

## Podium Session One:

### 0905 Abstract 1

**The Spinal Cord Injury Rehabilitation Evidence (SCIRE) Project** - Purpose and future in evidence-based practice. Mathew Queree, Rehabilitation Research Laboratory.

The Spinal Cord Injury Rehabilitation Evidence (SCIRE) Project is dedicated to providing up-to-date, accurate information about the effects of rehabilitation for people with SCI. We review and rate the research on spinal cord injury and put the results on the web – eliminating your need to search and screen individual databases. The speaker will present the history of the project, statistics from website analytics and project evaluation, and aspects of the website ([www.scireproject.com](http://www.scireproject.com)) to participants. The presenter will also engage the audience in discussion regarding clinical utility, purpose and future directions of the SCIRE Project.

### 0918 Abstract 2

**Incremental cost of notable spinal cord injury complications in Canada's healthcare system.** Barry White, Health Economist, Rick Hansen Institute

**Objective:** Illustrate the hospital costs attributable to urinary tract infections (UTIs) and pressure ulcers (PUs) in traumatic-SCI (tSCI) admissions at a specialized spine center in Canada and discuss in the context of prevailing estimates.

**Design:** A matched case-control methodology is employed to estimate the incremental costs of hospital-acquired UTIs and PUs. Mutually exclusive subgroups of patients enrolled in the Rick Hansen Spinal Cord Injury Registry are defined to explore the cost of the notable Spine Adverse Events Severity instrument documented complications.

**Setting:** Acute spine quaternary referral center in Vancouver, British Columbia.

**Participants:** Eligible tSCI patients who experienced one or more UTIs and no other documented complications were matched to patients who experienced no complications. Similarly, tSCI patients who experienced one or more PUs and perhaps other complications were matched to tSCI patients who did not experience PUs but perhaps experienced other complications. Total acute costs were retrieved for 10 and 15 nearest pairs from the

UTI and PU strict/probabilistic matching process, respectively (n=50).

**Main Outcome Measure:** The incremental costs of UTIs and PUs in eligible tSCI admissions were assessed using calculated total costs from admitting hospital finance formulas.

**Results:** The incremental cost of hospital-acquired UTIs is estimated to be \$7,709 and UTIs were determined to add on average 6.8 days to length of stay (LOS). The mean difference in acute hospital costs between accepted pairs with and without PUs described as complications requiring minor non-invasive treatment is estimated to be \$18,758 and recorded PUs added on average 15.8 days to LOS.

**Conclusions:** In terms of understanding the cost of complications in tSCI admissions and establishing evidence of the economic benefits of informed interventions and/or policies to avert complications, the analysis illustrates the potential in utilizing information from a comprehensive SCI registry (including SCI specific data and systematically documented hospital complications) and hospital costs from existing finance formulas. Robust evidence of the incidence and economic burden of secondary complications across the continuum of care is required to inform decisions concerning the delivery of care to SCI patients in Canada. A potential consequence of insufficient evidence is under investment and/or misplaced investment in established and emerging SCI interventions and/or therapies for SCI patients.

### 0931 Abstract 3

**Impaired cerebrovascular health in experimental spinal cord injury: the role of autonomic dysreflexia.** Aaron Phillips, Postdoctoral Fellow, ICORD

Autonomic dysreflexia (AD) is a life-threatening ephemeral episode of extreme hypertension occurring on a on average 11 times/day in individuals with high-level spinal cord injury (SCI). Although severe, usually-unmanaged, single episodes of AD can lead to cerebral hemorrhage, we do not understand the impact of chronic AD exposure on cerebrovascular health or cognitive function. Fourteen days post-complete T3 SCI rats were randomized to receive ether colorectal distension to induce AD (SCI+CRD n=7) or normal care (n=6). At 42 days post-SCI middle cerebral artery (MCA) structure and function was assessed ex vivo using pressure myography, and spatial acquisition and memory were assessed using Morris water maze. SCI+CRD rats exhibited reductions in MCA endothelium-dependent dilation assessed using carbachol (-36% at 10-5 M, P=0.04),

and distensibility (-24% at 80 mmHg,  $P < 0.0001$ ). Myogenic tone was not different between groups. Additionally, spatial acquisition was impaired in SCI+CRD (i.e., +18% duration and distance to platform on day 4 training, both  $P = 0.049$ ). We demonstrate for the first time that chronic exposure to AD results in detrimental changes in cerebrovascular health. Specifically, AD exposure was associated with impaired cerebrovascular function and cognitive deterioration in animals with SCI.

**0944** **Abstract 4**

**Physical activity during inpatient SCI Rehabilitation.** Dominik Zbogar, PhD Student, Rehabilitation Research Laboratory.

**0957** **Abstract 5**

**A new method to quantify lower extremity kinesthesia deficits using a robotic exoskeleton in people with a spinal cord injury.** Amanda Chisholm, Postdoctoral Fellow, ICORD.

**Objective:** The purpose of this study was to establish the validity and reliability of a robotic assessment tool to measure lower limb kinesthesia in people with spinal cord injury (SCI).

**Design:** Cross-sectional.

Setting: Canadian research laboratory.

**Participants:** Seventeen individuals with an incomplete SCI and seventeen age-matched controls completed two assessments, separated by at least one week.

**Intervention:** A lower limb robotic exoskeleton was used to quantify the amount of displacement bilaterally for the hip and knee joints. Four movement speeds (0.5, 1.0, 2.0, 4.0°/s) were applied to a 10° maximum displacement. The movement onset was randomly delayed. Catch trials were used randomly throughout the test. Participants pressed a joystick button when movement was felt, and indicated the direction of movement. A manual assessment was also performed bilaterally for the hip and knee joints.

**Main Outcome Measure:** We calculated a score by dividing the degree of displacement by 10 and adding 1 or 0 for an incorrect or correct response to the movement direction, respectively.

**Results:** The score was significantly higher in people with SCI compared to the control group. Kinesthesia scores with the robotic-based and manual tests demonstrated negative correlations ( $r = -0.47$  to  $-0.86$ ,  $p < 0.05$ ). Our score showed high test-retest reliability (ICC  $> 0.90$ ,  $p < 0.001$ ) and good internal consistency (Cronbach's alpha 0.87-0.95).

**Conclusions:** Our findings show that our robotic-based method is a valid and reliable measure of lower limb kinesthesia. This work is important for improving our ability to objectively monitor and track changes in sensory function following SCI.

## Podium Session Two:

**1045** **Abstract 6**

**From mouth to anus: obstacles in bowel function after spinal cord injury.** Mincheol Joo, Visiting Scientist, ICORD.

**Background:** Spinal cord injury (SCI) significantly impacts bowel function, resulting in decreased gut motility, constipation, and fecal incontinence. Unfortunately, in addition to the neurological injury (e.g. autonomic and motor/sensory dysfunctions), other factors could play a significant role in bowel dysfunction following SCI (e.g. medications, diet, immobility or other factors).

**Objective:** To identify the bowel habits and factors influencing bowel function during the acute period of rehabilitation following SCI.

**Methods:** Retrospective chart analysis of individuals with SCI admitted for acute rehabilitation to GF Strong Rehabilitation Centre over a one-year period was performed. Data were obtained at one-week post-admission and prior to discharge. Data included: patient demographics, SCI level/severity (American Spinal Injury Association Impairment Scale), bowel habits and protocols (e.g. Bristol Stool Form Scale, BSFC), and medications that could affect bowel routine (e.g. opioids, anticholinergics, laxatives, etc.).

