

Podium Session One:

1005 Abstract 1 **Development and Implementation of a Universal Standing and Walking Assessment Tool (SWAT) for Spinal Cord Injury during the Rehabilitation Process**

Christine Poirier, GF Strong; Gillian Coates, GF Strong; Tova Plashkes, Rick Hansen Institute.

Objectives: Spinal cord injury (SCI) often causes sensorimotor impairments of lower extremities, making standing and walking (S&W) an important rehabilitation goal. Many tools for assessing S&W in SCI exist, however, there is no consensus on which instruments to use during rehabilitation or the stage of functional recovery to initiate specific assessments. Our objective was to develop and implement a SWAT for inpatient rehabilitation centers to: inform evidence-based physical therapy practice, improve efficiencies in service delivery, and evaluate innovative approaches to improve ambulation.

Design: Three phases: Engagement of researchers and clinicians to form a development group, development of a robust SWAT, SWAT implementation into clinical practice. Implementation used the Consolidation Framework for Implementation Research (CFIR) model. The Rick Hansen Spinal Cord Injury Registry was used to support data collection and dissemination.

Participants: Physical therapists and researchers from eight Canadian inpatient rehabilitation centers

Interventions: Development included review of literature, existing practices, and feasibility. A new tool was designed outlining different stages of standing and walking recovery. Outcome measures (OM's) are

indicated based on stage and completed during inpatient rehabilitation.

OM's included: Berg Balance Scale, 10 Meter and 6 Minute Walk Tests, Timed Up and Go, and Activities Specific Balance Confidence Scale. Lead clinicians received standardized training and act as implementation champions at their center.

Main Outcome Measure: Reach, Use and Usefulness of SWAT

Results: 10 hospitals are collecting the SWAT. SWAT completion rates vary from 38%-100%. Physical Therapists use the information collected to inform clinical practice and patient education.

Conclusion: The SWAT is a universal assessment tool for S&W at standardized stages of recovery after SCI and is currently being validated and updated.

1018 Abstract 2 **Acute pharmacological management after spinal cord injury: A secondary analysis of clinical trial data.**

Catherine Jutzeler, Postdoctoral Fellow, UBC School of Kinesiology.

Background: Spinal cord injury is often immediately coupled with various secondary health conditions including infections, spasticity, and the development of neuropathic pain. These conditions necessitate the administration of a range of medications (e.g., antibiotics, analgesics). To date, a comprehensive evaluation of the drugs administered in the acute phase of spinal cord injury is missing.

Objectives: To determine the types of drugs commonly administered, alone or in combination, in the acute phase of spinal cord injury.

Methods: We completed a secondary analysis of a cohort of adult patients with traumatic spinal cord injury who participated in the multi-centre randomized controlled clinical trial (Sygen).

Concomitant medication use (non-randomized medications), including dosage, timing and reason for administration, was tracked through the duration of the one-year trial. Descriptive statistics (means, percentages, standard deviation, confidence intervals, etc.) were used to describe the drugs administered. Patterns of poly-pharmacy was determined using a hierarchical cluster analysis. R Statistical Software was used for all statistical analyses and to create plots for data visualization. **Results:** Of 797 patients included in our analysis (mean age at injury: 34 years; 83% male), 75% were injured at the cervical level. A total of 640 drugs from 49 different drug classes were administered within 90 days after injury. The average number of drugs given to one patient in the first month was 30 [range 1-66]. The highest prevalence was found for analgesics (acetaminophen [92.6%], morphine [75.4%]), coagulants (heparin [68.3%]), and antibiotics (cefazolin [52.4%]). The most frequent drug-combination was acetaminophen and heparin [68.4%]. The drug exposure patterns ranged from single (i.e., drug was given once), to intermittent, to continuous exposure (i.e., drug was administered for 90 days).

Conclusions: Our study reveals important findings regarding the types and prevalence of drugs administered (alone or in combination) to patients sustaining a traumatic spinal cord injury.

1031 **Abstract 3**
Impact of altering spinal cord excitability on exercise capacity during peak arm-crank ergometry.

Tom Nightingale, Postdoctoral Research Fellow, ICORD.

Objective: To assess whether direct epidural spinal cord stimulation (ESCS) leads to improved upper-body exercise capacity via optimized control over cardiovascular functions.

Design: Randomized cross-over, single-blind trial.

Setting: Clinical research facility.

Participant: A 33 year old male with a chronic (5 years) motor-complete spinal cord injury (SCI)

(ASIA impairment scale B) at the C5 level, who 18 months prior to testing was fitted with an epidural spinal cord stimulation unit and 16-electrode array (Restore-ADVANCED and Specify 5-6-5; Medtronic) between T11-L1. Ethical approval was obtained from the University of British Columbia Clinical Research Ethics Board. The participant provided written informed consent.

Interventions: the participant performed a progressive intensity arm-crank ergometry test to volitional exhaustion across eight laboratory visits (each separated by ~8 days), with no ESCS (n = 2), low-intensity ESCS (n = 3) and high-intensity ESCS (n = 3).

Main Outcome Measure: Peak oxygen uptake (VO_{2peak}) (measured via an online breath-by-breath system).

Results: absolute and relative VO_{2peak} values were similar during control (no ESCS) trials 0.78-0.79 $L \cdot min^{-1}$ and 9.18-9.52 $ml \cdot kg^{-1} \cdot min^{-1}$, with negligible inter-trial coefficients of variation; 0.7% and 2.5%, respectively. Relative to both control trials, ESCS improved VO_{2peak} by 16–27% depending on stimulation parameters and electrode configuration.

Conclusions: our preliminary data demonstrate, for the first time, that lumbosacral ESCS is capable of activating spinal cord circuitry which enhances autonomic regulation of the cardiovascular system. Thus, this neuroprosthetic device has the potential to 'boost' functional capacity during upper-body exercise in individuals with SCI, irrespective of stimulation amplitude.

1044 **Abstract 4**
Restoring supraspinal control to promote cardio-autonomic recovery after spinal cord injury.

Rahul Sachdeva, Craig H. Neilsen Postdoctoral Fellow, ICORD.

Objective: Spinal cord injury (SCI) disrupts cardio-autonomic control and leads to autonomic dysreflexia, a condition where routine stimuli (e.g. full bladder) can instigate life-threatening surges in blood pressure (BP). Since dysreflexia results from the loss of

supraspinal control and aberrant sprouting of spinal nociceptive afferents, we tested a combination approach to simultaneously target these mechanisms.

Design: Rats received a T3 SCI followed by intraspinal nerve grafts, intrathecal delivery of chondroitinase enzyme and cycling exercise. Cardiovascular function (resting BP, heart rate and response to colorectal distension) was assessed using radiotelemetry. Functional regeneration was determined using stimulus-linked neuronal activity. Neural tract tracing was performed to determine the 'neural origin' and 'extent' of regenerating axons.

