td>Harriss, Alexandra</td>
<td>797</td>
</tr>
<tr>
<td>Hart, Shannon</td>
<td>767</td>
</tr>
<tr>
<td>Hartl, Elisabeth</td>
<td>664</td>
</tr>
<tr>
<td>Hartling, Lisa</td>
<td>690</td>
</tr>
<tr>
<td>Hartman, John</td>
<td>794</td>
</tr>
<tr>
<td>Hartman, Laura</td>
<td>80, 695</td>
</tr>
<tr>
<td>Hartmanova, Martina</td>
<td>685</td>
</tr>
<tr>
<td>Hastings, Robert</td>
<td>235, 237</td>
</tr>
<tr>
<td>Haswell, Courtney</td>
<td>321</td>
</tr>
<tr>
<td>Hatch, Ellie</td>
<td>454</td>
</tr>
<tr>
<td>Hauger, Solveig Lægreid</td>
<td>435</td>
</tr>
<tr>
<td>Hawley, Lenore</td>
<td>89, 152, 154</td>
</tr>
<tr>
<td>Haworth, Karen</td>
<td>450</td>
</tr>
<tr>
<td>Hawthorne, Danielle</td>
<td>96</td>
</tr>
<tr>
<td>Hayashi, Morito</td>
<td>326</td>
</tr>
<tr>
<td>Hays, Kaitlyn</td>
<td>530</td>
</tr>
<tr>
<td>Hearps, Stephen</td>
<td>155</td>
</tr>
<tr>
<td>Heaton, Karen</td>
<td>540</td>
</tr>
<tr>
<td>Hebert, Debbie</td>
<td>697</td>
</tr>
<tr>
<td>Heble, Sucheta</td>
<td>531</td>
</tr>
<tr>
<td>Hedrick, Andria</td>
<td>351</td>
</tr>
<tr>
<td>Heeren, Timothy</td>
<td>535</td>
</tr>
<tr>
<td>Heidbuurt, Dorothy</td>
<td>643</td>
</tr>
<tr>
<td>Heijenbrok-Kal, Majanka</td>
<td>436, 474</td>
</tr>
<tr>
<td>Helén, Pauli</td>
<td>660</td>
</tr>
<tr>
<td>Hellström, Torgeir</td>
<td>511</td>
</tr>
<tr>
<td>Helseth, Eirik</td>
<td>367</td>
</tr>
<tr>
<td>Hendrey, Genevieve</td>
<td>298</td>
</tr>
<tr>
<td>Henson, Jeffrey</td>
<td>368</td>
</tr>
<tr>
<td>Heran, Manraj</td>
<td>377</td>
</tr>
<tr>
<td>Herceg, Mark</td>
<td>707</td>
</tr>
<tr>
<td>Hickling, Andrea</td>
<td>672, 677, 680</td>
</tr>
<tr>
<td>Hicks, Amelia</td>
<td>58, 59, 60, 418</td>
</tr>
<tr>
<td>Ibáñez, David</td>
<td>129</td>
</tr>
<tr>
<td>Iboaya, Aiwane</td>
<td>406</td>
</tr>
<tr>
<td>Ibrahim, Omar</td>
<td>202</td>
</tr>
<tr>
<td>Ietaka, Hiroshi</td>
<td>327</td>
</tr>
<tr>
<td>Ifejiaka, Nnka</td>
<td>406</td>
</tr>
<tr>
<td>Igarashi, Yutaka</td>
<td>155</td>
</tr>
<tr>
<td>Ikeda, Kumi</td>
<td>740</td>
</tr>
<tr>
<td>Ikeda, Tomomi</td>
<td>327</td>
</tr>
<tr>
<td>Im, Brian</td>
<td>215, 651</td>
</tr>
<tr>
<td>Imam, Syed</td>
<td>513</td>
</tr>
<tr>
<td>Incashola, Tony</td>
<td>766</td>
</tr>
<tr>
<td>Name</td>
<td>Page Numbers</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Ingraham, Benjamin</td>
<td>177, 184</td>
</tr>
<tr>
<td>Intiso, Domenico</td>
<td>349</td>
</tr>
<tr>
<td>Jacinto, Jorge</td>
<td>508</td>
</tr>
<tr>
<td>Jack, Keisha</td>
<td>573</td>
</tr>
<tr>
<td>Jackson, LaDonya</td>
<td>102</td>
</tr>
<tr>
<td>Jacob, Binu</td>
<td>538, 585, 634</td>
</tr>
<tr>
<td>Jacquin, Arnaud</td>
<td>268</td>
</tr>
<tr>
<td>Jadgal, Mahenoor</td>
<td>655</td>
</tr>
<tr>
<td>Jaglal, Susan</td>
<td>130, 507</td>
</tr>
<tr>
<td>Jahn, Klaus</td>
<td>103, 467</td>
</tr>
<tr>
<td>James, Amelia</td>
<td>58, 59</td>
</tr>
<tr>
<td>James, Jennifer</td>
<td>64</td>
</tr>
<tr>
<td>James, Kenneth</td>
<td>56</td>
</tr>
<tr>
<td>Jang, Myeong Jin</td>
<td>182</td>
</tr>
<tr>
<td>Janodia, Nikita</td>
<td>462</td>
</tr>
<tr>
<td>Jansen, Marcus</td>
<td>202</td>
</tr>
<tr>
<td>Janzen, Shannon</td>
<td>464, 616</td>
</tr>
<tr>
<td>Jaramillo, Carlos</td>
<td>321, 388</td>
</tr>
<tr>
<td>Jayaram, Mahesh</td>
<td>58, 60</td>
</tr>
<tr>
<td>Jayasuriya, Cheryl</td>
<td>751</td>
</tr>
<tr>
<td>Jean, Alexandra</td>
<td>358, 589, 595</td>
</tr>
<tr>
<td>Jean, Danièle</td>
<td>557</td>
</tr>
<tr>
<td>Jeffay, Eliyas</td>
<td>748</td>
</tr>
<tr>
<td>Jefferson, Mark</td>
<td>573</td>
</tr>
<tr>
<td>Jenkins, Darlene</td>
<td>648</td>
</tr>
<tr>
<td>Kahn, Michelle</td>
<td>300</td>
</tr>
<tr>
<td>Kakkanatt, Ashley</td>
<td>709</td>
</tr>
<tr>
<td>Kakonge, Lisa</td>
<td>475</td>
</tr>
<tr>
<td>Kalachev, Leonid</td>
<td>766</td>
</tr>
<tr>
<td>Kameda, Naoko</td>
<td>327</td>
</tr>
<tr>
<td>Kamenskaya, Elina</td>
<td>745</td>
</tr>
<tr>
<td>Kanagalingam, Sanji</td>
<td>250, 380</td>
</tr>
<tr>
<td>Kanakia, Saloni</td>
<td>268</td>
</tr>
<tr>
<td>Kanaya, Takahiro</td>
<td>155</td>
</tr>
<tr>
<td>Kandeepan, Sivayini</td>
<td>638</td>
</tr>
<tr>
<td>Kane, Chelsea</td>
<td>628</td>
</tr>
<tr>
<td>Kang, Xiaojian</td>
<td>321</td>
</tr>
<tr>
<td>Kannan, Ramanathan</td>
<td>340</td>
</tr>
<tr>
<td>Kapoor, Neera</td>
<td>43</td>
</tr>
<tr>
<td>Karami, Ghodrat</td>
<td>90, 273, 732</td>
</tr>
<tr>
<td>Karhunen, Pekka</td>
<td>654</td>
</tr>
<tr>
<td>Karim, Saleema</td>
<td>372</td>
</tr>
<tr>
<td>Karlsson, Michael</td>
<td>427</td>
</tr>
<tr>
<td>Karp, Andrew</td>
<td>722</td>
</tr>
<tr>
<td>Name</td>
<td>Page Numbers</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Karr, Justin</td>
<td>239, 240</td>
</tr>
<tr>
<td>Karumbaiah, Lohitash</td>
<td>102</td>
</tr>
<tr>
<td>Kashiwabara, Kazumi</td>
<td>740</td>
</tr>
<tr>
<td>Kasitinon, Donald</td>
<td>401</td>
</tr>
<tr>
<td>Kastner, Monika</td>
<td>130</td>
</tr>
<tr>
<td>Kataja, Anneli</td>
<td>240, 626</td>
</tr>
<tr>
<td>Katan, Mira</td>
<td>199</td>
</tr>
<tr>
<td>Katila, Ari</td>
<td>134, 432, 485, 512</td>
</tr>
<tr>
<td>Katz-Leurer, Michal</td>
<td>724</td>
</tr>
<tr>
<td>Kaufmann, David</td>
<td>664</td>
</tr>
<tr>
<td>Kaux, Jean-François</td>
<td>257</td>
</tr>
<tr>
<td>Kay, Jacob</td>
<td>291, 764, 785</td>
</tr>
<tr>
<td>Kay, Melissa</td>
<td>162</td>
</tr>
<tr>
<td>Kay-Lambkin, Frances</td>
<td>519, 520</td>
</tr>
<tr>
<td>Kaylor, Paul</td>
<td>72</td>
</tr>
<tr>
<td>Keays, Glenn</td>
<td>114</td>
</tr>
<tr>
<td>Kelly, Ryan Patrick</td>
<td>767</td>
</tr>
<tr>
<td>Kelsen, Jesper</td>
<td>427</td>
</tr>
<tr>
<td>Kendall, Mary-Ellen</td>
<td>622</td>
</tr>
<tr>
<td>Kennedy, Areti</td>