**Results:** A total of 93 individuals (51±18.6 years) with SCI were identified (47% cervical SCI; 43% motor-complete SCI). In all identified individuals, a bowel protocol was initiated. Frequency of digital stimulation (2.34±1.15 versus 2.12±1.33,  $p \leq 0.05$ ) and disimpaction as bowel routine (43 versus 20,  $p \leq 0.0002$ ) were reduced prior to discharge. Frequency of bowel movements per week increased between admission and discharge (3.5±2.0 vs. 4.2±1.2,  $p \leq 0.01$ ), while stool consistency (BSFS) was unchanged (3.9±1.7 vs. 3.8±1.0,  $p = 0.453$ ). There was a significant decrease in the number of individuals who were taking opioids at the time of discharge (47±1.7 % vs. 27±1.3 %,  $p \leq 0.01$ ) and laxatives (92.5±2.2% vs. 85±1.9%,  $p \leq 0.01$ ).

**Discussion:** There were noticeable changes in bowel routine among individuals with SCI during the acute rehabilitation. Neurological recovery, decrease in opioids, and learning skills on management of

neurogenic bowel probably were among major factors that influenced recovery of bowel function.

**1058** **Abstract 7**

**Pilot study of a peer-led wheelchair training program to improve self-efficacy using a manual wheelchair: A randomized controlled trial.** Krista Best, Postdoctoral Fellow, CIRRISS and Grant Huston, Physiotherapist/Clinical Instructor, GFS

**Objective:** The primary objective was to evaluate the effect of a peer-led wheelchair training program on self-efficacy for manual wheelchair (MWC) use. Secondary outcomes were to explore influences of the intervention on MWC skills, life-space mobility and satisfaction with participation.

**Design:** Pilot randomized controlled trial

**Setting:** Rehabilitation centre and community

**Participants:** Community-living, MWC users, mean age 49y, 21% female.

**Interventions:** The experimental group (n=16) received 6, 1.5 hour sessions of a peer-led self-efficacy enhanced wheelchair training program (WheelSee). Peer-trainers administered WheelSee to a pair of MWC users, but the program was individualized based on individualized goals. The control group (n=12) did not receive any intervention.

**Main Outcome Measures:** The primary outcome, wheelchair use self-efficacy, was assessed using the Wheelchair Use Confidence Scale (WheelCon 3.0). Secondary outcomes included wheelchair skills capacity and performance (Wheelchair Skills Test-Questionnaire (WST-Q 4.1)), life-space mobility (Life-space Assessment (LSA)), and satisfaction with participation (Wheelchair Outcome Measure (WhOM)).

**Results:** Controlling for baseline scores, analysis of co-variance revealed that WheelSee had a large statistically significant effect on MWC use self-efficacy (Cohen's d=1.4, p=0.002). WheelSee also had a large statistically significant effect on MWC skills capacity (Cohen's d=1.3, p=0.003) and performance (Cohen's d=1.0, p=0.02). There were no statistically significant differences between the groups for life-space mobility or satisfaction with participation.

**Conclusion:** A peer-led MWC training program improves wheelchair use self-efficacy in adult MWC users, and had a positive influence on other wheelchair-related outcomes. WheelSee may offer a promising intervention strategy to accommodate the

training needs of community-living manual wheelchair users.

**1111** **Abstract 8**

**Home-GRASP: A novel upper limb exercise program for individuals post stroke.** Lisa Simpson, PhD Student, Rehabilitation Research Laboratory.

**Background and Objective:** The majority of individuals with stroke will experience difficulties using their affected upper limb. With lengths of rehabilitation stays continuing to decrease, novel home treatments may fill a need for continued upper limb rehabilitation. The purpose of this study was to evaluate the effect of an arm and hand exercise program undertaken at home with monitoring and motivation provided by phone.

**Methods:** We modified the original GRASP (Graded Repetitive Arm Supplementary Program) protocol for use in a home setting. Participants completed the 8-week exercise program and were monitored weekly by therapists over the phone. Behavioural strategies were utilized to promote greater use of the affected upper limb. A single group repeated measure design was utilized: two baseline assessments separated by one month; post treatment and two follow up assessments (3 months and 6 months post treatment). Outcomes included: the Chedoke Arm and Hand Inventory, Motor Activity Log, grip strength and the Canadian Occupational Performance Measure.

**Results:** Eight individuals with stroke (mean 66 years and 273 days post stroke) with mild to moderate upper limb dysfunction were recruited. Participants were stable across the baseline period. Statistically significant improvements with the following effect sizes were observed for all four outcome measures after the 8-week program: CAHAI (effect size, p-value; 0.482, p=0.046); MALQ (0.958, p=0.03) grip strength (0.801, p=0.046); COPM (0.939, p=0.03). Improvements were maintained at three and six month follow ups. All but one of the participants who completed the 8 week program met the exercise target of 60 minutes/day, 6 days/week.

**Conclusions:** Community dwelling individuals with stroke may benefit from a phone-monitored upper limb home exercise program that includes behavioural strategies that promote transfer of exercise gains into daily upper limb use.

**1124** **Abstract 9**

**A systematic review and meta-analysis on self-management for improving risk factor control in**

**stroke patients.** Brodie Sakakibara, Postdoctoral Fellow, Rehabilitation Research Laboratory

**Objectives:** Improving risk factor control in stroke patients is warranted because many individuals continue with lifestyle behaviours that may have contributed to their initial stroke. The objectives of this review are to describe the self-management interventions used to improve stroke risk factor control, and quantitatively assess their effects on: 1) behavioural risk factors (physical activity, diet and nutrition, stress management, smoking, alcohol, medication adherence); and 2) risk factors related to medical conditions (blood pressure, cholesterol, blood glucose).

**Methods:** A systematic search of the PubMed, PsycINFO, CINAHL, and Cochrane Database of Systematic Reviews databases was employed to identify all relevant randomized controlled trials investigating self-management at improving risk factor control in stroke patients. The self-management programs were qualitatively described, and the data included in meta-analyses. Subgroup and sensitivity analyses tested the robustness of the results.

**Results:** To date, fourteen studies have been identified and included for review. No study tested the effects on stress management. Preliminary analyses indicate that at the individual risk factor level, self-management programs have a statistically significant medium sized effect at improving medication adherence. After removing four low quality studies, the sensitivity analysis revealed a statistically significant effect on blood pressure, and overall risk factor control.

**Discussion:** Preliminary analyses have resulted in mixed findings on the effectiveness of self-management programs at improving risk factor control. At the individual risk factor level, self-management programs were shown to be effective at improving two of eight stroke risk factors. However, that self-management programs appear to reduce the risk of stroke at the composite level, interventions that target multiple health behaviours may be more relevant than unilateral approaches because unhealthy behaviours tend to cluster together.

**1137** **Abstract 10**  
**Power mobility assessment and training: successes and opportunities.** Emma Smith, PhD Student, Rehabilitation Research Laboratory.

The objective of this qualitative study was to describe current powered mobility assessment and training

practices in British Columbia, and identify relevant themes to inform future practice and research.

**Design:** Semi-structured qualitative interviews were conducted with 15 occupational or physical therapists who provide powered mobility assessment and training across multiple practice areas and health regions. Practice settings included acute care, rehabilitation, community care, and residential care. All participants had a minimum of 2 years clinical experience in powered mobility provision. Purposive sampling was conducted to ensure maximal theoretical variability.