Results: In response to colorectal distension (experimental autonomic dysreflexia), combination treatment showed 53.8% reduction in systolic BP elevation, 42.2% reduction in diastolic BP elevation, 57.6% reduction in mean arterial pressure elevation as well as abolishment of bradycardia. Stimulus-driven activity of neurons across the graft confirmed functional regeneration. Moreover, the autonomic recovery was abolished upon graft transection, suggesting that recovery was mediated through the grafts. Interestingly, retrograde tracing identified neurons in the Raphe Nuclei, indicating restoration of supraspinal control.

Conclusion: Combined regenerative and rehabilitative approach led to significant autonomic recovery after SCI. With advances in Schwann cell transplantation in individuals with SCI and clinical feasibility of exercise, this study holds significant potential in improving autonomic function and the quality of life after SCI.

Funding support: Craig H. Neilsen Foundation (RS), Rick Hansen Foundation (AVK), Heart and Stroke Foundation (AVK).

1057 Abstract 5

Motherhood after spinal cord injury: lactation, breastfeeding and autonomic dysreflexia.

Amanda Lee, MSc Student, Autonomic Research Laboratory, ICORD.

Setting: Aside from lactation dysfunction, the specific complications in breastfeeding

associated with spinal cord injury (SCI) are poorly understood. This gap must be addressed to improve clinical care and breastfeeding outcomes.

Objectives: Identify the major barriers to breastfeeding in women with SCI.

Design & Participants: We conducted a prospective, multi-center (ICORD, Vancouver; Karolinska Institute, Stockholm) study with an international sample of women who breastfed with SCI ($n = 102$). An expert panel of researchers, health care professionals and women with lived experience used the Delphi method to develop a questionnaire on breastfeeding and SCI.

Main Outcome Measure: SCI was categorized as cervical (C1-C7), upper thoracic (T1-T6) or low-level (T7 and below). Questionnaire domains included: breastfeeding duration, complications, reasons for breastfeeding cessation, mobility and education.

Results: The most severe complication was lack of the let-down reflex after cervical SCI, and insufficient milk production after upper and low-level SCI. Overall, 24% of women experienced Autonomic Dysreflexia (AD) triggered by breastfeeding. AD prevalence was greater with higher SCI (cervical: 46.7%; upper thoracic: 25.0%, low-level: 13.1%). The odds of breastfeeding for over 6 months (as per World Health Organization recommendations) was 2.61 times greater for low-level SCI than cervical SCI ($p = 0.029$). The top reason for breastfeeding cessation for cervical & upper thoracic SCI was time needed for activities of daily living and lack of sleep for low-level SCI.

Conclusions: Clinicians should become adept at managing AD in the breastfeeding mother and emphasize interdisciplinary care to address complications that differ with SCI level.

1110 Abstract 6

Exploring the activity spaces of people with disabilities.

Mike Prescott, PhD Candidate.

Background: People with disabilities (PwDs) face many barriers trying to get around their communities. The environment limits the

activity spaces that define where they travel and compromises their ability to meet their needs. As a result, PwDs have lower levels of physical activity, participation, and quality of life.

Objectives: The goals were to understand where PwDs go in their community and what barriers and facilitators they face during their travels.

Design: Participants completed standardized questionnaires regarding socio-demographic information, anxiety and depression, confidence, function independence, social capital, and Life Space areas. They also kept trip diaries, took photos of mobility challenges, and wore global positioning system (GPS) devices for 7 days, A qualitative interview followed regarding their experiences and the role of their assistive mobility devices.

Setting: Greater Vancouver region and Quebec City.

Participants: 105 people with disabilities who use assistive mobility devices (manual wheelchairs, power wheelchairs, scooters, walkers, canes, crutches)

Interventions: Not applicable

Measures: GPS tracks were used to measure the area of their activity spaces (single deviation ellipses and minimum convex polygons) and compared across personal, assistive technology, and environmental factors. General walkability measures were based on WalkScores and BikeScores.

Results: An inverse relationship was found between more walkable neighbourhoods and activity spaces. This may suggest people are able to travel in their local community to achieve most of their daily activities.

Conclusions: The match between the abilities of the person, the assistive device used, and the ever-changing environment affects the size of activity spaces PwDs experience.

Objectives: Inflammatory arthritis (IA) includes rheumatoid arthritis and other variants; about 3% of the population. Patients rate pain management as the highest priority in overall disease treatment. Listening to music (ML) is associated with decreased pain intensity and opioid levels needed, reduced depression and decreased pain. Evidence supports music therapy (MT) to aid in pain management. More options for pain management are needed within this population; studies indicate NSAID's can increase cardiac, renal and gastrointestinal concerns.

Design: Patients admitted to GFS-ARS were stratified into 4 strata: Rheumatoid Arthritis (RA), Surgery (S), RA no surgery (NS), other inflammatory Arthritis (OIA) surgery, and OIA, NS, each with a 1:1 allocation ratio using blocks of size 2 or 4 and were randomly assigned to MT or a ML control group that listens to a relaxation recording. Thirteen patients completed the research.

Methods: Standardized tests determined whether MT achieves different outcomes than ML with respect to pain (primary outcome).

Results: No meaningful differences at baseline between MT and ML groups. Results suggest that the worst pain in each group was similar, and the pain mean for the MT group was lower than the ML group at the end of therapy.

Conclusions: The possible benefits of MT over ML could benefit from a larger study to provide more convincing evidence of the merits of music therapy.

1123 **Abstract 7**

Do inflammatory arthritis inpatients receiving group music therapy improve pain control compared to music listening over the 3 weeks using a randomised controlled open-label trial?

Katherine Wright, Sophia Zhao, G.F. Strong Rehabilitation Centre.

Podium Session Two:

1445 Abstract 8

An analysis of functional brain connectivity following concussions in adolescents.

Vrinda Munjal, Undergraduate Research, Djavaad Mowafaghian Centre for Brain Health.

The objective of this study is to evaluate long-term changes in resting state functional brain networks in individuals with sports related concussion. A group of 14 concussed adolescents were compared with age and gender matched controls. All concussed athletes were observed to have sustained a blow to the head and showed a change in their SCAT-3 scores. All participants took part in SCAT-3 assessment by trained research assistant at each time point. Resting state EEG was recorded using a 64-channel Hydrogel Geodesic SensorNet (EGI, Eugene, OR). EEG was recorded with a Net Amps 300 amplifier at a sampling rate of 250 Hz. Five minutes of resting data were collected while participants sat quietly with their eyes closed. Graph theory was used to characterize global and local network features. Data was collected at 1 week and 12 months post-injury. The results show significant changes in functional connectivity in different areas of the brain, particularly in the frontal lobe. This suggests that recovery from concussions may be an ongoing and dynamic process which may not be elucidated by simply examining the concussion-related symptoms following the injury

1458 Abstract 9

Updated prevalence of upper limb weakness following stroke: Do fewer people experience arm weakness today?