<td>131, 671, 689</td>
</tr>
<tr>
<td>Kennedy, Sidney</td>
<td>586</td>
</tr>
<tr>
<td>Kennelly, Megan</td>
<td>610</td>
</tr>
<tr>
<td>Kenney, Kimbra</td>
<td>164, 321</td>
</tr>
<tr>
<td>Kenny, Rebecca</td>
<td>323</td>
</tr>
<tr>
<td>Keren, Ofer</td>
<td>543</td>
</tr>
<tr>
<td>Kerr, Zachary</td>
<td>162, 387, 434</td>
</tr>
<tr>
<td>Ketcham, Caroline</td>
<td>344, 615, 635</td>
</tr>
<tr>
<td>Ketchum, Jessica</td>
<td>89, 152, 154, 530</td>
</tr>
<tr>
<td>Khalil Arjmandi, Meisam</td>
<td>27, 36</td>
</tr>
<tr>
<td>Khan, Zahra</td>
<td>791</td>
</tr>
<tr>
<td>Khatra, Omeet</td>
<td>409, 410</td>
</tr>
<tr>
<td>Khaydukov, Evgeny</td>
<td>334</td>
</tr>
<tr>
<td>Khazoom, François</td>
<td>385</td>
</tr>
<tr>
<td>Kibayashi, Kazuhiko</td>
<td>332</td>
</tr>
<tr>
<td>Laberg Holthe, Ingvil</td>
<td>339</td>
</tr>
<tr>
<td>Laberge-Poirier, Andréanne</td>
<td>180</td>
</tr>
<tr>
<td>Labow, Amber</td>
<td>320</td>
</tr>
<tr>
<td>Lcombe-Barrios, Jessica</td>
<td>598</td>
</tr>
<tr>
<td>Ladowsky-Brooks, Ricki</td>
<td>419</td>
</tr>
<tr>
<td>Laflamme, Mélissa</td>
<td>358</td>
</tr>
<tr>
<td>Lafarge, Geoffrey</td>
<td>719</td>
</tr>
<tr>
<td>Lafuente, Jose Vicente</td>
<td>178, 212</td>
</tr>
<tr>
<td>Lagerstedt, Linnéa</td>
<td>134, 175, 198, 432, 485</td>
</tr>
<tr>
<td>Lagier, Aude</td>
<td>257</td>
</tr>
<tr>
<td>Laguè-Beauvais, Maude</td>
<td>490</td>
</tr>
<tr>
<td>Lalonde, Celine</td>
<td>247</td>
</tr>
<tr>
<td>Lalonde, Gabrielle</td>
<td>277</td>
</tr>
<tr>
<td>Lambert, Gianfranco</td>
<td>348, 504</td>
</tr>
<tr>
<td>Name</td>
<td>Pages</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lamontagne, Marie-Eve</td>
<td>82, 264, 310, 589, 595, 649</td>
</tr>
<tr>
<td>Lamoureux, Julie</td>
<td>490</td>
</tr>
<tr>
<td>Landa, Janna</td>
<td>484, 647</td>
</tr>
<tr>
<td>Landar, Viktoriya</td>
<td>462</td>
</tr>
<tr>
<td>Landau, Alex</td>
<td>137</td>
</tr>
<tr>
<td>Lang, Donna</td>
<td>377, 602</td>
</tr>
<tr>
<td>Lange, Rael</td>
<td>705</td>
</tr>
<tr>
<td>Langer, Laura</td>
<td>200</td>
</tr>
<tr>
<td>Langhammer, Birgitta</td>
<td>336</td>
</tr>
<tr>
<td>Langois, Valerie</td>
<td>270</td>
</tr>
<tr>
<td>Lantz, Susan</td>
<td>244, 513, 749</td>
</tr>
<tr>
<td>Lapierre, Chantale</td>
<td>598</td>
</tr>
<tr>
<td>Lapierre-Féauta, Vanessa</td>
<td>199</td>
</tr>
<tr>
<td>Lapointe, Andrew</td>
<td>291, 550, 624</td>
</tr>
<tr>
<td>Lapore, Sue</td>
<td>648</td>
</tr>
<tr>
<td>Larsen, Kristian</td>
<td>41</td>
</tr>
<tr>
<td>Lateef, Shan</td>
<td>64</td>
</tr>
<tr>
<td>Latorre, Jorge</td>
<td>481</td>
</tr>
<tr>
<td>Laukes, Cindi</td>
<td>766</td>
</tr>
<tr>
<td>Laureys, Steven</td>
<td>87, 129, 257, 333, 421, 424, 503, 504, 625, 744, 747, 790</td>
</tr>
<tr>
<td>Lavezzi, Susanna</td>
<td>362, 365</td>
</tr>
<tr>
<td>Lavoie, Gabriel</td>
<td>597</td>
</tr>
<tr>
<td>Lavrijsen, Jan</td>
<td>133, 601</td>
</tr>
<tr>
<td>Law, Caitlyn</td>
<td>147</td>
</tr>
<tr>
<td>Lawrence, David</td>
<td>696</td>
</tr>
<tr>
<td>Lazarus, Rachael</td>
<td>644</td>
</tr>
<tr>
<td>Le Dorze, Guylaine</td>
<td>718</td>
</tr>
<tr>
<td>Le Sage, Natalie</td>
<td>310, 384</td>
</tr>
<tr>
<td>Leblanc, Élizabeth</td>
<td>277</td>
</tr>
<tr>
<td>LeBlanc, Joanne</td>
<td>180</td>
</tr>
<tr>
<td>Lecky, Fiona</td>
<td>119, 120, 229, 230, 231, 237</td>
</tr>
<tr>
<td>L’Ecuyer, Sydnée</td>
<td>385</td>
</tr>
<tr>
<td>Leddy, John</td>
<td>787</td>
</tr>
<tr>
<td>Ledochowski, Justine</td>
<td>541</td>
</tr>
<tr>
<td>Ledoux, Didier</td>
<td>257</td>
</tr>
<tr>
<td>Lee, Daniel</td>
<td>340</td>
</tr>
<tr>
<td>Lee, David</td>
<td>71</td>
</tr>
<tr>
<td>Lee, Jeong Nam</td>
<td>182</td>
</tr>
<tr>
<td>Lee, Sharon</td>
<td>533</td>
</tr>
<tr>
<td>Lefèvre, Clémence</td>
<td>315</td>
</tr>
<tr>
<td>Lejeune, Nicolas</td>
<td>348, 747, 790</td>
</tr>
<tr>
<td>Lemme, Jordan</td>
<td>594</td>
</tr>
<tr>
<td>Lemsky, Carolyn</td>
<td>592, 603, 648</td>
</tr>
<tr>
<td>Lequerica, Anthony</td>
<td>282, 376</td>
</tr>
<tr>
<td>Lesage, Natalie</td>
<td>264</td>
</tr>
<tr>
<td>Lesniewska, Aneta</td>
<td>450</td>
</tr>
<tr>
<td>Leung, Chung Ho</td>
<td>791</td>
</tr>
<tr>
<td>Name</td>
<td>Pages</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Levav, Miriam</td>
<td>609</td>
</tr>
<tr>
<td>Maanpää, Henna-Riikka</td>
<td>134, 432, 512</td>
</tr>
<tr>
<td>Maas, Andrew</td>
<td>275, 459, 470</td>
</tr>
<tr>
<td>Macca, Marina</td>
<td>365</td>
</tr>
<tr>
<td>Macdonald, Warren</td>
<td>568</td>
</tr>
<tr>
<td>MacDonell, Christine</td>
<td>276</td>
</tr>
<tr>
<td>MacGregor, Nneka</td>
<td>663, 668</td>
</tr>
<tr>
<td>Mack, Karen</td>
<td>147</td>
</tr>
<tr>
<td>Mackay, Leila</td>
<td>773</td>
</tr>
<tr>
<td>Mackenzie, Stephanie</td>
<td>293, 294, 309</td>
</tr>
<tr>
<td>Mackenzie, Heather</td>
<td>338</td>
</tr>
<tr>
<td>Maclean, Meghan</td>
<td>661</td>
</tr>
<tr>
<td>MacRae, Louise</td>
<td>688, 692</td>
</tr>
<tr>
<td>Maerz, Gary</td>
<td>245</td>
</tr>
<tr>
<td>Magat, Elaine</td>
<td>357</td>
</tr>
<tr>
<td>Magliacano, Alfonso</td>
<td>348</td>
</tr>
<tr>
<td>Mah, Katie</td>
<td>695</td>
</tr>
<tr>
<td>Mahawattage, Indika</td>
<td>297</td>
</tr>
<tr>
<td>Main, Cheryl</td>
<td>573</td>
</tr>
<tr>
<td>Maisonobe, Pascal</td>
<td>508</td>
</tr>
<tr>
<td>Makhkamova, Inara</td>
<td>103</td>
</tr>
<tr>
<td>Makley, Michael</td>
<td>245, 738, 769</td>
</tr>
<tr>
<td>Makris, Nikos</td>
<td>664</td>
</tr>
<tr>
<td>Malina, Aaron</td>
<td>177</td>
</tr>
<tr>
<td>Mallory, Kylie</td>
<td>672, 677, 680</td>
</tr>
<tr>
<td>Mamone-Lucciona, Justine</td>
<td>282</td>
</tr>
<tr>
<td>Mandurah, Rouaa</td>
<td>389</td>
</tr>
<tr>