**Methods:** Participants were asked to complete a semi structured interview focused on their current and former clinical practice in the provision of powered mobility. Interviews were conducted by an Occupational Therapist with experience in the area, and an Engineer involved in the design of technologies to be used in practice. Interviews were transcribed and coded for thematic analysis.

**Results:** The majority of assessment in powered mobility is informal, with few formal assessments used on a regular basis. Training is limited by time and practice environments. Preliminary themes include “Assessment is Training,” “Never say No,” and “It Depends.”

**Conclusions:** Current assessment and training for powered mobility skills in British Columbia are limited by time and resources in all settings. Therapists are client centred in their approaches, with integrated assessment and training practices, with no consistent assessment or training methods used across client groups or settings.

## Podium Session Three:

**1305** **Abstract 11**

**The relationship between sleep, fatigue, pain, and depression in people with spinal cord injury.** Kyle Diab, MSc Student, Department of Occupational Science & Occupational Therapy.

**Objectives:** Despite sleep issues being highly prevalent with SCI, they are currently under-evaluated in clinics. Having a clear understanding of the relationships between sleep and other conditions will help direct treatment decisions for clinicians. Our objective is to examine the relationship between sleep problems, fatigue, pain, and depression in adults with SCI while controlling for the effects of age, sex, level of injury, and completeness of injury.

**Design:** Cross-sectional survey.

**Setting/Participants:** This study is a secondary analysis of data collected in Seattle, Washington and Atlanta, Georgia from 620 community-dwelling adults living with a self-reported SCI.

**Interventions:** None

**Main Outcome Measures:** Main outcome measures included the Medical Outcomes Study Sleep Scale, the Fatigue Severity Scale, the Brief Pain Inventory, and the Patient Health Questionnaire-9.

**Results:** Hierarchical multiple regression analysis was performed to examine the relationship between sleep problems (dependent variable) and fatigue, pain, and depression (independent variables) after controlling for the influence of age, sex, level of injury, and completeness of injury. The overall model explained for 46.2% of the variance in sleep problems and was shown to be statistically significant ( $p < .001$ ). Additionally, age ( $\beta = -.117$ ), fatigue ( $\beta = .098$ ), pain ( $\beta = .269$ ), and depression ( $\beta = .393$ ) all made a unique statistically significant contribution to the model ( $p < .05$ ).

**Conclusions:** This study highlights the importance of understanding the complexity of sleep, and its common co-occurrence with fatigue, pain and depression. Treatment plans must be adjusted to a multi-pronged approach in order for clinicians to effectively manage the secondary conditions associated with SCI.

### **1318** Abstract 12

**A longitudinal perspective on messages in social media: CCSVI and MS as an example.** Sinéad Hynes, Postdoctoral Research Fellow, Department of Occupational Science & Occupational Therapy

**Objectives:** To determine if people with MS were still reporting benefits of CCSVI treatment on social media, and if perspectives on CCSVI have changed in recent years

**Data Sources:** Videos were sourced from Youtube.com between August 2011 and December 2014.

**Data Selection:** Videos included were related to MS and CCSVI, in English and involved a person with MS. Conference proceedings, television, radio programmes and promotional videos were excluded.

**Data Extraction:** 1269 videos related to CCSVI were uploaded by people with MS. One video per person, on the impact of CCSVI treatment, was included leaving 50 videos that met the inclusion criteria.

**Data Synthesis:** 64% were positive of the treatment; 14% were negative; 12% were neutral and 10% were not classified. Although people are positive when

reporting on specific symptoms the overall commentaries given were not always supportive of the treatment: "The first two months were quite good and then it got worse and worse." Very little long-term data was available. 34% of the participants sampled are now recommending alternative treatments to CCSVI which include diet change, stem cell transplant and homeopathic treatment.

**Conclusion:** The overall messages that came from the videos were on whole positive. There appears to be an inconsistency, however, between positive results, actual improvements in symptoms, and in many cases the overall message being reported. Participants' expectations of the treatment appear to have diminished as the longer-term results have been scant and in many cases disappointing. Many participants are now suggesting other treatments.

### **1331** Abstract 13

**Clinicians with disabilities: is my profession accessible?** Laura Bulk, Occupational Therapist, Sahara Rehab

**Introduction:** Policymakers articulate the right to equitable access to occupational opportunities for individuals with disabilities [1]. Nevertheless, individuals with disabilities remain underrepresented in universities, are more likely to drop out than students without disabilities, and experience higher unemployment rates [3,4,5]. These inequities are especially pronounced in health and human service (HHS) programs, which creates an occupational injustice by limiting engagement within school and work. Moreover, this hinders the development of a population of HHS professionals who accurately represent the diversity of the society that they serve.

**Methods:** In-depth interviews were conducted with 12 students in HHS programs who identified as having a disability to explore the challenges and facilitators they experienced.

**Results:** Students had to legitimate their ability to perform the roles of student and future practitioner, a process involving negotiation of the disability label, selective disclosure, and advocacy.

**Discussion:** Our findings demonstrate how subtle and insidious forms of marginalization and stigmatization work to create barriers and challenges for individuals with disabilities, and consequently, a mechanism through which occupational choice is limited.

**Contribution to Knowledge:** Understanding the experiences of students with disabilities in HHS programs will help inform researchers and policymakers regarding how to improve existing structures and processes in order to facilitate the participation of students with disabilities. This will

help students thrive within universities, thereby improving their occupational health and well-being, as well as ultimately increasing the diversity of the future clinical population. Individuals at GF Strong can benefit from learning from this project, as the professionals at GF serve as preceptors for students in HHS programs, work with individuals who have disabilities who might be interested in pursuing HHS careers, and are HHS professionals who can advocate for inclusion of persons with disabilities.

#### References

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**1344** **Abstract 14**  
**EEG-Driven exoskeleton for upper extremity rehabilitation.** Ahmed Elnady, Engineering Sciences, Simon Fraser University

Stroke impairs individuals to perform activities of daily living [1]. Stroke rehabilitation offers hope to regain full or partial motor skill activities, but it often lacks intensity due to the cost of the required human resources [2]. In order to reduce the cost and enhance the quality of stroke rehabilitation, researchers around the world have been focusing on robotic rehabilitation [3]. Studies have shown that the exercises requiring the patient's own effort to initiate the motion have better outcomes than the passive robot assisted exercises [4]. Recent research suggests that mental exercises using BCI can induce neuroplasticity, which is particularly important for individuals with stroke [5]. Electroencephalography (EEG) is the most commonly used method for BCI due to its non-invasive nature. Here we proposed a novel EEG-driven exoskeleton system for upper limb rehabilitation application. The exoskeleton has 4 DOF of control. It was designed in a modular fashion to maximize its practicality for different rehabilitation tasks. It consists of two modules, the

elbow-forearm module and the wrist module. Each module can be used independently. It allows independent control of the following movements: elbow flexion/extension, forearm pronation/supination, wrist flexion/extension and ulna/radial deviation. Each movement can be driven by user's own thought at one instance. An experiment was designed to assess if a healthy volunteer can operate the system with ease. The result of the experiment shows the system can correctly distinguish between a conscious thought and the volunteer's neutral state and the system can use this information to drive different movements of the exoskeleton.