Lisa Simpson, PhD student, UBC Rehabilitation Sciences.

Objectives: The 1999 Copenhagen Stroke Study is one of the most frequently cited studies when reporting the prevalence of upper limb weakness after stroke (ie. 69%). The purpose of this study was to examine the current prevalence of upper limb weakness among

people admitted to a Canadian regional acute stroke unit.

Methods: Patients admitted to the acute neurological unit were screened from March 2016 to August 2017. The Shoulder Abduction and Finger Extension (SAFE) scores were captured for individuals with stroke by unit physical therapists within 5 days of their stroke. Arm weakness was defined as a SAFE score of 8 or less. Severe weakness was defined as a SAFE score of 4 or less and mild/moderate weakness was defined as a SAFE score of between 5 and 8.

Results: A total of 1090 consecutive admissions were screened and 869 individuals with stroke were included in this study. A total of 803 individuals were administered the SAFE and 42% of patients had arm weakness. Weakness was classified as severe in 64% of individuals and as mild/moderate in 36% of individuals.

Conclusions: Fewer people are experiencing arm weakness compared to those observed in the Copenhagen Stroke Study. In addition, the roughly equal proportion of people with severe vs mild/moderate weakness has changed with a greater proportion of people now experiencing severe arm weakness. The changes in the distribution of arm weakness observed in this study have important implications for stroke service and clinical trial planning.

1511 Abstract 10

Stuck in a state of inattention? Functional hyper-connectivity as an indicator of disturbed intrinsic brain dynamics in adolescents with concussion: A pilot study.

Angela Muller, Postdoctoral Fellow, Department of Physical Therapy, UBC.

Objective: Hyper-connectivity in individuals with mild traumatic brain injury (mTBI) is one of the most characteristic features reported in functional studies using resting-state fMRI or EEG. The aim of this pilot-study was to gain a better understanding of how hyper-connectivity affects the intrinsic dynamics of the brain in a group of adolescents.

Participants and Methods: 6 adolescents diagnosed with mTBI, 6 aged and gender matched controls (mean age = 14.4 years). We modelled three common brain-states and computed the individual times spent in each of these brain-states (dwell time (DT)) by a sliding windows analysis (SWA) of the rs-fMRI data. Association of DT with the network organization of the white matter tracts was computed using graph theory analysis (GTA).

Results: Adolescents with mTBI showed impaired flexibility in shifting between different brain-states and spent significantly more time in brain-state 2 ($t = 2.62$; $p = .0254$) and significantly less time in brain-state 3 ($t = 2.532$; $p = .0302$) than the controls. Additionally, this lack of dynamic flexibility was associated with the nodal strength value (NS) of a region located in the left middle frontal gyrus (Spearman's $r = -0.86$; $p < 0.05$ FDR).

Conclusion: This is the first study to show disturbed brain dynamics following mTBI. We interpret the NS in the adolescents with mTBI as a consequence of injury-related axonal swelling of the underlying white matter structure. Our findings may explain why adolescents with mTBI have difficulties with tasks that require attention over a long period.

1524 **Abstract 11**
Lower extremity mirror therapy for balance and gait post-stroke: A systematic review and meta-analysis.

Riley Louie, PhD Candidate, UBC Rehabilitation Sciences.

Objectives: To evaluate the efficacy of lower extremity mirror therapy in improving balance and gait for individuals with stroke.

Methods: PubMed, Cochrane Central Register of Controlled Trials, MEDLINE, Embase, CINAHL, PEDro, and PsychINFO were searched from inception to February, 2018. Randomized controlled trials (RCTs) comparing post-stroke mirror therapy for the lower extremity (with or without supplemental stimulation) with control were selected by two independent reviewers. Data regarding participants, intervention, comparison, and outcome were extracted. The

primary outcome was gait, with a secondary focus on balance and motor function. Methodological quality was assessed using the PEDro (Physiotherapy Evidence Database) scale.

Results: From 166 retrieved articles, 14 RCTs involving 531 patients with a median PEDro scale score of 6.5 were selected for inclusion. Of these, nine studies focused on chronic stroke. In a meta-analysis of seven that assessed change in gait speed, a large beneficial effect was observed following lower extremity mirror therapy training (SMD 0.88, 95% CI 0.29-1.48, $p=0.004$). In addition, 3 of 5 studies investigating balance reported significant between-group differences, all in favour of mirror therapy. Four of 7 studies reported significant between-group differences in favour of mirror therapy for motor function improvement, while one favoured the control intervention (mental imagery).

Conclusion: This review found that lower extremity mirror therapy resulted in a large improvement in walking after stroke, as well as other possible positive benefits on balance and motor function.

1537 **Abstract 12**

Preliminary evidence of atypical somatic symptoms in individuals with prolonged recovery from mild traumatic brain injury.

Katherine Green, MSc Candidate, Experimental Medicine.

Objectives: We sought to characterize somatic symptoms atypical of concussion (e.g. joint pain or GI distress) in addition to classic somatic symptoms of concussion (e.g. headache, dizziness) in individuals with prolonged recovery from MTBI.

Design: Cross-sectional.

Setting: Research laboratory.

Participants: 21 mild traumatic brain injury patients with post-concussion syndrome and 15 healthy group-matched controls with no history of brain injury.

Interventions: None

Main outcome measures: Somatic symptoms were inventoried by the Patient Health-Questionnaire-15. PHQ-15 items were categorized *a priori* as measuring either classic

symptoms of MTBI (e.g. headache, dizziness, etc.) or symptoms atypical of MTBI (e.g. stomach pain, sexual dysfunction). Post-concussive symptoms were inventoried by the Rivermead Post-Concussion Symptom Questionnaire.

Results: Symptoms commonly conceptualized as linked to concussion were significantly elevated in the post-concussion syndrome group (Rivermead Mann-Whitney $U = 0.0$, $p < 0.0005$, Cohen's $d = 2.85$; classic PHQ-15 symptoms $U = 3.0$, $p < 0.0005$, $d = 3.49$). Atypical somatic symptoms were also significantly higher in the patient group, as compared to controls (atypical PHQ-15 symptoms $U = 31.0$, $p < 0.0005$, $d = 1.78$).

Conclusions: Our results show that a broad range of somatic symptoms frequently accompany MTBI, and that somatization may represent an important, modifiable factor in MTBI recovery.

1550 **Abstract 13**

The effect of social context on functional connectivity and between-brain coupling.

Amna Hyder, MSc Student, Neurosciences, UBC.

Objective: Human brains are shaped by their interactions with others. Most studies in social neuroscience focus on an individual subject within a constrained social context. However, perceptual and motor actions do not occur in social isolation and little is known about how the activity of one brain dynamically changes as a function of the other during a real social interaction. The aims of this study were to: a) investigate changes in functional connectivity in varying social contexts (cooperative, competitive and independent) between two individuals and b) quantify emergent properties of two brains interacting simultaneously.