<td>Mangset, Margrete</td>
<td>431, 439, 579</td>
</tr>
<tr>
<td>Mann, Robert</td>
<td>556, 627, 796</td>
</tr>
<tr>
<td>Mäntykoski, Tuomas</td>
<td>626</td>
</tr>
<tr>
<td>Mao, Haojie</td>
<td>706, 720</td>
</tr>
<tr>
<td>March, Gretchen</td>
<td>462</td>
</tr>
<tr>
<td>Marcus, Lauren</td>
<td>796</td>
</tr>
<tr>
<td>Marin, Jorge</td>
<td>691</td>
</tr>
<tr>
<td>Marinowitz, Carl</td>
<td>229, 230, 231, 275</td>
</tr>
<tr>
<td>Marinkovic, Ivan</td>
<td>375, 378, 425</td>
</tr>
<tr>
<td>Marino, Silvia</td>
<td>349</td>
</tr>
<tr>
<td>Markovic, Gabriela</td>
<td>168, 429</td>
</tr>
<tr>
<td>Mars, Nicole</td>
<td>177</td>
</tr>
<tr>
<td>Marsalek, Pavel</td>
<td>234</td>
</tr>
<tr>
<td>Marshall, Cameron</td>
<td>77</td>
</tr>
<tr>
<td>Marshall, Jane</td>
<td>455, 752</td>
</tr>
<tr>
<td>Martens, Géraldine</td>
<td>117, 129, 324, 333, 421, 424, 625</td>
</tr>
<tr>
<td>Martial, Charlotte</td>
<td>504, 744, 747</td>
</tr>
<tr>
<td>Martin, Andréanne</td>
<td>284</td>
</tr>
<tr>
<td>Martin, Paula</td>
<td>386</td>
</tr>
<tr>
<td>Martinez, Darwin</td>
<td>691</td>
</tr>
<tr>
<td>Martini, Angelita</td>
<td>156, 174, 251</td>
</tr>
<tr>
<td>Name</td>
<td>Pages</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Martino, Carmen</td>
<td>521</td>
</tr>
<tr>
<td>Martinsen, Randi</td>
<td>431, 439, 579</td>
</tr>
<tr>
<td>Martyniuk, Christopher</td>
<td>270</td>
</tr>
<tr>
<td>Marwitz, Jennifer</td>
<td>599</td>
</tr>
<tr>
<td>Masanic, Cheryl</td>
<td>235, 237</td>
</tr>
<tr>
<td>Mason, Karen</td>
<td>653</td>
</tr>
<tr>
<td>Mason, Suzanne</td>
<td>119, 120</td>
</tr>
<tr>
<td>Masotta, Orsola</td>
<td>348, 349, 353, 504, 638</td>
</tr>
<tr>
<td>Massey, Jill</td>
<td>345, 391</td>
</tr>
<tr>
<td>Massicotte, Véronique</td>
<td>284</td>
</tr>
<tr>
<td>Master, Christina</td>
<td>405</td>
</tr>
<tr>
<td>Matheson, Flora</td>
<td>556, 627</td>
</tr>
<tr>
<td>Mathieu, Bernard</td>
<td>264</td>
</tr>
<tr>
<td>Matre, Martin</td>
<td>346</td>
</tr>
<tr>
<td>Mattia, Donatella</td>
<td>348, 453, 457</td>
</tr>
<tr>
<td>Maudoux, Audrey</td>
<td>257</td>
</tr>
<tr>
<td>Maurer-Karattup, Petra</td>
<td>206</td>
</tr>
<tr>
<td>Maurits, Natasha</td>
<td>460</td>
</tr>
<tr>
<td>Maxfield-Panker, Stephanie</td>
<td>642, 644</td>
</tr>
<tr>
<td>Maxwell, Bruce</td>
<td>239, 331</td>
</tr>
<tr>
<td>Mayr, Katrin</td>
<td>605</td>
</tr>
<tr>
<td>Maza, Anny</td>
<td>481</td>
</tr>
<tr>
<td>McAllister, Thomas</td>
<td>291, 550, 624</td>
</tr>
<tr>
<td>McCart, Melissa</td>
<td>317, 750</td>
</tr>
<tr>
<td>McCollum, Jim</td>
<td>163</td>
</tr>
<tr>
<td>McConnachie, Alex</td>
<td>440</td>
</tr>
<tr>
<td>Mccormick, Brandon</td>
<td>81</td>
</tr>
<tr>
<td>McCourt, Teresa</td>
<td>400</td>
</tr>
<tr>
<td>McCrea, Michael</td>
<td>291, 550, 624</td>
</tr>
<tr>
<td>McCullagh, Scott</td>
<td>514</td>
</tr>
<tr>
<td>McCulloch, Karen</td>
<td>544, 563</td>
</tr>
<tr>
<td>McDonald, Catherine</td>
<td>405</td>
</tr>
<tr>
<td>McDonald, Kyla</td>
<td>541</td>
</tr>
<tr>
<td>McDougall, Alexandre</td>
<td>637</td>
</tr>
<tr>
<td>McFetridge, Grant</td>
<td>450</td>
</tr>
<tr>
<td>McGettrick, Grainne</td>
<td>101</td>
</tr>
<tr>
<td>McGinley, Abi</td>
<td>444, 448</td>
</tr>
<tr>
<td>McGlinchey, Regina</td>
<td>491, 664</td>
</tr>
<tr>
<td>McIntyre, Amanda</td>
<td>505, 548, 678, 681</td>
</tr>
<tr>
<td>McKay, Adam</td>
<td>381</td>
</tr>
<tr>
<td>McKay, Danny</td>
<td>440</td>
</tr>
<tr>
<td>McKay, Ondrea</td>
<td>84, 399</td>
</tr>
<tr>
<td>McKenzie, Dean</td>
<td>304, 364</td>
</tr>
<tr>
<td>McKenzie, Shayne</td>
<td>450</td>
</tr>
<tr>
<td>McKerral, Michelle</td>
<td>179, 187, 188, 217</td>
</tr>
<tr>
<td>McKevitt, Christopher</td>
<td>345</td>
</tr>
<tr>
<td>McKinlay, Audrey</td>
<td>155</td>
</tr>
<tr>
<td>Mclean, Lin</td>
<td>441</td>
</tr>
<tr>
<td>Name</td>
<td>Page</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>McLeod, Hamish</td>
<td>412</td>
</tr>
<tr>
<td>McLoughlin, Mary</td>
<td>177</td>
</tr>
<tr>
<td>McMillan, Tom</td>
<td>440, 441, 446, 447, 448</td>
</tr>
<tr>
<td>McNaughton, Shirley</td>
<td>683</td>
</tr>
<tr>
<td>McNulty, Mary</td>
<td>184</td>
</tr>
<tr>
<td>McVicker, Sally</td>
<td>455, 752</td>
</tr>
<tr>
<td>Mdzinarishvili, Alexander</td>
<td>351, 561</td>
</tr>
<tr>
<td>McNulty, Mary</td>
<td>296</td>
</tr>
<tr>
<td>Murray, Laura</td>
<td>236, 407</td>
</tr>
<tr>
<td>Mursanu, Dafin</td>
<td>212</td>
</tr>
<tr>
<td>Murugesan, Neveda</td>
<td>45</td>
</tr>
<tr>
<td>Mutlu, Bilge</td>
<td>170, 241, 646</td>
</tr>
<tr>
<td>Muzquiz, LeeAnna</td>
<td>766</td>
</tr>
<tr>
<td>Myhre, Mia</td>
<td>339</td>
</tr>
<tr>
<td>Naeser, Margaret</td>
<td>386</td>
</tr>
<tr>
<td>Nair, Ajoy</td>
<td>121</td>
</tr>
<tr>
<td>Nakae, Ryuta</td>
<td>155</td>
</tr>
<tr>
<td>Nakase-Richardson, Risa</td>
<td>100, 140, 164, 209, 510</td>
</tr>
<tr>
<td>Nakashima, Ann</td>
<td>775</td>
</tr>
<tr>
<td>Nakayama, Haruo</td>
<td>326</td>
</tr>
<tr>
<td>Nakua, Hajer</td>
<td>98</td>
</tr>
<tr>
<td>Nalder, Emily</td>
<td>358, 556, 627</td>
</tr>
<tr>
<td>Nally, Emma</td>
<td>214, 215, 651</td>
</tr>
<tr>
<td>Naoe, Yasutaka</td>
<td>155</td>
</tr>
<tr>
<td>Narad, Megan</td>
<td>610</td>
</tr>
<tr>
<td>Nardone, Antonio</td>
<td>349</td>
</tr>
<tr>
<td>Nashawi, Mouhamed</td>
<td>56</td>
</tr>
<tr>
<td>Natale, Audrey</td>
<td>530</td>
</tr>
<tr>
<td>Navarro, Maria</td>
<td>481, 617</td>
</tr>
<tr>
<td>Nakase, Mary</td>
<td>296</td>
</tr>
<tr>
<td>Nakashima, Ann</td>
<td>775</td>
</tr>
<tr>
<td>Nakayama, Haruo</td>
<td>326</td>
</tr>
<tr>
<td>Nakua, Hajer</td>
<td>98</td>
</tr>
<tr>
<td>Nalder, Emily</td>
<td>358, 556, 627</td>
</tr>
<tr>