#### References

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**1357** **Abstract**  
**15**

**Using functional brain connectivity to characterize recovery from sports related concussion.** Shaun Porter, MSc Student, Rehabilitation Sciences, UBC.

**Objectives:** Measurement of brain signals at rest is a powerful tool to map the functional connectivity of the brain in healthy and disease/injury states. The purpose of our study is to use resting state brain signals combined with tools from graph theory to evaluate changes in brain network properties in adolescents who are recovering from sports related concussion.

**Design:** Adolescents diagnosed with acute concussion were evaluated within 1-week of concussion and 1-month post-concussion.

**Setting:** Research laboratory.

**Participants:** 10 healthy adolescent athletes and 6 recently concussed adolescent athletes.

**Intervention:** None

**Main Outcome Measure:** Global and local graph theory measures derived from resting state electroencephalography (EEG) data. All participants were also evaluated using the Sport Concussion Assessment Tool (SCAT3 or Child SCAT3).

**Results:** Functional brain networks of both groups showed small-world topology with no statistically significant differences in the global metrics.

However, we observed significant differences in the local metrics in frontal electrodes sites. Specifically we found a large increase in values of degree, betweenness, hub value, and authority at 1-week post injury in comparison with the control group. These values decreased at 1 month but remained higher than in the control group.

**Conclusion:** Our preliminary results suggest that there is increased functional brain connectivity in the frontal regions following concussion that begins to return to baseline after 1 month. These results show the potential for using resting state functional brain connectivity as a means of assessing recovery from concussion.

## Podium Session Four:

### 1500 Abstract 16

**The effect of transcranial electrical stimulation on orthostatic hypotension following traumatic cervical spinal cord injury: a pilot study.** Darren Gray, Resident in Physical Medicine and Rehabilitation, UBC.

**Design:** Prospective case series.

**Objective:** To determine the feasibility of a protocol designed to assess transcranial electrical stimulation (TES) for treatment of orthostatic intolerance secondary to cervical spinal cord injury (SCI). A secondary objective was to produce preliminary data on the effect of TES on orthostatic BP.

**Setting:** GF Strong

**Methods:** Four adults (age 18-64 yrs) undergoing inpatient rehabilitation for traumatic cervical SCI, with orthostatic intolerance confirmed by Sit-up Test.

**Intervention:** Six sessions of 30 minutes of TES were delivered over 2 weeks. Sit-up Tests were performed immediately before the 1st TES session, during the 1st TES session, immediately after the 6th TES session, and at 3 weeks follow up.

**Main Outcome Measure:** Maximum postural change in systolic BP, and diastolic BP, was calculated for all Sit-up Tests.

**Results:** Over one year four patients met full inclusion criteria, all of whom were successfully

recruited, with no drop outs or adverse events. The primary outcome was successfully collected for 88% of data collection time points. Preliminary data showed amelioration in the drop of SBP from -23.4 mmHg ( $\pm 4.6$ ) at baseline to -18.9 mmHg ( $\pm 5.7$ ) with the use of TES. None of the results reached statistical significance.

**Conclusion:** The protocol was feasible and safe in this sample population. Preliminary data demonstrated an immediate effect of TES with amelioration in the maximum drop in SBP and DBP below the clinical definition of OH. Further research is required to determine whether individuals with SCI and OH could benefit from TES.

### 1513 Abstract 17

**Botulinum neurotoxin injection techniques for the treatment of limb spasticity: a systematic review.**

Aaron Chan, Resident in Physical Medicine and Rehabilitation, UBC.

**Objective:** To systematically review the literature on botulinum neurotoxin (BoNT) injection techniques used for limb spasticity.

**Methods:** Data Sources: MEDLINE, EMBASE, CINAHL, and Cochrane Central Register of Controlled Trials electronic databases were searched for English language human randomized controlled trials (RCTs) from 1990 to April 2014. Data **Extraction:** Studies were assessed in duplicate for data extraction and risk of bias using the Physiotherapy Evidence Database (PEDro) scale and graded according to Sackett's levels of evidence.

**Results:** Eight of 249 studies screened met selection criteria. Four categories of BoNT injection techniques were identified: 1) Injection site localization; 2) Injection site selection; 3) Injectate volume; 4) Injection volume and site selection. There is level 1 evidence that: ultrasound (US) is more accurate than electrostimulation (ES) when injecting the lateral gastrocnemius specifically; US is equivalent in efficacy to ES in wrist/finger flexors; electromyography has better efficacy than manual needle placement; endplate injections improve outcomes versus multisite quadrant injections; motor point injections are equivalent to multisite injections; effects of high volume and low volume injections are similar; high volume injections distant from the endplate are more efficacious than low volumes closer to the endplate. All findings are based on single RCTs.

**Conclusion:** Level 1 evidence exists for differences in accuracy and treatment outcomes using specific BoNT injection techniques. Findings are based on

single studies that require independent replication and further study.

**1526** **Abstract 18**

**Interdisciplinary spasticity management clinic - outcomes using the Goal Attainment Scale: a retrospective chart review.** Amy Hanlan, Resident in Physical Medicine and Rehabilitation, UBC.

**Objective:** To describe the elements and outcomes of an interdisciplinary spasticity management clinic.

**Design:** Retrospective chart review.

**Setting:** Interdisciplinary Spasticity Management Clinic at a tertiary rehabilitation hospital.

**Participants:** 225 adult patients referred for spasticity management and returned for follow up after initial consultation, between 2010 and 2013.

**Interventions:** Treatment strategies include occupational and physical therapies, orthoses, oral medications and focal chemodenervation with botulinum neurotoxin (BoNT) and phenol.

**Outcome Measure:** Goal Attainment Scale (GAS).

**Results:** The most common etiology of spasticity was stroke (31.6%). The average age was 47.8 years with 50.2% female. The most common referral source was a specialist physician (43.1%). The distribution of GAS outcomes did not vary by diagnosis, age or gender. The overall GAS T-Score for the clinic was 47.7. T-scores did not vary by diagnosis or International Classification of Functioning, Disability and Health (ICF) domain. Significant intervention effects were identified for BoNT with improvements in GAS T scores for treatment targeted to both upper (mean 50.01, 95% confidence interval 48.01-52.00,  $P < 0.001$ ) and lower (mean 48.86, 95% confidence interval 47.21-50.52,  $P < 0.001$ ) limb muscles compared with no BoNT, across diagnoses and ICF domains.

**Conclusion:** We have provided an example of an interdisciplinary approach to spasticity management. The GAS is a useful patient-centred outcome measure in a heterogeneous population with diverse goals. BoNT treatment in this setting was associated with improved goal attainment for both upper and lower limb spasticity relating to multiple ICF domains.

**1539** **Abstract 19**

**Computerized analysis of equinus gait in children with Cerebral Palsy.** Nicola Hahn, Resident in Physical Medicine and Rehabilitation, UBC.

**Objectives:** To describe equinus gait kinetics and kinematics and variation of these measures in two

specific age groups of children with spastic diplegic cerebral palsy.

**Design:** A retrospective, observational study.

**Setting:** A gait analysis laboratory gait in an academic health facility.

**Participants:** Forty one children with spastic diplegic cerebral palsy and equinus gait (20 aged 6-8 years, 21 aged 11-13 years).