Participants: 48 right handed females (ages: 17-30) came in as dyads at UBC

Design: Each dyad participated in a game which required responding to a green light with a button press under the following conditions: 1) independent: one participant is asked to respond, while the other observes, 2) cooperative: both are asked to synchronize their responses, and 3) competitive: both are asked to respond faster than the other.

Main outcome measures: EEG and behavioural data was collected in each. We applied graph theory analysis on EEG data to evaluate functional connectivity.

Results and Conclusions: We found higher clustering in right frontal regions during the cooperative condition, and higher clustering in left frontal regions during the competitive condition. These preliminary results suggest that brain-behaviour relationships are dynamically altered during social interactions & influenced by the nature of the task. Further work is underway to detect the emergent properties and differences in brain-brain synchrony across conditions.

1603 **Abstract 14**

Intra-rater and inter-rater reliability of Penn Spasm Frequency Scale in chronic traumatic spinal cord injury.

Lawrence Kei MD, UBC Resident in Physical Medicine & Rehabilitation.

Objective: To evaluate the intra-rater and inter-rater reliability of the Penn Spasm Frequency Scale in chronic traumatic spinal cord injury (SCI).

Design: Observational study.

Setting: General community setting.

Participants: Individuals with chronic (> 1 year) traumatic SCI.

Interventions: Not applicable.

Main Outcome Measure: The Penn Spasm Frequency Scale (PSFS) is a self-reported measure of spasticity in which the individual documents the frequency (Part 1) and severity (Part 2) of their muscle spasms.

Results: Reliability was assessed using weighted kappa (95% CI) statistics. In 61 participants, the intra-rater reliability of the PSFS reported between 5 to 10 days and 4 to 6 weeks after baseline was 0.822 (0.709, 0.935) and 0.734 (0.586, 0.883), respectively, for spasm frequency (PSFS Part 1). With the addition of reporting on spasm severity (PSFS Part 2), the intra-rater reliabilities were 0.812 (0.705, 0.919) and 0.729 (0.586, 0.872) for 5 to 10 days and 4 to 6 weeks respectively. The PSFS inter-rater reliability within a 3 day time interval was 0.862 (0.759,

9th Annual GF Strong Research Day
May 9th, 2018

0.965) for spasm frequency and 0.857 (0.762, 0.952) with addition of spasm severity.

Conclusions: For PSFS Part 1 (spasm frequency) Intra-rater and inter-rater reliability weighted kappa statistics are in the “almost perfect” category, with lower confidence bounds in the “substantial” range. As expected, by adding the PSFS Part 2 (spasm severity) the reliability decreases, but the kappa statistics remain “substantial”, with a lower confidence bound in the moderate range. The PSFS is therefore probably a reliable outcome measure to assess self-reported spasticity in the chronic traumatic SCI population 5 to 10 days and 4 to 6 weeks after baseline administration.

Poster Presentations:

Outcomes of a brief coping skills group intervention for adults with severe persisting symptoms after concussion.

Jordan Ali, Psychology Practicum Student.

Background: Maladaptive illness beliefs and coping behaviours are risk factors for persistent symptoms after concussion. Psychologically-informed treatment targeting these risk factors may improve concussion outcomes. We designed and evaluated an abbreviated group-based coping skills (CS) intervention.

Objectives: To provide preliminary evidence that a brief group intervention can reduce symptom severity and disability.

Methods: Secondary analysis of a database compiled for a clinical Quality Improvement initiative. From consecutive education session attendees, 58 patients screened positive for high symptom burden. These were placed into 3 groups, 22 completed a three-session intervention focused on introducing healthy CS, 16 declined or did not complete the intervention, and 19 were not offered the intervention based on their week of program entry. A blinded assessor reached 26 of the 58 patients by telephone (Mean=33.8 weeks post-injury) to administer outcome measures, including the Rivermead Postconcussion Symptom Questionnaire (RPQ).

Results: Symptom severity decreased over time in all groups, equivalently (Mean Δ =10.2 on RPQ), and remained elevated at follow-up (Mean=30.7, SD=10.9 on RPQ). Change in self-rated disability did not differ by group. Most intervention completers were satisfied (8 of 10 were at least “somewhat” satisfied) and perceived it as credible (9 of 10 would recommend it to a friend in a similar situation).

Conclusion: The intervention was well-received. However, there was no evidence that it was an effective adjunctive treatment for highly symptomatic patients. A larger “dose”, different patient selection, or individual therapy may be required. Notable limitations of this study were no randomization and high loss to follow-up.

Cardiorespiratory fitness responses to body weight-support treadmill training (BWSST) and arm-cycle ergometry training (ACET) in individuals with chronic complete-motor spinal cord injury: A randomized controlled trial.

Abdullah A. Alrashidi, PhD Candidate, Experimental Medicine, Autonomic Research Laboratory.

Objective: The aim of this randomized, controlled trial is to study the effect of Body Weight-Support Treadmill Training (BWSTT) and Arm-Cycle Ergometry Training (ACET) on the cardiorespiratory fitness (CRF), expressed as oxygen uptake and power output, with those with chronic, motor-complete SCI.

Method/Design: Eligible candidates were randomly assigned to either BWSTT or ACET. Each group trained 3 times per week for 6 months. Peak oxygen consumption (VO_{2peak}) and peak power output (PO_{peak}), as the main outcome measures, were derived at the point of volitional fatigue during cardiopulmonary exercise testing at baseline and after the intervention completion.

Result: 26 participants (BWSTT, $n=14$) and (ACET, $n=12$) completed the study. For the peak oxygen consumption there were no significant day x group interaction (relative $P = 0.08$, absolute $P = 0.06$). ACET group, pre-post within group difference was significant ($P < 0.05$), relative VO_{2peak} changed by 07% and 24% for BWSTT and ACET respectively, and absolute VO_{2peak} by 06% and 26% for BWSTT and ACET respectively. In regards to PO_{peak} , data showed non-significant day x group interaction ($P = 0.29$). PO_{peak} changed by 17% for BWSTT and 26% for ACET with $P < 0.05$ pre-post within group differences for both groups.

Conclusion: These preliminary data potentially revealed superior changes in CRF with ACET compared to BWSTT. Such improvement can have profound impacts on quality of life and independence in individuals with SCI. Moreover, such similar improvements have been linked to significant reduction in all-cause and CVD mortality in able-bodied individuals.

Evidence of brain network fragmentation 1-year post concussion in adolescent athletes: A pilot study.

Dorian Aur, PhD, Research Associate,
Dept of Psychiatry, UBC.

Objective: The management and diagnosis of traumatic injuries is highly dependent on patient-reported symptoms; however, little is known about the relationship between brain networks and symptoms post-concussion. Our objective was to evaluate changes in network dynamics over a 1 year time period post-concussion and correlate these changes with symptom severity

Design and Participants: Data from 8 adolescents with sports related concussion were analyzed at the following time points post initial concussion: 1 week, 1 month, 3 months, 6 months and 1 year.