<td>Nally, Emma</td>
<td>214, 215, 651</td>
</tr>
<tr>
<td>Naoe, Yasutaka</td>
<td>155</td>
</tr>
<tr>
<td>Narad, Megan</td>
<td>610</td>
</tr>
<tr>
<td>Nardone, Antonio</td>
<td>349</td>
</tr>
<tr>
<td>Nashawi, Mouhamed</td>
<td>56</td>
</tr>
<tr>
<td>Natale, Audrey</td>
<td>530</td>
</tr>
<tr>
<td>Navarro, Maria</td>
<td>481, 617</td>
</tr>
<tr>
<td>Nazari, Roghieh</td>
<td>97</td>
</tr>
<tr>
<td>Neal, Lindsey</td>
<td>652</td>
</tr>
<tr>
<td>Nedimyer, Aliza</td>
<td>162, 387, 434</td>
</tr>
<tr>
<td>Nedley, Neil</td>
<td>438, 693</td>
</tr>
<tr>
<td>Nelson, Audrey</td>
<td>650</td>
</tr>
<tr>
<td>Nelson, David</td>
<td>81</td>
</tr>
<tr>
<td>Nelson, Michelle</td>
<td>130</td>
</tr>
<tr>
<td>Nemani, Katlyn</td>
<td>651</td>
</tr>
<tr>
<td>Newcombe, Virginia</td>
<td>134, 432, 512</td>
</tr>
<tr>
<td>Newman, Jody</td>
<td>738, 769</td>
</tr>
<tr>
<td>Newman, Rochelle</td>
<td>37</td>
</tr>
<tr>
<td>Newman-Norlund, Roger</td>
<td>584</td>
</tr>
<tr>
<td>Nazari, Roghieh</td>
<td>97</td>
</tr>
<tr>
<td>Noel, Gregory</td>
<td>471</td>
</tr>
<tr>
<td>Noelia, Argüello Rachz</td>
<td>753</td>
</tr>
<tr>
<td>Nopper, Isabella</td>
<td>611</td>
</tr>
<tr>
<td>Northcote, Sarah</td>
<td>227, 228</td>
</tr>
<tr>
<td>Normandy, Emmanuelle</td>
<td>315</td>
</tr>
<tr>
<td>Numata, Yuriko</td>
<td>326</td>
</tr>
<tr>
<td>Orner, Avi</td>
<td>472, 748</td>
</tr>
<tr>
<td>Orridge, Samantha</td>
<td>121</td>
</tr>
<tr>
<td>Orsini, Mario</td>
<td>638</td>
</tr>
<tr>
<td>Ostrowski-Delahanty, Sarah</td>
<td>480</td>
</tr>
<tr>
<td>Otamendi, Thalia</td>
<td>161</td>
</tr>
<tr>
<td>Otesile, Olubukola</td>
<td>275</td>
</tr>
<tr>
<td>Ouellet, Marie-Christine</td>
<td>284, 290, 310, 320, 384</td>
</tr>
<tr>
<td>O'Valle, Myrtha</td>
<td>617</td>
</tr>
<tr>
<td>O’Driscoll, Daniel</td>
<td>592</td>
</tr>
<tr>
<td>Ogilvie, Jacqueline</td>
<td>622</td>
</tr>
<tr>
<td>Ogilvie, Jacqueline</td>
<td>622</td>
</tr>
<tr>
<td>Olaya, José</td>
<td>617</td>
</tr>
<tr>
<td>Oliveira, Paulo</td>
<td>560</td>
</tr>
<tr>
<td>Ollinger, John</td>
<td>321</td>
</tr>
<tr>
<td>O'Brien, Katy</td>
<td>394</td>
</tr>
<tr>
<td>O'Connor, Tiffany</td>
<td>377, 602</td>
</tr>
<tr>
<td>Oddy, Michael</td>
<td>534</td>
</tr>
<tr>
<td>O'Dell, Denise</td>
<td>530</td>
</tr>
<tr>
<td>O'Driscoll, Daniel</td>
<td>592</td>
</tr>
<tr>
<td>Ogilvie, Jacqueline</td>
<td>622</td>
</tr>
<tr>
<td>Olaya, José</td>
<td>617</td>
</tr>
<tr>
<td>Oliveira, Paulo</td>
<td>560</td>
</tr>
<tr>
<td>Ollinger, John</td>
<td>321</td>
</tr>
<tr>
<td>O’Valle, Myrtha</td>
<td>617</td>
</tr>
<tr>
<td>Name</td>
<td>Page Numbers</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Olshaker, Jonathan</td>
<td>262</td>
</tr>
<tr>
<td>Olver, John</td>
<td>364</td>
</tr>
<tr>
<td>Ong, Bee Eng</td>
<td>571</td>
</tr>
<tr>
<td>Ordóñez-Rubiano, Edgar</td>
<td>691</td>
</tr>
<tr>
<td>Orenczuk, Steve</td>
<td>596</td>
</tr>
<tr>
<td>Öhman, Juha</td>
<td>240, 342, 626, 660, 666</td>
</tr>
<tr>
<td>Øland, Christoffer</td>
<td>420</td>
</tr>
<tr>
<td>Pacheco, Nicole</td>
<td>46</td>
</tr>
<tr>
<td>Packer, Leora</td>
<td>647</td>
</tr>
<tr>
<td>Pahlevan Sharif, Saeed</td>
<td>97</td>
</tr>
<tr>
<td>Palmer, Philip</td>
<td>138</td>
</tr>
<tr>
<td>Palola, Vili</td>
<td>645</td>
</tr>
<tr>
<td>Panda, Rajanikant</td>
<td>421, 790</td>
</tr>
<tr>
<td>Panenka, William</td>
<td>323, 377, 602, 705</td>
</tr>
<tr>
<td>Pang, Boon Chuan</td>
<td>340</td>
</tr>
<tr>
<td>Papa, Linda</td>
<td>800</td>
</tr>
<tr>
<td>Paquette, Guillaume</td>
<td>718</td>
</tr>
<tr>
<td>Pareto, Deborah</td>
<td>516</td>
</tr>
<tr>
<td>Park, Eugene</td>
<td>793</td>
</tr>
<tr>
<td>Parker, Rachel</td>
<td>778</td>
</tr>
<tr>
<td>Parkkari, Jari</td>
<td>645</td>
</tr>
<tr>
<td>Pascarella, Angelo</td>
<td>349</td>
</tr>
<tr>
<td>Pasculli, Rosa</td>
<td>215</td>
</tr>
<tr>
<td>Pasternak, Ofer</td>
<td>664</td>
</tr>
<tr>
<td>Pastorino, Jennifer</td>
<td>686</td>
</tr>
<tr>
<td>Patel, Kirtida</td>
<td>615, 635</td>
</tr>
<tr>
<td>Patel, Nirav</td>
<td>623</td>
</tr>
<tr>
<td>Patriarca, Elena</td>
<td>349</td>
</tr>
<tr>
<td>Patterson, David</td>
<td>546</td>
</tr>
<tr>
<td>Patton, Declan</td>
<td>405</td>
</tr>
<tr>
<td>Pau, Ashni</td>
<td>568</td>
</tr>
<tr>
<td>Pauktuutit Inuit Women of</td>
<td>668</td>
</tr>
<tr>
<td>Canada,</td>
<td></td>
</tr>
<tr>
<td>Paul, Harriet</td>
<td>534</td>
</tr>
<tr>
<td>Pavlov, Yuri</td>
<td>611</td>
</tr>
<tr>
<td>Paxman, Eric</td>
<td>417</td>
</tr>
<tr>
<td>Payne, Lisa</td>
<td>89</td>
</tr>
<tr>
<td>Pearson, Richard</td>
<td>262</td>
</tr>
<tr>
<td>Pecharroman, Emilio</td>
<td>539</td>
</tr>
<tr>
<td>Pechouskova, Katerina</td>
<td>685</td>
</tr>
<tr>
<td>Pell, Jill</td>
<td>440</td>
</tr>
<tr>
<td>Name</td>
<td>Pages</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Pellerin, Marc-André</td>
<td>589, 595</td>
</tr>
<tr>
<td>Pellicer, Mary</td>
<td>450</td>
</tr>
<tr>
<td>Pellichero, Alice</td>
<td>193, 649</td>
</tr>
<tr>
<td>Penalba, Anna</td>
<td>539</td>
</tr>
<tr>
<td>Peppel, Lianne</td>
<td>474</td>
</tr>
<tr>
<td>Perdrérieau, Valérie</td>
<td>315</td>
</tr>
<tr>
<td>Perera, Christine</td>
<td>751</td>
</tr>
<tr>
<td>Perera, Gihan</td>
<td>389, 692</td>
</tr>
<tr>
<td>Perez, Carolyn</td>
<td>393</td>
</tr>
<tr>
<td>Perin, Cecilia</td>
<td>349</td>
</tr>
<tr>
<td>Perkins, Danielle</td>
<td>692</td>
</tr>
<tr>
<td>Perrier, Laure</td>
<td>189</td>
</tr>
<tr>
<td>Perrin, Paul</td>
<td>311, 373, 374</td>
</tr>
<tr>
<td>Perry, Luke</td>
<td>60</td>
</tr>
<tr>
<td>Petkus, Vytautas</td>
<td>437</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Quah, Boon Leong</td>