**Interventions:** None (descriptive, observational study).

**Main Outcome Measure:** Three-dimensional computerized analysis of gait.

**Results:** Most children were in Gross Motor Function Classification Level II. Typical features of equinus gait and early crouch gait were seen in both age groups. Prior interventions for gait management were common, particularly bracing and botulinum toxin injections. All children had bilateral hamstrings tightness with increased popliteal angles. Plantarflexion contractures at the ankle were rare (one single unilateral contracture in older age group). Large standard deviations for most objective measures of gait were found in both groups, particularly in sagittal plane kinematics at the ankle.

**Conclusions:** Gait in children with spastic diplegic cerebral palsy is highly variable. Despite efforts to select populations with narrow age ranges and specific subtypes of cerebral palsy, the many different contributors to abnormal gait in these children result in heterogeneous populations for research. Researchers, clinicians, therapists and parents must use caution in applying evidence from population studies in management of equinus gait in an individual patient.

**1552** **Abstract 21**

**Prediction of spasticity outcomes following traumatic spinal cord injury utilizing Rick Hansen Spinal Cord Injury Registry.** Kaila Holtz, Resident in Physical Medicine and Rehabilitation, UBC.

**Objective:** To quantify and characterize spasticity following traumatic spinal cord injury (SCI). Predictors of spasticity and its relationship between long-term outcomes including community integration and quality of life will be explored. We hypothesize: 1) spasticity is predicted by the level and completeness of SCI, and 2) more severe spasticity on hospital discharge to the community will correlate with worse long-term outcomes.

**Design:** Retrospective cohort registry and chart review.

**Setting:** Tertiary acute and rehabilitation hospitals, community. **Participants:** Patients admitted with a SCI between 2005 and 2013 to Vancouver General

Hospital and enrolled in the Rick Hansen Spinal Cord Injury Registry.

**Intervention:** None.

**Outcome Measures:** ASIA Impairment Scale (AIS), spasticity medications, Penn Spasm Frequency Scale (PSFS), Community Integration and Quality of Life Questionnaires.

**Preliminary Results:** Utilizing the presence of spasticity medications and PSFS on discharge to the community, subjects (n=90) were categorized into 1 of 5 spasticity categories: 1) no spasticity (PSFS=0), no medication (n=35, 39%); 2) no spasticity, on medications (n=0); 3) spasticity (any level, PSFS  $\geq$ 1), no medications (n=32, 36%); 4) spasticity (PSFS  $\leq$  2), on medications (n=8, 9%); 5) spasticity (PSFS  $\geq$  3), on medications (n=10, 11%); incomplete data (n=5, 6%).

**Conclusions:** Future directions include creating a predictive model for spasticity outcomes based on level and severity of SCI and spasticity category. This will facilitate identification of patients at higher risk for developing severe, problematic spasticity in the sub-acute and chronic phases of SCI.

#### **1605 Abstract 21**

**Impact of Critical Illness Polyneuropathy in rehabilitation: results from a prospective observational pilot study.** Cameron Cunningham, Resident in Physical Medicine and Rehabilitation, UBC.

**Objective:** To determine the prevalence and functional impact of Critical Illness Polyneuropathy (CIPNM) on inpatient rehabilitation.

**Design:** Prospective observational study.

**Setting:** Inpatient rehabilitation.

**Participants:** Participants had ICU admission  $\geq$  72 hours, were admitted to inpatient rehabilitation from 2013-2014, were  $\geq$  19 years old, had no contraindications to electromyography or nerve conduction studies (EMG/NCS), and had no known history of neuropathy, myopathy, neuromuscular junction disorder or diabetes.

**Interventions:** EMG/NCS to evaluate for axonal neuropathy and/or myopathy in at least one upper and one lower limb.

**Outcome Measures:** Primary outcome measure was prevalence of CIPNM. Secondary outcome measures were Functional Independence Measure (FIM) scores at admission and discharge, FIM gain, FIM efficiency, rehabilitation length of stay and discharge disposition.

**Results:** 33 participants were enrolled. 23 (69.7%) had evidence of CIPNM. Average admission FIM score, discharge FIM and FIM gain were 60.0, 97.5 and 30.2 in those with CIPNM versus 74.8, 102.8 and 15.5 in those without. FIM efficiency was 0.37 in both groups. Average rehabilitation length of stay was 117 days versus 63 days and discharge to home was 43% versus 80% in the CIPNM and non-CIPNM groups, respectively.

**Conclusion:** Our results suggest that CIPNM is very common in rehabilitation inpatients with a history of ICU admission. CIPNM is associated with lower admission FIM scores. Discharge FIM scores were similar between groups, but those with CIPNM had longer lengths of stay and were less likely to be discharged home. Our results will enable design of appropriately powered future studies to further determine the impact of CIPNM on rehabilitation outcomes.

## Poster Presenters:

**If we build it, will they come? Tracking exercise participation levels at the PARC (Physical Activity Research Center) an accessible research gym for people with paralysis due to spinal cord dysfunction.** Abdullah Alghamdi, ICORD/School of Kinesiology, University of British Columbia

**Objectives:** 1) To determine whether the availability of an accessible fitness facility designed for people with paralysis supports the maintenance of regular exercise in people with complete or partial paralysis due to spinal cord dysfunction. 2) To evaluate the changes in general health and fitness over a 6-month period.

**Methods:** Forty-two participants were included for analysis in this study (31 males; 35 traumatic SCI, 5 multiple sclerosis (MS), 2 spina bifida (SB); 11 complete paralysis). All participants were at least one year after injury and were provided with free access to a gym (PARC) with specialized strength and cardiovascular equipment for people with disabilities. Exercise participation was tracked by attendance (times/week) and the volume of exercise undertaken (number of exercises and repetitions/visit). Measures of fitness were recorded at intake and 6-months following the first gym visit. Outcome measures included weight, resting heart rate (HR), resting blood pressure (BP), grip strength (GS), waist circumference (WC), muscle strength (manual muscle testing), and questionnaires surveying level of physical activity (Physical Activity Scale for

Individuals with Physical Disability, PASIPD), fatigue (Multidimensional Assessment of Fatigue, MAF), spasticity (Spinal Cord Injury Spasticity Evaluation Tool, SCI-SET) life satisfaction (Life Satisfaction Questionnaire 9, LiSAT-9), and pain (Multidimensional Pain Inventory (SCI Version), MPI).

**Results:** In their first 6 months of attending PARC, participants averaged 1.2 (SD: 0.88) visits to the gym per week, and used on average 6.6 (SD: 9.1) machines per visit. Participants tended to visit the gym more frequently, on average 2.4 (SD: 0.19) times, in the first week of joining the gym. Attendance rates dropped to 1.35 (SD: 0.21) over weeks 2 to 10, and then to 1.14 (SD: 0.13) times per week through the remaining 16-week observational period. There were no significant differences between individuals with paraplegia and tetraplegia or between people with incomplete or complete injuries in average number of visits or machines used. Comparisons of outcomes between intake and 6-months post indicated no significant improvements in any of the outcome measures.

**Conclusions:** Lack of accessible fitness facilities has been cited as a major barrier to exercise participation among people with SCI. However, our results indicate that even with such access, most participants do not meet the published guidelines of exercise 2 times/week. This work provides baseline knowledge about exercise participation when no specific interventions are provided. Further work is required to understand the best strategies to increase the level of participation in regular exercise among people with SCI.