Outcome measure: Dynamic cross entropy (DCE) was used to analyze brain network dynamics. This measure was correlated with symptom severity from the Sports Concussion Assessment Tool (SCAT3). Using this method the area under the ROC curve was used to detect the network fragmentation in all brain regions. We performed Pearson correlation analyses of fragmentation connectivity changes and symptom severity score modifications using the difference between the one week baseline resting state EEG (rsEEG) and rsEEG one year post injury.

Results: There was an increase of fragmentation connectivity one year post-concussion in all participants. This increase was statistically significantly negatively correlated with symptom severity ($r=-0.79$, $p=0.018$). In addition, we observed a relationship between the location of injured regions and the presence of specific symptoms.

Conclusions: The increase of network dysfunction at 1 year post concussion may impact functional recovery and have an effect on adolescent brain development. Further detailed assessment of cognitive recovery is needed.

Left ventricular function after acute spinal cord injury.

Shane Balthazaar, Graduate student at ICORD, Autonomic Function Lab, UBC.

Objective: Spinal cord injury (SCI) results in unfavourable changes to the cardiovascular system and its regulation via the autonomic nervous system. Rodent investigations demonstrates the heart changes after SCI. Studies in humans with chronic SCI demonstrate different cardiac indices compared to able-bodied individuals, as well as between lesion levels (i.e., cervical vs. thoracic). The time-course of cardiac adaptations post-SCI in humans is presently unknown. Therefore, the goal of this study was to track the time-course of cardiac changes following acute SCI using a longitudinal study design with measurements at 3, 6 and 12-months post-SCI. Data collection is currently ongoing, therefore we present a preliminary comparison of cardiac indices at 3 and 6-months post-SCI in cervical and thoracic SCI groups.

Design/Methods: Eight subjects (AIS A and B, males and females, age 18-60) with cervical ($n=4$) and thoracic ($n=4$) SCI underwent echocardiography at 3 and 6 months post-acute traumatic SCI. Stroke volume and ejection fraction (i.e., systolic function) were calculated by using a one plane volumetric assessment by method of disks (4 chamber, apical view). Diastolic function was assessed using the ratio of early transmitral filling velocity (E) to the average of early septal and lateral myocardial annular velocities (E').

Results: Preliminary analysis revealed no difference in E/E' between lesion level groups at 3 ($p=0.23$) and 6-months post-SCI ($p=0.19$). Stroke volume was also similar between groups at each time point. Mean ejection fraction was similar at 3-months ($61 \pm 6\%$ vs. $57 \pm 2\%$, for cervical vs. thoracic at $p=0.22$), but lower in cervical SCI at 6-months ($54 \pm 2\%$ vs. $62 \pm 2\%$, for cervical vs. thoracic at $p<0.01$).

Conclusion: This study is the first to examine the cardiac indices during acute and subacute periods of SCI in humans. Our observations suggest diastolic function is similar between lesion level groups during this acute period.

Conversely, the difference in ejection fraction at 6-months suggests this variable may have changed. Further insight into what variables change and their specific time-course of adaptation will be established upon study completion. The importance of these temporal changes could provide us insight on clinical management and prevention of cardiac function deterioration following SCI.

Timing of acute vasopressor administration after traumatic SCI: The impact on blood flow, oxygenation, pressure, and metabolic responses using a porcine model.

Amanda Cheung, MSc student, Neuroscience, ICORD.

There are currently limited early intervention strategies for patients who suffer acute spinal cord injury (SCI). Vasopressor support of mean arterial blood pressure (MAP) to improve spinal cord blood flow is one of the few treatment options available. However, the effect of intervention timing, on blood flow, oxygenation, pressure, and metabolic responses warrants consideration. The focus of this study is to determine the timing and effect of MAP support intervention on acute hemodynamic and metabolic responses during the compressed and decompressed states of injury. Using our porcine model of SCI, a T10 contusion injury was administered followed by 2-hours of sustained compression. After SCI, norepinephrine was used to elevate MAP by 20 mmHg for a period of 1.5 to 3.0 hours while the cord was compressed, after the cord was decompressed, or during both injury states. Laser Doppler flowmetry/oxygenation, fibre optic pressure, and microdialysis probes were used to measure spinal cord blood flow (SCBF), oxygenation (PO₂), and spinal cord pressure (SCP). Microdialysis samples were collected to analyze for lactate, pyruvate, glucose, glutamate, and glycerol. Our data suggests that MAP augmentation during compression or decompression of the spinal cord modestly restores SCBF and PO₂ and reduces the lactate/pyruvate ratio more effectively during compression. However, MAP augmentation

during both states of injury may result in deleterious effects due to increased total hemorrhage observed near the injury site.

Increased network connectivity across all frequency bands in adolescents with concussion.

Amna Hyder, MSc student, Neurosciences, UBC.

Objective: Although several studies have used electroencephalography (EEG) to investigate brain states associated with concussion, few have explored the resting state of concussed individuals at a network level, along a range of frequency bands.

Methods: Data from twenty-seven adolescents with subacute concussion and thirty-three healthy adolescents were analyzed. Resting state, eyes-closed EEG was recorded with a 64 channel EEG. Phase locking values (PLVs) in the: delta (1–3 Hz), theta (4–8 Hz), alpha (8–12 Hz), beta-1 (13–20 Hz), beta-2 (21–30 Hz), and gamma (30–50 Hz) ranges were averaged for each source. To compare the average PLVs between subjects with mTBI and controls, non-parametric Wilcoxon rank sum tests were conducted on the data from each frequency band. In addition, graph theory analysis was done on connectivity networks constructed from the resting state data.

Results: Investigating phase synchronization between EEG channels showed increased connectivity in participants with concussion across all frequency bands in several regions. Increases in synchrony were the most significant in the alpha and gamma band (in frontal and parietal electrodes). Concussed individuals also demonstrated a broader range of phase locking values than controls. Graph theory measures showed a deviation from a small world network for concussion, and power spectrum density showed variations in power at the alpha and gamma frequency bands.

Conclusion: Our findings show that concussion disrupts network dynamics, and that this disruption can be detected in resting state.

Caught in between: Tensions experienced by community scooter users.

Sharon Jang, MSc Candidate.

Background: The use of mobility scooters is becoming more common due to their reasonable cost and social acceptability. Various benefits have been associated with scooter use, such as an increased sense of independence, increased social participation, and increased confidence. However, scooter users still face a variety of barriers in their communities.

Objective: To explore the everyday experiences of scooter users within the context of their physical and social environments.

Methods: In a research lab, 20 community dwelling scooter users participated in semi-structured interviews. The average age of participants was 63 years, and the majority were retired.