<td>340</td>
</tr>
<tr>
<td>Quatriti, Adam</td>
<td>76</td>
</tr>
<tr>
<td>Quatriti, Vincent</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Radan, Michael</td>
<td>232</td>
</tr>
<tr>
<td>Radyushkin, Konstantin</td>
<td>571</td>
</tr>
<tr>
<td>Ragauskas, Arminas</td>
<td>437</td>
</tr>
<tr>
<td>Rahimi, Alma</td>
<td>574</td>
</tr>
<tr>
<td>Raimondo, Federico</td>
<td>790</td>
</tr>
<tr>
<td>Raizman, Reut</td>
<td>572</td>
</tr>
<tr>
<td>Raj, Stacey</td>
<td>610</td>
</tr>
<tr>
<td>Rajadurai, Arthi</td>
<td>557</td>
</tr>
<tr>
<td>Rakers, Sandra</td>
<td>444, 449</td>
</tr>
<tr>
<td>Ramirez, Francisco</td>
<td>438, 693, 794</td>
</tr>
<tr>
<td>Ramjattan, Elijah</td>
<td>794</td>
</tr>
<tr>
<td>Ramos, Sara</td>
<td>534, 536</td>
</tr>
<tr>
<td>Ramovic, Azra</td>
<td>429</td>
</tr>
<tr>
<td>Rappai, Tony</td>
<td>736</td>
</tr>
<tr>
<td>Rask, Charlotte Ulrikka</td>
<td>587</td>
</tr>
<tr>
<td>Rasmussen, Mari</td>
<td>311, 374, 620</td>
</tr>
<tr>
<td>Rastenyte, Daiva</td>
<td>437</td>
</tr>
<tr>
<td>Ratajczak, Monika</td>
<td>110</td>
</tr>
<tr>
<td>Rathbone, Michael</td>
<td>692</td>
</tr>
<tr>
<td>Rathi, Yogesh</td>
<td>664</td>
</tr>
<tr>
<td>Rau, Gabriel</td>
<td>515</td>
</tr>
<tr>
<td>Rau, Thomas</td>
<td>515</td>
</tr>
<tr>
<td>Rauen, Katrin</td>
<td>467</td>
</tr>
<tr>
<td>Rauhala, Minna</td>
<td>660</td>
</tr>
<tr>
<td>Raukola-Lindblom, Marjaana</td>
<td>106, 281</td>
</tr>
<tr>
<td>Rausa, Vanessa</td>
<td>155</td>
</tr>
<tr>
<td>Rautava, Päivi</td>
<td>135</td>
</tr>
<tr>
<td>Name</td>
<td>Pages</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>Razran, Mira</td>
<td>679</td>
</tr>
<tr>
<td>Real, Ruben</td>
<td>459, 470</td>
</tr>
<tr>
<td>Reber, Justin</td>
<td>623</td>
</tr>
<tr>
<td>Reddi, Preethi</td>
<td>666</td>
</tr>
<tr>
<td>Rodgers, Mike</td>
<td>659</td>
</tr>
<tr>
<td>Reed, Nick</td>
<td>80, 280, 283, 395, 527, 545, 554, 672, 677, 680, 695</td>
</tr>
<tr>
<td>Register-Mihalik, Johna</td>
<td>162</td>
</tr>
<tr>
<td>Reichelt, Lara</td>
<td>467</td>
</tr>
<tr>
<td>Reid, Benjamin</td>
<td>664</td>
</tr>
<tr>
<td>Reilly, Kaitlin</td>
<td>177</td>
</tr>
<tr>
<td>Rendell, Luke</td>
<td>355</td>
</tr>
<tr>
<td>Renvall, Kati</td>
<td>281</td>
</tr>
<tr>
<td>Resnick, Arielle</td>
<td>282</td>
</tr>
<tr>
<td>Retel Helmrich, Isabel</td>
<td>143, 470</td>
</tr>
<tr>
<td>Rhind, Shawn</td>
<td>696, 775, 791</td>
</tr>
<tr>
<td>Ribbers, Gerard</td>
<td>436, 474, 782</td>
</tr>
<tr>
<td>Ribeiro de Paula, Demetrius</td>
<td>638</td>
</tr>
<tr>
<td>Ribó, Marc</td>
<td>539</td>
</tr>
<tr>
<td>Riccio, Angela</td>
<td>457</td>
</tr>
<tr>
<td>Richardi, Graziella</td>
<td>492</td>
</tr>
<tr>
<td>Richards, Doug</td>
<td>696</td>
</tr>
<tr>
<td>Richardson, Fran</td>
<td>514</td>
</tr>
<tr>
<td>Rideout, Lindsay</td>
<td>784</td>
</tr>
<tr>
<td>Sabatini, Umberto</td>
<td>361</td>
</tr>
<tr>
<td>Sabers, Anne</td>
<td>420</td>
</tr>
<tr>
<td>Sabo, Tonia</td>
<td>401, 566</td>
</tr>
<tr>
<td>Saedehkhah, Soha</td>
<td>731, 735</td>
</tr>
<tr>
<td>Saha, Chandan</td>
<td>236</td>
</tr>
<tr>
<td>Saheed, Ushna Saeed</td>
<td>655</td>
</tr>
<tr>
<td>Saito, Norihiko</td>
<td>326</td>
</tr>
<tr>
<td>Sakurai, Takatoshi</td>
<td>326</td>
</tr>
<tr>
<td>Salanki, Krista</td>
<td>703</td>
</tr>
<tr>
<td>Salat, David</td>
<td>664</td>
</tr>
<tr>
<td>Salbach, Nancy</td>
<td>130</td>
</tr>
<tr>
<td>Saleem, Madiha</td>
<td>358</td>
</tr>
<tr>
<td>Salomon, Raja</td>
<td>578</td>
</tr>
<tr>
<td>Salvi, Gian Pietro</td>
<td>349</td>
</tr>
<tr>
<td>Samadani, Uzma</td>
<td>631</td>
</tr>
<tr>
<td>Samsa, Silvia</td>
<td>663</td>
</tr>
<tr>
<td>Sanchez, Geylimar</td>
<td>557</td>
</tr>
<tr>
<td>Sanchez, Jean-Charles</td>
<td>134, 175, 176, 198, 199, 432, 485, 512, 516</td>
</tr>
<tr>
<td>Sankinen, Matti</td>
<td>135</td>
</tr>
<tr>
<td>Sant’Angelo, Nino</td>
<td>349</td>
</tr>
<tr>
<td>Sanz, Leandro</td>
<td>504, 744, 790</td>
</tr>
<tr>
<td>Sapir, M.</td>
<td>543</td>
</tr>
<tr>
<td>Sarà, Marco</td>
<td>349</td>
</tr>
<tr>
<td>Name</td>
<td>Page Numbers</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Sarkar, Sumit</td>
<td>749</td>
</tr>
<tr>
<td>Sas, Andrew</td>
<td>529</td>
</tr>
<tr>
<td>Sato, Joao</td>
<td>451, 452</td>
</tr>
<tr>
<td>Saunders, Doug</td>
<td>775</td>
</tr>
<tr>
<td>Sauvé, William</td>
<td>569</td>
</tr>
<tr>
<td>Savage, Roy</td>
<td>766</td>
</tr>
<tr>
<td>Savard, Joséé</td>
<td>284, 384</td>
</tr>
<tr>
<td>Saveman, Britt-Inger</td>
<td>413, 442</td>
</tr>
<tr>
<td>Saville, Joanna</td>
<td>571</td>
</tr>
<tr>
<td>Sawyer, Thomas</td>
<td>270</td>
</tr>
<tr>
<td>Sayko Adams, Rachel</td>
<td>279</td>
</tr>
<tr>
<td>Scarneo, Samantha</td>
<td>584</td>
</tr>
<tr>
<td>Scarponi, Federico</td>
<td>349</td>
</tr>
<tr>
<td>Schache, Anthony</td>
<td>299</td>
</tr>
<tr>
<td>Schanche, Anne-Kristine</td>
<td>307, 367, 489</td>
</tr>
<tr>
<td>Schäpers, Barbara</td>
<td>467</td>
</tr>
<tr>
<td>Scheenen, Myrthe</td>
<td>444</td>
</tr>
<tr>
<td>Scheibel, Randall</td>
<td>321, 388</td>
</tr>
<tr>
<td>Schena, Alberto</td>
<td>176</td>
</tr>
<tr>
<td>Schiattone, Sara</td>
<td>260, 261</td>
</tr>
<tr>
<td>Schlegel, Amy</td>
<td>727</td>
</tr>
<tr>
<td>Schminkey, Donna</td>
<td>607</td>
</tr>
<tr>
<td>Schmoe, Jeremy</td>
<td>181</td>
</tr>
<tr>
<td>Schnakers, Caroline</td>
<td>348, 533, 546, 747</td>
</tr>
<tr>
<td>Schneider, Eric</td>
<td>704</td>
</tr>
<tr>
<td>Schneider, Heidi</td>
<td>738</td>
</tr>
<tr>
<td>Schneider, Kathryn</td>
<td>724</td>
</tr>
<tr>
<td>Schofield, Peter</td>
<td>519</td>
</tr>
<tr>
<td>Schraa, James</td>
<td>738</td>
</tr>
<tr>
<td>Schrader, Mareike</td>