#### **Interventions for Improving Social Participation after Stroke: a Systematic Review and Meta-**

**Analysis.** Adebimpe Obembe, Postdoctoral Fellow, Rehabilitation Research Laboratory

**Background and Purpose:** Despite the fact that social participation is considered a pivotal outcome of successful rehabilitation, there has been little attention on the impact of activities and services on this important domain after stroke. Therefore, we performed a systematic review and meta-analysis on the effects of rehabilitation interventions on social participation after stroke from randomized controlled trials (RCTs).

**Methods:** Eight electronic databases were searched for relevant RCTs that evaluated the effects of an intervention on the outcome of social participation after stroke. Standardized mean differences (SMD) and confidence intervals (CI) were estimated using fixed and random effect models.

**Results:** Twenty six RCTs involving 2548 stroke survivors were identified. There was a small beneficial effect of interventions that utilized exercise on social participation (ten studies, SMD = 0.43, 95% CI = 0.09, 0.78,  $p = 0.01$ ) immediately after the program ended. Exercise in combination with other interventions (thirteen studies, SMD = 0.33, 95% CI = 0.07, 0.57,  $p = 0.009$ ) also resulted in beneficial effects. No significant effect was observed for interventions that involved support services over nine studies (SMD = 0.09 [95% CI = -0.04, 0.21],  $I^2 = 0\%$ ,  $p = 0.16$ ).

**Conclusions:** The included studies provide evidence that stroke rehabilitation interventions may be effective in improving social participation after stroke, especially if exercise is one of the components.

**An Evaluation of the International Standards to Document Remaining Autonomic Function after Spinal Cord Injury (ISAFS CI): Input from the International SCI Community.** Andrew Round, Research Assistant

**Impaired endothelial function in rat femoral artery after spinal cord injury.** Annie Zheng

**“Fast and Slow”: bowel dysfunction in spinal cord injured animal.** Bárbara Frias, Postdoctoral Fellow, ICORD.

**Introduction:** Bowel dysfunction following spinal cord injury (SCI) is commonly recognized as a major area of physical and psychological difficulty due to the elevated risk and occurrence of fecal incontinence, constipation and pain. However, interventions for bowel management are still limited. This study was undertaken to examine the possible neurological/autonomic factors involved in bowel dysfunctions following SCI.

**Methods:** Male Wistar rats were assigned to four groups ( $n=6$ /group): Sham, T3-SCI, T3-SCI+autonomic dysfunctions with colorectal distension (CRD) and T10-SCI. Each animal was placed in a separate cage and allowed to acclimatize. The number of fecal pellets and total gastrointestinal transit time (TGTT) were assessed at baseline and then weekly after SCI for 4 weeks.

**Results:** The number of fecal pellets was significantly decreased at 4 weeks in T3-SCI and 2 weeks in T10-SCI animals ( $p < 0.05$  vs. Sham). Induced-CRD (T3-SCI+CRD) did not affect the number of fecal pellets. Basal TGTT in Sham was  $6.3 \pm 0.1$  hours ( $p > 0.05$  vs. baseline). TGTT was increased at 2, 3 and 4 weeks in T3-SCI ( $p < 0.05$  vs. Sham), and 2 and 4 weeks in T10-SCI ( $p < 0.05$  vs. Sham). In T3-SCI+CRD, a significant increase of TGTT was only registered at 1 week ( $p < 0.05$  vs. T3-SCI).

**Conclusions:** Our preliminary data demonstrated that animals with SCI that were exposed to the additional autonomic stress of repetitive CRD (frequent episodes of autonomic dysreflexia) developed an increase in the severity and onset of bowel dysfunction.

**Cardiovascular stress during inpatient SCI Physical and Occupational Therapy.** Dominik Zbogar, PhD Student, Rehabilitation Research Laboratory.

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**Objective:** The objectives were 1) To measure the amount of cardiovascular stress experienced by individuals with SCI during physical (PT) and occupational therapy (OT) and 2) To determine correlates of cardiovascular stress.

**Design:** Observational study.

**Setting:** Two Canadian inpatient SCI rehabilitation centres.

**Participants:** Eighty-nine patients with traumatic and non-traumatic SCI were included through consecutive sampling.

**Interventions:** Heart rate (HR) was captured prior to discharge from rehabilitation via a Holter monitor. Additionally, demographic information and clinical assessments were collected. Time spent at different HR intensities was calculated. A Spearman correlation was performed to identify relationships between HR intensity and variables representing impairments and activities.

**Main Outcome Measure:** heart rate.

**Results:** The average time spent at a HR within a cardiovascular training zone ( $\geq 40\%$  heart rate reserve) was  $6.0 \pm 9.0$  minutes in PT and  $4.6 \pm 8.5$  minutes in OT sessions. Few patients met guidelines for obtaining a cardiovascular training effect. Decreased spasticity, and increased exercise self-efficacy, and orthostatic tolerance, were correlated with a greater amount of time within a cardiovascular training zone.

**Conclusion:** The cardiovascular stress incurred by individuals with SCI during PT and OT sessions is

low and not sufficient to obtain a cardiovascular training effect. Exercise self-efficacy, orthostatic tolerance, and spasm intensity may present targets for improving time spent at higher heart rates during inpatient therapy.

**Met and unmet needs of wheelchair users in Canada.** Edward Giesbrecht, PhD Student, Rehabilitation Research Laboratory.

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**Objectives:** To inform clinical and policy directions related to healthcare resources, this study reports on the demographics and assistance requirements of Wheeled Mobility Device (WMD) users, including unmet equipment and assistance needs.

**Design:** Secondary data analysis

**Setting:** Community-dwelling individuals

**Participants:** Canadian Survey on Disability respondents aged 15 and older

**Interventions:** N/A

**Main Outcome Measures:** Descriptive statistics related to prevalence and need for a WMD, home modifications, assistance, and expenses incurred.

**Results:** Almost 300,000 Canadians use at least one WMD (68% a manual wheelchair, 15% a power wheelchair and 38% a scooter); 25% of persons with a disability require but do not own a WMD. Demographically, WMD users typically are female, not employed, with an income lower than the Canadian mean. Compared to all persons with a disability, the assistive equipment and home adaptation needs, both met and unmet, are higher. On average, WMD users require care provider assistance with  $4.4 \pm 2.4$  out of 9 activities of daily living; assistance is provided predominantly by family living in (65%) or away (44%), friends and neighbours (26%), or paid individuals (20%). Such assistance is typically required on a daily (65%) or weekly (21%) basis. Nearly half of WMD users spend over \$1000 annually on assistance and almost 20% spend more than \$5000.

**Conclusions:** A sizable number of Canadians with a disability do not have the mobility equipment and home adaptations they require. WMD users typically have higher assistance needs and expend more to acquire assistance, despite lower employment rates and family income.

**Spinal cord injury and migraine headache: A population-based study.** Freda Warner.

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**Objectives:** Spinal cord injury (SCI) is a devastating neurological disorder, resulting in profound sensory,

autonomic, and motor dysfunction. Among secondary complications associated with SCI, pain is considered to have a substantial impact on quality of life. Beyond the classification of nociceptive (e.g., musculoskeletal and visceral) and neuropathic pain after SCI (e.g., at and below-level), little is known regarding “other” chronic pain conditions. The objective of this study was to evaluate a potential “other” type of chronic pain, examining the association between SCI and migraine headache, as well as the impact of these conditions on quality of life.

**Methods:** Data from a sample of 61,047 participants were obtained from the 2010 Annual Component of the cross-sectional Canadian Community Health Survey. Multivariable logistic regression was used to explore the association between SCI and migraine headache using probability weights and adjusting for confounders.