Results: Our analysis revealed three main themes that involved tensions with using a scooter. *Accidents and incidents* examined the different physical mishaps experienced by participants (such as falls and bumps), and the perceived contributions to their accidents. Accident prevention strategies and the requirement of training were also discussed. In this theme, tradeoffs were identified regarding scooter maneuverability versus stability, and concerns about being blamed for accidents were noted. *Dealing with environmental challenges* examined scooter users' concerns in the built, social, and natural environments, and techniques used to overcome them. *Stuck in the middle* revealed the ambiguous status of scooters as a mobility device (e.g., whether scooter users are treated as vehicles or pedestrians) and as a disability signifier. Participants also debated the conspicuousness of a scooter.

Conclusion: This study provides insight to the common issues faced by scooter users, many of which relate to the ambiguity associated with these devices.

Atrophic changes in pelvic ganglia neurons following spinal cord injury.

Arshdeep Marwaha, Undergraduate Student.

Spinal Cord Injury (SCI) not just causes sensorimotor paralysis but also results in more devastating autonomic dysfunctions such as loss of bowel/bladder/sexual control. Regaining autonomic function is among the top priorities for recovery in patients with SCI. However, the mechanisms underlying these dysfunctions are poorly understood and hence the treatment strategies are severely limited. The pelvic ganglia are crucial for controlling urogenital function. Post-ganglionic neurons in these ganglia directly innervate the urinary bladder and sexual organs, thereby regulating their function. Thorough understanding of how SCI affects these key structures is essential to develop therapeutic strategies.

To test the hypothesis that SCI alters neuronal morphology in pelvic ganglia, we used a well-characterized rat model of T3 spinal transection that causes severe autonomic dysfunctions. Using immunohistochemistry for neuronal markers, the neuronal soma size was quantified following SCI. We used a robust and unbiased mathematical model called Recursive Translation to quantify changes in size-frequency distributions of neuron populations.

We report that eight weeks post SCI, the pelvic ganglia neurons show a significant left-shift (i.e. atrophy) in the size distribution. Specifically, in a normalized size-frequency distribution of neurons, SCI led to a 47% decrease in cell diameter. To gain a better understanding of the time course of these changes, earlier time points after SCI (one and four weeks) are currently being investigated.

To our knowledge, this is the first characterization of SCI-associated changes in pelvic ganglia neurons, that control autonomic functions defining the quality of life after SCI. These findings will contribute to the global understanding of the morphological and molecular changes underpinning autonomic instability and help devise targeted therapies.

Funding support: Rick Hansen Foundation (AVK), Heart and Stroke Foundation (AVK), Craig H.

Neilsen Postdoctoral Fellowship (RS), University of British Columbia Work-Learn Program (ASM).

Balance training using artificial delays: a novel robotic intervention for people with neurological disorders.

Geoff McKendry, MSc Student, Sensorimotor Physiology Lab, UBC.

The aim of this project was to develop a robotic rehabilitative tool for people with neurological disorders affecting neural conduction times (e.g. Multiple Sclerosis, Parkinson's Disease, Stroke). To do so, we developed a robot allowing participants to balance in a safe environment while challenging their balance control by introducing artificial delays between their motor commands and associated sensory feedback. Three participants with Multiple Sclerosis (EDSS < 4.5 ; age: 33, 46, 61 ; 1 male, 2 females) and one healthy control participant (age: 59 ; female) were recruited to take part in this pilot project. Participants were first asked to maintain balance on the robot over nine 2-minute trials with induced delays between 0 and 500 ms. Participants then trained at an artificial delay (300 ms) for 160 minutes over 4 days in a two week period. Pre- and post-training performance was measured by the number of 'virtual falls' defined as the participant exceeding the soft limits of the robot (4° anterior or 3° posterior). Preliminary data indicate that individuals with Multiple Sclerosis as well as the healthy control adapted (i.e. decreased their number of 'virtual falls') to the 300 ms delay. Concurrently, participants learned to balance with smaller delays (<300ms) without practicing them during training. These preliminary results are encouraging and suggest that our robotic approach may help individuals experiencing sensorimotor conduction delays associated with Multiple Sclerosis learn to adapt their control of standing balance.

Enhancing quality of life in children with Autism Spectrum by improving their central human functional capabilities.

Tamineh Mousavi, PhD in Rehabilitation Sciences, OT; Assistant Professor, Occupational Therapy Department.

Objectives: Increasing rates of Autism Spectrum Disorder (ASD) have changed the assessments and interventions for this disorder. People with Autism Spectrum Disorder (ASD) are more likely to experience lack of Central Human Functional Capabilities (CHFCs).

Design: Qualitative research

Setting: Shiraz, Fars, Iran.

Participants: Six parents of children with ASD.

Results: Indicate that the importance of enhancing the CHFCs of people with ASD.

Conclusions: Enhancing CHFCs can provide interventions to be effective in promoting individuals with ASD's quality of life, and help occupational therapists to consider what are these people actually able to do and to be and, what real opportunities are available to them?

Towards an affordable, portable and easy to use bimanual training device: a preliminary study.

Abbas Orand, Post-Doctoral Fellow, MENRVA Laboratory.

Objective: The objective of this study is to design and develop a bimanual training system for rehabilitation of the hemiplegics. We hypothesis that continuous bimanual training with this device can facilitate recovery (Alavi, 2015) and improve arm joints range of motion and might boost rehabilitation outcome by stimulating brain's neuroplasticity (Simona, 2017). Design & Setting Four Inertial Measurement Units (IMU) and 2 vibrating modules (VM) which are placed on wrists, elbows and shoulders of the two arms are used.

Participants & Interventions: One able-bodied individual participated in the study. The subject carried out 3 sets of tasks each for 10 times while sitting on a chair: I. Elbow Flexion and Extension: He flexed his forearms fully and extended it back to its original positions. II. Shoulder Flexion and Extension: He fully flexed both arms and

extended his arms back to their original positions. III. Shoulder Semi- Abduction and Adduction: He abducted both arms and adducted them back to their original positions.

Result: Arms' angular velocity differences were calculated from the arms angular velocities.

Conclusion: Tactile (Boian, 2003) and visual (Ramachandran, 2009) feedbacks are used for rehabilitation. In our system, users receive vibrotactile feedback when movement of one of their arms lag with respect to the other one. This bimanual device by using the feedback allows the hemiplegics to train, assists them to recover, and possibly triggers motor recovery.

References

N. Alavi, G. Herrnstadt, B.K. Randhawa, L.A. Boyd, and C. Menon. Bimanual Elbow Exoskeleton: Force Based Protocol and Rehabilitation Quantification, 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMGC), 4643-4646, 2015.

C. Simona, M Cempini, S. Mazzoleni, M.C. Carrozza, F. Posteraro, N. Vitiello. Phase-II Clinical Validation of a Powered Exoskeleton for the Treatment of Elbow Spasticity. Technology Report, 11(261), 1-10, 2017

2/2

R. F. Boian, J. E. Deutsch, C. Lee, G. C. Burdea, and J. Lewis. Haptic effects for virtual reality-based post-stroke rehabilitation. In HAPTICS'03, 247–253, 2003.