<td>496</td>
</tr>
<tr>
<td>Schröder, Andreas</td>
<td>587</td>
</tr>
<tr>
<td>Schudlo, Larissa</td>
<td>554</td>
</tr>
<tr>
<td>Schult, Marie-Louise</td>
<td>168</td>
</tr>
<tr>
<td>Schwarb, Hilary</td>
<td>360, 710</td>
</tr>
<tr>
<td>Schwartz, Daniel</td>
<td>100, 209</td>
</tr>
<tr>
<td>Schwartzkopf, Ashley</td>
<td>236</td>
</tr>
<tr>
<td>Schweizer, Julianne</td>
<td>199</td>
</tr>
<tr>
<td>Schweizer, Tom</td>
<td>586</td>
</tr>
<tr>
<td>Scott, Shannon</td>
<td>690</td>
</tr>
<tr>
<td>Scratch, Shannon</td>
<td>280, 526, 687</td>
</tr>
<tr>
<td>Seaton, Samantha</td>
<td>216</td>
</tr>
<tr>
<td>Seel, Ron</td>
<td>173</td>
</tr>
<tr>
<td>Seifi, Ali</td>
<td>45, 56</td>
</tr>
<tr>
<td>Sekar, Sathiya</td>
<td>578, 713</td>
</tr>
<tr>
<td>Sekely, Angela</td>
<td>472</td>
</tr>
<tr>
<td>Selles, Ruud</td>
<td>782</td>
</tr>
<tr>
<td>Sephton, Keith</td>
<td>99</td>
</tr>
<tr>
<td>Seppänen, Arttu</td>
<td>645</td>
</tr>
<tr>
<td>Sequeira, Keith</td>
<td>338, 678, 681</td>
</tr>
<tr>
<td>Seresova, Alena</td>
<td>180</td>
</tr>
<tr>
<td>Sergio, Lauren</td>
<td>285, 574</td>
</tr>
<tr>
<td>Serra, Laura</td>
<td>361</td>
</tr>
<tr>
<td>Name</td>
<td>Page Numbers</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Server, Marta</td>
<td>617</td>
</tr>
<tr>
<td>Senenbaugh, Joshua</td>
<td>674</td>
</tr>
<tr>
<td>Seto, Katherine</td>
<td>390</td>
</tr>
<tr>
<td>Seveigny, Mitch</td>
<td>530</td>
</tr>
<tr>
<td>Severini, Giacomo</td>
<td>365</td>
</tr>
<tr>
<td>Sevick, Jessica</td>
<td>377</td>
</tr>
<tr>
<td>Seward, Karen</td>
<td>472, 748</td>
</tr>
<tr>
<td>Sewell, Lisa</td>
<td>661</td>
</tr>
<tr>
<td>Sexton, Kevin</td>
<td>368, 372</td>
</tr>
<tr>
<td>Seyone, Chant</td>
<td>652, 659</td>
</tr>
<tr>
<td>Shade, Ashley</td>
<td>665</td>
</tr>
<tr>
<td>Shafi, Reema</td>
<td>636, 641</td>
</tr>
<tr>
<td>Shah, Manish</td>
<td>469</td>
</tr>
<tr>
<td>Shalvoy, Keriann</td>
<td>651</td>
</tr>
<tr>
<td>Shannon, Tracy</td>
<td>661</td>
</tr>
<tr>
<td>Shapiro, Colin</td>
<td>379</td>
</tr>
<tr>
<td>Shapiro, Jesse</td>
<td>249</td>
</tr>
<tr>
<td>SharifNia, Hamid</td>
<td>97</td>
</tr>
<tr>
<td>Sharma, Aruna</td>
<td>178, 212, 783</td>
</tr>
<tr>
<td>Sharma, Hari Shanker</td>
<td>178, 212, 783</td>
</tr>
<tr>
<td>Sharma, Pushpa</td>
<td>779</td>
</tr>
<tr>
<td>Sharma, Vivek</td>
<td>73</td>
</tr>
<tr>
<td>Shears, Steven</td>
<td>242</td>
</tr>
<tr>
<td>Sheldon, Rollo</td>
<td>633</td>
</tr>
<tr>
<td>Sheldon, Trevor</td>
<td>229, 230, 231</td>
</tr>
<tr>
<td>Shelley, Jacob</td>
<td>773</td>
</tr>
<tr>
<td>Shen, Shan</td>
<td>451, 452</td>
</tr>
<tr>
<td>Shenton, Martha</td>
<td>321, 664</td>
</tr>
<tr>
<td>Shepherd, John</td>
<td>130</td>
</tr>
<tr>
<td>Shibata, Yasushi</td>
<td>183</td>
</tr>
<tr>
<td>Shin, Mi Ran</td>
<td>727</td>
</tr>
<tr>
<td>Shirokova, Olesya</td>
<td>334</td>
</tr>
<tr>
<td>Shiu, Maria</td>
<td>775, 791</td>
</tr>
<tr>
<td>Shlomo, S.</td>
<td>543</td>
</tr>
</tbody>
</table>

T

<table>
<thead>
<tr>
<th>Name</th>
<th>Page Numbers</th>
<th>Name</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tabet, Sabrina</td>
<td>180</td>
<td>Tinawi, Simon</td>
<td>264</td>
</tr>
<tr>
<td>Taghibiglou, Changiz</td>
<td>578, 713</td>
<td>Toccalino, Danielle</td>
<td>248</td>
</tr>
<tr>
<td>Takagi, Michael</td>
<td>155, 249, 250, 380</td>
<td>Togher, Leanne</td>
<td>454</td>
</tr>
<tr>
<td>Takala, Riikka</td>
<td>134, 432, 485, 512</td>
<td>Tomaszczyk, Jennifer</td>
<td>795</td>
</tr>
<tr>
<td>Takayama, Yasuhiro</td>
<td>155</td>
<td>Toni, Torres-McGehee</td>
<td>764</td>
</tr>
<tr>
<td>Tallus, Jussi</td>
<td>134, 432, 512</td>
<td>Toninato, Joseph</td>
<td>371</td>
</tr>
<tr>
<td>Tam, Alan</td>
<td>235, 237</td>
<td>Toong, Tiffany</td>
<td>280, 283, 395, 526</td>
</tr>
<tr>
<td>Tam, Sammi</td>
<td>381</td>
<td>Toppi, Lena</td>
<td>348, 453, 457</td>
</tr>
<tr>
<td>Tanel, Michelle</td>
<td>527, 545</td>
<td>Tornás, Sveinung</td>
<td>307</td>
</tr>
<tr>
<td>Tang, Deborah</td>
<td>643, 652, 659, 730</td>
<td>Torreiter, Sony</td>
<td>235, 237</td>
</tr>
<tr>
<td>Tanis, Mary</td>
<td>122</td>
<td>Torres, Alcy</td>
<td>262</td>
</tr>
<tr>
<td>Taranto, Lindsay</td>
<td>686</td>
<td>Torres, Ivan</td>
<td>323</td>
</tr>
<tr>
<td>Tartaglia, Carmella</td>
<td>641</td>
<td>Torres, Lucía</td>
<td>617</td>
</tr>
<tr>
<td>Name</td>
<td>Page(s)</td>
<td>Name</td>
<td>Page(s)</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------</td>
<td>-----------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>Tarwater, Patrick</td>
<td>769</td>
<td>Tosta, Sandra</td>
<td>445</td>
</tr>
<tr>
<td>Tatara, Yuki</td>
<td>332</td>
<td>Townend, William</td>
<td>229, 231</td>
</tr>
<tr>
<td>Tate, David</td>
<td>321, 388</td>
<td>Townley, Ashleigh</td>
<td>108, 687</td>
</tr>
<tr>
<td>Tatlock, Tom</td>
<td>648</td>
<td>Tran, Pauline</td>
<td>77</td>
</tr>
<tr>
<td>Tator, Charles</td>
<td>641</td>
<td>Treble-Barna, Amery</td>
<td>674</td>
</tr>
<tr>
<td>Tavakkoli, Jahan</td>
<td>793</td>
<td>Treleaven, Dakota</td>
<td>294</td>
</tr>
<tr>
<td>Tavor, Ido</td>
<td>572</td>
<td>Tremblay, Mélissa</td>
<td>264</td>
</tr>
<tr>
<td>Taylor, Brian</td>
<td>321, 388</td>
<td>Tremblay, Sébastien</td>
<td>555</td>
</tr>
<tr>
<td>Taylor, H. Gerry</td>
<td>674</td>
<td>Trick, Sarah</td>
<td>755</td>
</tr>
<tr>
<td>Tchvaloon, E.</td>
<td>543</td>
<td>Trier, Jessica</td>
<td>202, 274, 699, 716</td>
</tr>
<tr>
<td>Teasell, Robert</td>
<td>464, 505, 548, 616, 678, 681</td>
<td>Trillingsgaard Naess-Schmidt, Erhard</td>
<td>587</td>
</tr>
<tr>
<td>Teel, Elizabeth</td>
<td>293, 294, 309</td>
<td>Tripathy, Arushi</td>