**Results:** The multivariable age- and sex-adjusted model revealed a strong association between SCI and migraine headache, with an adjusted odds ratio for migraine of 4.82 (95% confidence interval [3.02, 7.67]) among those with SCI compared to those without SCI. Further, individuals who experienced both SCI and migraine tended to report poorer perceived general health compared with the other groups (i.e., SCI and no migraine).

**Conclusion:** This study established a strong association between SCI and migraine headache. Further research is needed to explore the possible mechanisms underlying this relationship. Improvements in clinical practice to address or minimize this issue could result in significant improvements in quality of life among SCI populations.

**Bimanual Elbow Robotic Force-feedback Rehabilitation.** Gil Herrnstadt, Simon Fraser University, Engineering Sciences.

Often accompanied by physical, cognitive, social or psychological impediment, stroke is a leading cause of disability [1], [2]. There is therefore a need to alleviate associated health and monetary costs. Treatment in the chronic phase predominantly focuses on the affected limb. There is however evidence that bimanual upper limb rehabilitation can enhance functional recovery [3]; several robotic devices have been integrated and utilized in a bimanual therapeutic process [4]. The work presented here investigated a user driven bimanual elbow orthoses with the objective of increasing the user’s active role in the therapy. The system enables the user to perceive with her/his non-hemiparetic arm the

movements as well as the forces applied by her/his hemiparetic arm. A Bimanual Wearable Robotic Device (BWRD) with a Master-Slave configuration for the elbow joint was developed to carry out the investigation. Novel force feedback based methods and protocol were developed and tested on eight participants with chronic unilateral stroke, in three one-hour sessions, delivered in a week. We are able to suggest identification of impairment patterns in the position-force plot results. Pre and post training functional (Fugl Meyer and Wolf Motor Function Test) along with proprioceptive assessments measured improvements (15% and 19%, and 32% respectively). Due to the brevity of the training, we place higher relevance to the proprioception testing ( $p=0.033$ ) and protocol distinctive features and results.

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**Bowel management and cardiovascular dysfunction after spinal cord injury.** Jessica Inskip, Department of Biomedical Physiology and Kinesiology, Simon Fraser University, International Collaboration on Repair Discoveries (ICORD), University of British Columbia.

**Introduction:** Constipation and incontinence are common problems for individuals with spinal cord injury (SCI) and improving bowel function has been identified as a key target to enhance their quality of life. Bowel care is a potent trigger for autonomic dysreflexia (AD) - sudden and extreme hypertension provoked by a sensory stimulus below the injury. Here we sought to gather more information about bowel management practices among individuals with SCI and determine the prevalence of cardiovascular symptoms during routine bowel care.

**Methods:** A survey combining the International Bowel Function Basic and Extended Data Sets and

our Cardiovascular Symptoms Questionnaire was completed by participants recruited from local rehabilitation centres, online SCI discussion forums, our institution website (www.icord.org), and social media.

**Results:** One hundred and one participants, with a wide range of SCI levels (C4-sacral) and severities (AIS A-D) completed the survey. More than half of participants (56%) reported being unsatisfied with their current bowel care routine. The majority of respondents (84%) reported at least one symptom of AD during their routine bowel care, including 29% who described experiencing palpitations. Overall, 39% felt AD interfered with their activities of daily living.

**Conclusion:** A considerable proportion of individuals with SCI are experiencing symptoms of AD during their routine bowel care, including sensations of palpitations. We believe it is a significant priority to investigate strategies to effectively manage bowel care and minimise AD and associated cardiovascular risk in people with SCI.

**Assessment of Autonomic Dysfunction in Multiple Sclerosis with and without Spinal Cord Involvement.** Jordan Squair, Research Assistant, International Collaboration on Repair Discoveries (ICORD), University of British Columbia.

**Objective:** To investigate if spinal cord involvement in individuals with multiple sclerosis (MS) results in impairment of the autonomic nervous system and subsequent orthostatic hypotension.

**Design:** Cross-sectional comparison.

**Setting:** Spinal Injury Research Centre (ICORD).

**Participants:** Eight individuals with MS (2 males; Age=46±8years; EDSS=2.8±1.1) have participated in the study to date. Participants were stratified into a spinal cord involvement group (SC; n=3) and brain lesion only group (BRAIN; n=5).

**Interventions:** Participants rested supine for 10 minutes wearing a brachial blood pressure cuff to establish baseline hemodynamics. Participants were then passively moved into an upright seated position and monitored for 10 minutes. Following the sit-up test participants were transferred to a tilt-table and rested for 5 minutes to return hemodynamics to baseline, at which time participants were tilted to 60° for 10 minutes. Hemodynamics were recorded at 1-minute intervals.

**Main outcome measures:** The maximum change from baseline in systolic and diastolic blood pressure (SBP, DBP), mean arterial pressure (MAP), and heart

rate (HR) were determined for both the sit-up test and tilt-test.

**Results:** During the sit-up test, no differences were observed between groups for SBP, DBP, or MAP and no participants developed orthostatic hypotension. However, HR increased significantly from baseline in the SC group compared to the BRAIN group ( $P=0.014$ ). In response to the tilt-test, 3 participants (2 SC) developed clinically defined orthostatic hypotension. Further, SBP and MAP significantly decreased from baseline in SC, compared to BRAIN ( $P=0.017$ ,  $P=0.015$ , respectively).

**Conclusion:** Spinal cord involvement elicits greater orthostatic intolerance in individuals with MS.

**A Walking Disaster: A Case of Motor-Incomplete Spinal Cord Injury with Severe Orthostatic Hypotension.** Katharine Currie, Postdoctoral Fellow, ICORD.

**Objectives:** We report the case of a patient with a motor-incomplete spinal cord injury (SCI) who experienced severe cases of orthostatic hypotension (OH), despite being ambulatory.

**Design:** Case report.

**Setting:** Inpatient and outpatient assessments at GF Strong Rehabilitation Centre and the Blusson Spinal Cord Centre.

**Participant:** A 58-year old male with a traumatic motor and sensory-incomplete SCI at C5 (central cord syndrome).

**Main Outcome Measures:** Change in systolic and diastolic blood pressure (BP) in response to 60° head-up tilting. OH was defined as a drop in systolic BP  $\geq 20$  mmHg or diastolic BP  $\geq 10$  mmHg with tilting.

**Results:** The first test was performed 40 days post-injury. Within two minutes of tilting, systolic and diastolic BP dropped 48 and 26 mmHg, respectively (from 124/75 to 76/49 mmHg). A second assessment was performed 254 days post-injury. Within 86 seconds of tilting, systolic and diastolic BP dropped 52 and 28 mmHg, respectively (from 134/81 to 82/53 mmHg). In both occasions the patient reported lightheadedness. He became unresponsive (15 seconds) and experienced extreme bradycardia (i.e., heart rate decreased to 12 bpm), both of which were consistent with syncope. Hemodynamics recovered within minutes of test termination.

**Conclusion:** Non-pharmacologic management, including dietary and physical measures, was recommended. This case report highlights the necessity to assess autonomic functions following SCI, regardless of the injury severity. Proper

diagnosis and management of OH will ensure the safety and well-being of individuals living with SCI.

**Impaired Hemodynamic Responses to Cold Pressor Test in Athletes with High Paraplegia.**  
Laura McCracken, Masters Student, ICORD.