V. S. Ramachandran, and Eric L. Altschuler. The use of visual feedback, in particular mirror visual feedback, in restoring brain function. *Brain*, 132, 1693-1710, 2009.

Efficacy of fesoterodine to reduce the severity of autonomic dysreflexia in individuals with neurogenic detrusor overactivity following spinal cord injury.

Andrea Ramirez, BSc, Clinical Research Facilitator, Autonomic Research Laboratory.

Objectives: To assess the capacity of fesoterodine to reduce the severity of autonomic dysreflexia (AD).

Design: Prospective, Open-Label Phase II Study.

Setting: University Research Institute.

Participants: Seven individuals with spinal cord injury (SCI) suffering from AD and neurogenic detrusor overactivity (NDO).

Methods and Interventions: This study was approved by the UBC Clinical Research Ethics Board and Health Canada. All participants underwent the following assessments pre and

during treatment (i.e. during week 10 to 12 of treatment): urodynamics (UDS)

and 24-hour ambulatory-blood-pressure-monitoring (ABPM) to record episodes of AD; questionnaires to obtain information of quality of life related to incontinence (I-QoL). Montreal Cognitive Assessment (MoCA) Scale and Neurogenic Bowel Dysfunction (NBD) score were used to monitor potentially negative effects on cognitive and bowel function.

Main Outcome Measure: Reduction of AD and improvement of QOL in individuals with SCI.

Results: Fesoterodine reduced severity of AD (Δ SBP 34 ± 15 vs. 25 ± 16 mmHg) during UDS as well as in daily life (Δ SBP 53 ± 31 vs. 34 ± 11 mmHg). Frequency of AD in daily life decreased significantly (23 ± 20 vs. 6 ± 5 , $p=0.034$). Furthermore, UDS parameters, i.e. maximum cystometric capacity (581 ± 158 vs. 311 ± 211 mL, $p=0.018$), volume at first detrusor contraction (302 ± 98 vs. 159 ± 85 mL) and maximum detrusor pressure (13 ± 11 vs. 58 ± 37 cmH₂O, $p=0.018$) as well as QoL (I-QoL: 81 ± 27 vs. 74 ± 24) improved during treatment. Five individuals reported adverse events (all grade 1). Cognitive (MoCA) and bowel (NBD score) function did not deteriorate during treatment.

Conclusions: Interim data suggests that fesoterodine reduces AD during UDS and in daily life, while improving lower urinary tract function and incontinence-related QoL without affecting cognitive or bowel function negatively in individuals with SCI.

Motor adaptation to visual symmetry error augmentation in bimanual forward reaching.

Leia Shum, MASc student at the CARIS/RREACH Lab.

Motor rehabilitation programs based on low-cost exercise devices such as the Nintendo Wii and Microsoft Kinect have proven efficacy, and with the emergence of commercially available immersive VR technology with motion-tracked controls, further exploration into engagement in exergaming is required. Specifically, for adolescents with neurological motor disorders, finding a balance between engaging activities

and effective exercises has not been well explored. The alignment of the weak and strong sides has been previously proven to increase neuroplastic growth via the linking of cerebral hemispheres during symmetric bimanual tasks. The use of head-mounted displays allowing for full occlusion of true visual positioning could be more advantageous for error augmentation and stereoscopic 3D spatial display of symmetric differences. The main purpose of this study is to explore the effect of using immersive VR environments to manipulate visual feedback via error augmentation to encourage more symmetric reaching in hemiparetic persons. Motor adaptation rates will be analysed to evaluate the effectiveness of the visual augmentation of the location of the weaker upper limb.

Using Oculus Rift VR system, motor adaptation to horizontal symmetric error in a forward bimanual reach is used as a starting point to explore possible motor learning opportunities. Discussions on pilot study data collected from healthy participants to evaluate maximum adaptation speeds to asymmetric augmentation is presented. Adolescents and young adults with hemiplegia (i.e. due to ABI, CP, etc.) will be recruited for upcoming studies to conduct testing with a similar single-session setup to validate the system's effectiveness with the target population.

Dual-task smooth pursuit eye movement improves the diagnostic performance of pursuit in mild traumatic brain injury.

Jacob Stubbs, BKin Student, Department of Psychiatry, UBC.

Objectives: To evaluate whether smooth pursuit eye movement with a concurrent working memory task improves the diagnostic performance of smooth pursuit in mild traumatic brain injury (mTBI).

Design: Cross-sectional.

Setting: Human Vision and Eye Movement Lab, VGH.

Participants: 16 patients who received an mTBI within the past year and were still symptomatic, group-matched to 15 healthy controls.

Intervention: In randomized order within groups: Baseline working memory tasks consisting of 1-back (easy) and 2-back (challenging) colour recognition tasks; baseline smooth pursuit assessment; dual-task smooth pursuit with 1-back and dual-task smooth pursuit with 2-back task.

Main outcome measure: Smooth pursuit eye movement variability in the radial and tangential directions, as well as a metric of overall pursuit variability. Measures of diagnostic performance including ROC curves yielding areas under the curve values (AUC) and discriminative indexes (d_a').

Results: The mTBI group had higher pursuit variability than the control group across all levels of working memory load. Performing pursuit with a concurrent 1-back (easy) working memory task improved pursuit variability for both groups. Performing pursuit with a concurrent 2-back (challenging) working memory task improved pursuit in the control group but deteriorated pursuit in the mTBI group. The diagnostic performance for each pursuit variable was highest in the dual-task pursuit and working memory condition when compared with baseline (e.g. radial pursuit error at baseline AUC = 0.87, and with concurrent 2-back AUC = 0.94).

Conclusions: Dual-task smooth pursuit with a challenging working memory task may provide better diagnostic performance than smooth pursuit alone.

Acute effects of epidural spinal cord stimulation on bladder and bowel function in one individual with spinal cord injury.

Matthias Walter, Post-Doctoral Research Fellow, ICORD.

Objectives: To investigate the acute effect of epidural spinal cord stimulation (ESCS) applied to lumbosacral spinal cord on bladder and bowel function.

Design: Prospective Case Study.

Setting: University Research Institute.

Participant: A 32-year-old man, suffering from autonomic dysreflexia (AD), neurogenic bladder and bowel dysfunction following his SCI (C5, AIS B), provided his written informed consent.

Methods and Interventions: This study was approved by the University of British Columbia Clinical Research Ethics Board. Subject recorded the duration (minutes) required for bowel evacuation with and without ESCS and completed the standardized, validated questionnaire 'Neurogenic Bowel Dysfunction (NBD) Score'. Urodynamic investigation (UDI), the gold standard to assess bladder function, was performed along with surface external anal sphincter/pelvic floor electromyography (EMG) with and without ESCS while continuously recording blood pressure (BP) and heart rate.