<td>665</td>
</tr>
<tr>
<td>Tefertiller, Candace</td>
<td>530</td>
<td>Tripodis, Yorghos</td>
<td>664</td>
</tr>
<tr>
<td>Tehran, Kayvan</td>
<td>102</td>
<td>Trojano, Luigi</td>
<td>348, 349, 353, 638</td>
</tr>
<tr>
<td>Tenn, Catherine</td>
<td>775</td>
<td>Troquet, Jean-Marc</td>
<td>264</td>
</tr>
<tr>
<td>Tenovuo, Olli</td>
<td>134, 198, 281, 432, 456, 485, 512, 666</td>
<td>Trovato, Erika</td>
<td>709</td>
</tr>
<tr>
<td>Teramoto, Masaru</td>
<td>322</td>
<td>Troxclair, Kenneth</td>
<td>50</td>
</tr>
<tr>
<td>Terry, Douglas</td>
<td>331, 518, 519, 520, 667</td>
<td>Troyanskaya, Maya</td>
<td>321</td>
</tr>
<tr>
<td>Thal, Serge</td>
<td>571</td>
<td>Truchon, Catherine</td>
<td>264</td>
</tr>
<tr>
<td>Thastum, Mille Moeller</td>
<td>587</td>
<td>Trujillo-Rodriguez, Diana</td>
<td>691</td>
</tr>
<tr>
<td>Thibaut, Aurore</td>
<td>87, 129, 333, 348, 421, 424, 504, 625, 743, 744, 747</td>
<td>Tsarfaty, G.</td>
<td>543</td>
</tr>
<tr>
<td>Thomas, Kevin</td>
<td>368, 372</td>
<td>Tselichtchev, Pavel</td>
<td>795</td>
</tr>
<tr>
<td>Thomas, Nicole</td>
<td>635</td>
<td>Tuborgh, Astrid</td>
<td>587</td>
</tr>
<tr>
<td>Thomas, Shirley</td>
<td>455, 752</td>
<td>Tuerk, Carola</td>
<td>197, 598</td>
</tr>
<tr>
<td>Thommessen, Bente</td>
<td>439, 579</td>
<td>Tuktareva, Inna</td>
<td>208</td>
</tr>
<tr>
<td>Thompson, James</td>
<td>797</td>
<td>Tuominen, Markku</td>
<td>645</td>
</tr>
<tr>
<td>Thompson, Paul</td>
<td>321</td>
<td>Turcotte, Kate</td>
<td>499</td>
</tr>
<tr>
<td>Thoms, Carla</td>
<td>130</td>
<td>Turgeon, Alexis</td>
<td>284</td>
</tr>
<tr>
<td>Thong, Derek</td>
<td>389</td>
<td>Turkstra, Lyn</td>
<td>170, 241, 366, 469, 646</td>
</tr>
<tr>
<td>Thornton, Allen</td>
<td>377, 602</td>
<td>Turner-Stokes, Lynne</td>
<td>99, 113, 121, 156, 247, 508</td>
</tr>
<tr>
<td>Thorpe, Maxwell</td>
<td>631</td>
<td>Twamley, Elizabeth</td>
<td>511</td>
</tr>
<tr>
<td>Tian, Ryan</td>
<td>178, 212</td>
<td>Tyler, Janet</td>
<td>288, 750</td>
</tr>
<tr>
<td>Tieck, Maria</td>
<td>48</td>
<td>Tyler, Mitchell</td>
<td>590</td>
</tr>
<tr>
<td>Tikhobrazova, Olga</td>
<td>745</td>
<td>Tzarfaty, Galia</td>
<td>572</td>
</tr>
<tr>
<td>Tilford, J.M.</td>
<td>372</td>
<td>Tzé, Nancy</td>
<td>264</td>
</tr>
<tr>
<td>Timmerman, Marieke</td>
<td>444</td>
<td>Uyeno, Caroline</td>
<td>283</td>
</tr>
<tr>
<td>Ugelstad, Helene</td>
<td>511</td>
<td>Urban, Karolina</td>
<td>554</td>
</tr>
<tr>
<td>Unsal, Ayse</td>
<td>149, 313</td>
<td>Ure, Andrea</td>
<td>659</td>
</tr>
<tr>
<td>Upadhyay, Jaymin</td>
<td>542, 570, 581, 594</td>
<td>Uyeno, Caroline</td>
<td>283</td>
</tr>
<tr>
<td>Name</td>
<td>Page Numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vackova, Jitka</td>
<td>685</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaidyanath, Chantal</td>
<td>235, 237</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vakil, Eli</td>
<td>647</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valeo, Flavia</td>
<td>571</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vallat-Azouvi, Claire</td>
<td>290, 428</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanderEnde, Jordan</td>
<td>338</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vanderploeg, Rodney</td>
<td>164</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vanhaudenhuyse, Audrey</td>
<td>257</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vanni, Simo</td>
<td>375, 378</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanRassel, Cody</td>
<td>724</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vardy, Linda</td>
<td>355</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vartanian, Oshin</td>
<td>775</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vartiainen, Riitta</td>
<td>106, 281</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vasquez-Builes, Santiago</td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vassend, Olav</td>
<td>367</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vataja, Risto</td>
<td>425</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaughan, Megan</td>
<td>614</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vedunova, Maria</td>
<td>334</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vanhaudenhuyse, Audrey</td>
<td>257</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanArendt, Jordan</td>
<td>338</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanBelle, Ronald</td>
<td>425</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanBerg, Rita</td>
<td>782</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanDonkelaar, Paul</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanGils, Mark</td>
<td>444, 449, 460</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanJagt, Mathieu</td>
<td>433</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanNaalt, Joukje</td>
<td>354, 356, 444, 449, 460</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanVliet, Rick</td>
<td>752</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vechta, Pilar</td>
<td>417</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veen, Ernest</td>
<td>433</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vening, Evert</td>
<td>475</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vos, Melissa</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voss, Michelle</td>
<td>359, 366, 646</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vosylius, Saulius</td>
<td>437</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vova, Joshua</td>
<td>506</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vyhnaneck, Frantisek</td>
<td>621</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VandeBerg, Rita</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanDenk, Paul</td>
<td>153, 409, 410, 653</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanDeVries, Mathieu</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanDonkelaar, Paul</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanDongen, Patrick</td>
<td>475</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanEvert, Evert</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanFries, Mathieu</td>
<td>475</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanGils, Mark</td>
<td>134, 432, 512</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanHorn, Harm</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanJagt, Mathieu</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanNaalt, Joukje</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VanVliet, Rick</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vechta, Pilar</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veen, Ernest</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voss, Michelle</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vosylius, Saulius</td>
<td>436</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vova, Joshua</td>
<td>506</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vyhnaneck, Frantisek</td>
<td>621</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wade, Benjamin</td>
<td>321, 388</td>
</tr>
<tr>
<td>Wade, Shari</td>
<td>674</td>
</tr>
<tr>
<td>Wagland, Janet</td>
<td>156</td>
</tr>
<tr>
<td>Wagner, Alexander</td>
<td>785</td>
</tr>
<tr>
<td>Waldauf, Petr</td>
<td>511</td>
</tr>
<tr>
<td>Walgampaya, Damindri</td>
<td>751</td>
</tr>
<tr>
<td>Wäljas, Minna</td>
<td>342</td>
</tr>
<tr>
<td>Walker, Kiara</td>
<td>236</td>
</tr>
<tr>
<td>Walker, Vicky</td>
<td>447, 448</td>
</tr>
<tr>
<td>Walker, William</td>
<td>321</td>
</tr>
<tr>
<td>Waller, Laura</td>
<td>322</td>
</tr>
<tr>
<td>Walsh, Stephen</td>
<td>101</td>
</tr>
<tr>
<td>Walter, Alexa</td>
<td>370</td>
</tr>
<tr>
<td>Walton, David</td>
<td>797</td>
</tr>
<tr>
<td>Wang, Jia-Yi</td>
<td>487</td>
</tr>
<tr>
<td>Wang, Kevin</td>
<td>427</td>
</tr>
<tr>
<td>Wang, Meng</td>
<td>417</td>
</tr>
<tr>
<td>Wang, Tong</td>
<td>210</td>
</tr>
<tr>
<td>Wang, Yu-Chio</td>
<td>487</td>
</tr>
<tr>
<td>Wang, Yushan</td>
<td>270</td>
</tr>
<tr>
<td>Wannez, Sarah</td>
<td>87, 747</td>
</tr>
<tr>
<td>Whiting, Diane</td>
<td>402, 412</td>
</tr>
<tr>
<td>Whyte, John</td>
<td>142</td>
</tr>
<tr>
<td>Widgett, Elaine</td>
<td>475</td>
</tr>
<tr>
<td>Wilcock, Ruth</td>
<td>130, 482, 726</td>
</tr>
<tr>
<td>Wild, Michelle</td>
<td>708</td>
</tr>
<tr>
<td>Wilde, Elisabeth</td>
<td>164, 321, 388, 584</td>
</tr>
<tr>
<td>Wilder, Virginia</td>
<td>236</td>
</tr>
<tr>
<td>Wilkinson, Shawn</td>
<td>789</td>
</tr>
<tr>
<td>Willer, Barry</td>
<td>787</td>
</tr>
<tr>
<td>Williams, Elly</td>
<td>156, 174</td>
</tr>
<tr>
<td>Williams, Ethan</td>
<td>615, 635</td>
</tr>
<tr>
<td>Williams, Gavin</td>
<td>298, 299, 300</td>
</tr>
<tr>
<td>Williams, Heather</td>
<td>99, 121, 247</td>
</tr>
<tr>
<td>Williams, Tricia</td>
<td>541</td>
</tr>
<tr>
<td>Willis, Karen</td>
<td>41</td>
</tr>
<tr>
<td>Wilson, David</td>
<td>134, 432, 512</td>
</tr>
<tr>
<td>Wilson, Katherine</td>
<td>280, 395, 527, 545, 672, 677, 680</td>
</tr>
<tr>
<td>Wilson, Lindsay</td>
<td>459, 470</td>
</tr>
<tr>
<td>Win, Phoo Pyae Sone</td>
<td>345</td>
</tr>
<tr>
<td>Wincentak, Joanne</td>
<td>687</td>
</tr>
<tr>
<td>Winter, Laraine</td>
<td>435</td>
</tr>
<tr>
<td>Name</td>
<td>Pages</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Ward, Irene</td>
<td>282, 462</td>
</tr>
<tr>
<td>Ware, Ashley</td>
<td>584</td>
</tr>
<tr>
<td>Watanabe, Shu</td>
<td>740</td>
</tr>
<tr>
<td>Watorek, Vanessa</td>
<td>149</td>
</tr>
<tr>
<td>Watson, Eric</td>
<td>137, 139</td>
</tr>
<tr>
<td>Watter, Kerrin</td>
<td>83, 131, 671, 689</td>
</tr>
<tr>
<td>Watters, Kelsey</td>
<td>177</td>
</tr>
<tr>
<td>Weintraub, Alan</td>
<td>245, 738, 769</td>
</tr>
<tr>
<td>Welch-West, Penny</td>
<td>616</td>
</tr>
<tr>
<td>Weppner, Justin</td>
<td>118</td>
</tr>
<tr>
<td>Westmacott, Robyn</td>
<td>541</td>
</tr>
<tr>
<td>Wetzel, Miles</td>
<td>766</td>
</tr>
<tr>
<td>Wheeler, Anne</td>
<td>210, 266</td>
</tr>
<tr>
<td>Whitehair, Victoria</td>
<td>731, 735</td>
</tr>
<tr>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Xavier, Jasmine</td>
<td>416</td>
</tr>
<tr>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Yadav, Shiv Lal</td>
<td>763</td>
</tr>
<tr>
<td>Yaghoobzadeh, Ameneh</td>
<td>97</td>
</tr>
<tr>
<td>Yang, Eugene</td>
<td>340</td>
</tr>
<tr>
<td>Yang, Yuan-Han</td>
<td>415</td>
</tr>
<tr>
<td>Yang, Zhihui</td>
<td>427</td>
</tr>
<tr>
<td>Yeagley, Noah</td>
<td>686</td>
</tr>
<tr>
<td>Yeates, Keith</td>
<td>159, 674</td>
</tr>
<tr>
<td>Yee, Gi Taek</td>
<td>182</td>
</tr>
<tr>
<td>Yelden, Kudret</td>
<td>355</td>
</tr>
<tr>
<td>Z</td>
<td></td>
</tr>
<tr>
<td>Zafonte, Ross</td>
<td>331, 341</td>
</tr>
<tr>
<td>Zakzanis, Konstantine</td>
<td>472, 748</td>
</tr>
<tr>
<td>Zalai, Dora</td>
<td>248, 379</td>
</tr>
<tr>
<td>Zarshenas, Sareh</td>
<td>507, 522, 531</td>
</tr>
<tr>
<td>Zasler, Nathan</td>
<td>348</td>
</tr>
<tr>
<td>Zavaliangos-Petropulu, Artemis</td>
<td>321</td>
</tr>
<tr>
<td>Zelmer, Amy</td>
<td>181</td>
</tr>
<tr>
<td>Zemek, Roger</td>
<td>233, 677</td>
</tr>
<tr>
<td>Zetterberg, Henrik</td>
<td>134, 432, 485, 512, 666</td>
</tr>
<tr>
<td>Zhang, Daniel</td>
<td>98</td>
</tr>
<tr>
<td>Zhang, Evangeline</td>
<td>531</td>
</tr>
</tbody>
</table>