Main Outcome Measure: Acute effect of ESCS on bladder and bowel function.

Results:

Depending on stimulation parameters and electrode configuration, ESCS effected bladder and bowel to various degrees. Acute ESCS reduced the time required for bowel routine by >80% and improved NBD Score. Specific ESCS configurations increased EMG signal and detrusor pressure, while other configurations had more modest or no effects. While ESCS was applied, no changes in cardiovascular parameters (i.e. BP and heart rate) were detected.

Conclusions:

Our preliminary data indicate for the first time, that acute lumbosacral ESCS has capacity to activate spinal cord circuits that affect bladder and bowel function in individuals after chronic motor complete SCI without eliciting episodes of AD.

Novel Predictors of Spinal Cord Injury Outcomes.

Anh Khoa Vo, MSc, ICORD.

Background: Traumatic spinal cord injury (SCI) is characterized by extensive heterogeneity in recovery, with very few predictors of long-term outcome. Prior studies have proposed biomarkers that can improve the prognosis and diagnosis of acute SCI. However, these studies only focused on individual biomarkers, which may not capture the complex nature of SCI.

Objective: To identify a novel set of predictors that can aid in the early diagnosis and prediction of outcomes after SCI.

Method: This was a retrospective analysis of the completed clinical Sygen trial, which tested the efficacy of GM-1 (monosialotetrahexosylganglioside) in acute SCI. A total of 42 serological biomarkers were analyzed using Factor Analysis. Other covariates: sex, age, spinal level injury, and American Spinal Injury Association Impairment Scale (AIS) grades, were included in the analysis. Outcomes included Lower Extremity Motor Scores (LMES), marked recovery (2 grades improvement from the baseline AIS grades), and survival.

Results: Patients who are not anemic (higher values of Blood factor – composite of red blood cells count, hemoglobin, and hematocrit) was significantly associated with 1.05 LEMS increase and 29% odds of marked recovery, independent of sex, age, spinal level injury, and AIS grades. In addition, lower values of "Liver Factor" was significantly associated with 48% odds of death, but higher values of "Kidneys Factor" were significantly associated 23% odds of death.

Conclusion: At emergency, a composite of red blood cells, hemoglobin, and hematocrit can be used as an independent predictor for motor recovery, whereas liver and kidney enzymes serve as independent predictors of death.

EEG neurofeedback as a potential therapy for Parkinson's disease symptoms.

Emma Kiss, BSc, Research Assistant, Pacific Parkinson's Research Centre, UBC.

Electroencephalographic (EEG)-neurofeedback has been used in recent research as a non-invasive, non-pharmacological treatment option for a number of different disorders, such as epilepsy¹ or ADHD², as well as to optimize performance in healthy participants³. PD behavioural and cognitive symptoms may be well-suited for EEG neurofeedback therapy, as new research has documented the ability of PD patients to perform neurofeedback using other technologies. Further, pathological oscillatory abnormalities^{4,5} unique to PD EEG have been

linked to common PD symptoms (such as rigidity and bradykinesia⁶). EEG was recorded from 4 participants with PD and 10 healthy controls (HC) at rest and during modulation using a dry, wireless EEG headband with 6 electrodes (Cognionics, USA). This data was sampled at 500Hz, de-trended, bandpass filtered at 0-50Hz, and eyeblink artefacts were removed before common spatial patterns (CSP) were applied and powers calculated for each strategy and bandwidth. CSP was used to find the combination of electrodes that maximizes the variance in the modulation data while minimizing that of the rest data. This data was separated into 2 models of EEG; one representative of PD patients, and the other representative of HC. PD participants were able to change the power of various bandwidths of their EEG using modulation strategies including imagining movement, imagining rewards and practicing mindfulness meditation. Our results suggest that PD subjects are able to effectively manipulate their EEG and that CSP is an effective preprocessing strategy for EEG based neurofeedback. Further work is required to determine optimal modulation strategies and if EEG normalization translates into behavioural or cognitive improvement.

References

- Tan, G., Thornby, J., Hammond, D. C., Strehl, U., Canady, B., Arnemann, K., & Kaiser, D. A. (2009). Meta-Analysis of EEG Biofeedback in Treating Epilepsy. *Clinical EEG and Neuroscience*, 40(3), 173–179.
<http://doi.org/10.1177/155005940904000310>
- Hillard, B., El-Baz, A. S., Sears, L., Tasman, A., & Sokhadze, E. M. (2013). Neurofeedback Training Aimed to Improve Focused Attention and Alertness in Children With ADHD. *Clinical EEG and Neuroscience*, 44(3), 193–202.
<http://doi.org/10.1177/1550059412458262>
- Hammond, C., Bergman, H., & Brown, P. (2007). Pathological synchronization in Parkinson's disease: networks, models and treatments. *Trends in Neurosciences*, 30(7), 357–364.
<http://doi.org/10.1016/j.tins.2007.05.004>
- Timmermann, L., & Florin, E. (2012). Parkinson's disease and pathological oscillatory activity: Is the beta band the bad guy? — New lessons learned from low-frequency deep brain stimulation. *Experimental Neurology*.
<http://doi.org/10.1016/j.expneurol.2011.10.022>
- Dostrovsky, J., & Bergman, H. (2004). Oscillatory activity in the basal ganglia--relationship to normal physiology and

pathophysiology. *Brain*, 127(4), 721–722.

<http://doi.org/10.1093/brain/awh164>

Zoltan K.J., Michael L.S., & Steven Z.Z. (1990). Spatial patterns underlying population differences in the background EEG. *Brain topography*, 2(4), 275-284, 1990.
<https://doi.org/10.1007/BF01129656>

The Effects of Gabapentinoids on Neurological Recovery after Spinal Cord Injury

Freda Warner, MSc, ICORD.

A study using a large, prospective, multi-centre, cohort (the European Multi-Center Study about Spinal Cord Injury [EMSCI]) was previously conducted to investigate the effects of pain medications after spinal cord injury. This cohort analysis revealed an association between anticonvulsants and improved motor recovery. Anticonvulsants are a broad category of drugs, many of which are frequently administered after spinal cord injury for disorders including neuropathic pain. Upon closer inspection, the data revealed that this effect was driven largely by the early administration of a specific anticonvulsant group, gabapentinoids, and corroborated with recent preclinical discoveries. To further explore this association, we conducted a case review of new patient charts from the EMSCI database and gathered specific information on timing and dosing of drug administration. This examination has continued to reveal the beneficial effects of gabapentinoids, and the specificity of early administration. Together, these findings support the conclusion that gabapentinoids are a unique anticonvulsant that may enhance motor function after spinal cord injury, and that intervention with gabapentinoids represents a potential drug repurposing strategy to improve neurological recovery after spinal cord injury.