**Objectives:** The cold pressor test (CPT) is used to detect autonomic dysfunctions in various conditions. In healthy individuals, CPT increases heart rate (HR) and blood pressure (BP); in spinal cord injury (SCI), responses can be altered based on lesion level. The objective of this study was to compare hand CPT responses in athletes with chronic complete paraplegia and able-bodied (AB) controls.

**Design:** Cross-sectional comparison.

**Setting:** Sochi and Vancouver.

**Participants:** Athletes with high (T2 - T6, n=6) and low (below T6, n=7) complete paraplegia, and 7 AB controls.

**Interventions:** 2 minutes of hand immersion in ice-cold water.

**Main Outcome Measures:** HR (one lead electrocardiogram) and BP (automated cuff) were measured at baseline, during and immediately after CPT. Brachial artery images were acquired using duplex ultrasound at baseline and 30, 75, and 105 seconds into CPT. End systolic and diastolic diameters (ESD; EDD) and blood flow were determined offline.

**Results:** There were no differences in baseline BP, diameter, or blood flow between groups. In response to CPT, athletes with high paraplegia exhibited reduced EDD and ESD from baseline at 75 and 105 seconds compared to low paraplegia and AB (both  $p < 0.002$ ); whereas EDD and ESD were unchanged from baseline in low paraplegia and AB. These differences occurred despite similar pressor responses and blood flows in response to CPT.

**Conclusions:** Athletes with high paraplegia exhibit a greater brachial vasoconstrictor response to CPT compared to low paraplegia and AB controls despite similar pressor responses. This response may be secondary to increased peripheral adrenoceptor sensitivity.

**A Universal Band for Detecting Functional Use in Rehabilitation Applications.** Lukas Karim Merhi, Engineering Sciences, Simon Fraser University.

Functional gains made by stroke survivors during the rehabilitation process are often lost post-rehabilitation due to factors such as lack of stimulation, encouragement or an unsuitable physical environment [1]. A device that is capable of detecting functional motion could act as a motivational tool by

providing feedback and positive reinforcement for the achievement of functional motion as part of a take-home rehabilitation program. We present an easy-to-use, wearable band capable of deciphering and providing quantitative, real-time feedback on a user's functional activity. The system detects the successful completion of tasks that involve the grasping, movement, and subsequent release of an object. The device consists of force sensing elements, signal processing circuitry and a machine learning classifier. The band is donned around the forearm for the purpose of detecting the onset of a grasp or release using Force Myography (FMG). FMG has been shown to be an effective method for detecting different upper-extremity postures [2]. The system requires a training step in order to characterize the FMG patterns associated with the grasp and neutral hand states of the user. The system's ability to detect the completion of three functional tasks, involving pick and place in the three co-ordinate axes was evaluated with five stroke survivors. The participants picked-up, moved and placed a coffee mug twenty times for each task. Data was analysed to determine the accuracy of the system and the optimal number of training repetitions required to obtain acceptable accuracy without requiring an arduous and lengthy training process. The system obtained an average accuracy of 89% across all three tasks when presented with 8 pick & place training samples.

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**Factors Influencing Augmentation Index in Individuals with Spinal Cord Injury.** Mackenzie Li, Student, AR & ICORD.

**Objective:** To explore the effects of spinal cord injury (SCI)-specific and non-specific factors on augmentation index (AIx) in individuals with tetraplegia and high paraplegia.

**Design:** A cross-sectional comparison.

**Setting:** Research laboratory at the Blusson Spinal Cord Centre.

**Participants:** Eighteen individuals (38±10 yrs; 9 males) with a traumatic, motor-complete SCI (C4-T3; 15±9 yrs post-injury) participated in the study.

**Interventions:** Blood pressure waveforms were obtained by applanation tonometry at the right

common carotid artery and calibrated to discrete brachial artery blood pressures.

**Main Outcome Measure:** AIx was calculated from the carotid artery pressure waveforms as the ratio between augmentation pressure and pulse pressure, and normalized to heart rate of 75 beats per minute (AIx@75bpm). Multiple univariate regressions were performed to determine the effect of SCI-specific (injury level, injury duration, autonomic completeness) and non-specific (age, sex, height, mass, body mass index, blood pressure, heart rate) factors on AIx@75bpm.

**Results:** The linear regressions showed that sex ( $R^2=0.350$ ;  $p=0.010$ ), height ( $R^2=0.258$ ;  $p=0.031$ ) and heart rate ( $R^2=0.360$ ;  $p=0.009$ ) were predictors of AIx@75bpm. All other factors were non-significant.

**Conclusions:** In people living with SCI, arterial stiffness quantified by AIx@75bpm is influenced by sex, height, and heart rate. These findings are in agreement with the able-bodied literature. Further research is required to determine the influence of physical activity on AIx@75bpm following SCI, and its role in the prediction of cardiovascular disease in the SCI population.

**Feasibility of exoskeleton-based balance and gait training combined with somatosensory tongue stimulation in people with MS: a pilot study.**  
Megan Brosseau, PARC coordinator, MSC Candidate, ICORD.

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**Objectives:** 1. To investigate the feasibility of using the Lokomat training combined with somatosensory tongue stimulation in people with MS.

2. To establish the feasibility and utility of combining tongue stimulation with usual at home and community-based exercise training regimens in people with MS.

**Research Methods:** A case report of an individual with primary progressive MS, 23 years post diagnosis. The training intervention included alternating treadmill-based exercise and quiet standing for 30 minutes, 5 days/week for 12 weeks. Training intensity (treadmill speed and body weight support) was controlled using the Borg CR10 Scale. During training sessions, participants received continuous somatosensory stimulation of the tongue. Main outcome measures: Standing balance – eyes open and closed. Gait Activation Patterns – EMG of 6 sites of the lower limbs. Proprioceptive Sense – joint position and movement detection of hip and knee joints. Qualitative Questionnaires including: Fatigue Severity Scale, Pain Severity Scale, Mood, Spasticity Scale, and Quality of Life.

**Results & Conclusion:** This pilot study indicates that daily 30-minute balance and gait training assisted by robotic exoskeleton along with weekly progress evaluations is a potentially feasible training protocol for people with multiple sclerosis. It also showed functional improvements in standing balance (with eyes open) were observed as were changes in proprioceptive sense. The observation of locomotor-related bursting activity in lower limb muscles post-training could suggest enhanced excitability of locomotor networks.

**The integration of vision and proprioception for obstacle crossing in people with motor-incomplete spinal cord injury.** Raza Malik, PhD Student, ICORD.

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**Background:** Our environment requires us to continuously adapt our walking patterns to maneuver and cross obstacles under different visual conditions (i.e. dimly lit versus a completely lit environment). Successful obstacle crossing is a critical component of community ambulation and dependent on the integration of visual and proprioceptive inputs. Thus, the overall objective was to understand how obstacle crossing strategies, assessed by gaze behaviour and the changes in limb trajectory parameters, are affected by a motor incomplete spinal cord injury (m-iSCI).

**Methods:** Nine individuals with m-iSCI and 10 able-bodied controls walked over an obstacle under full and obstructed vision conditions. An eye tracker was used

to determine gaze behaviour and motion capture analysis was used to determine the kinematic trajectory of the foot relative to the obstacle. In participants with m-iSCI, motor capacity was assessed by tests of strength, balance and walking speed. Self-efficacy in balance and gait was also assessed. Lower limb proprioceptive sense was assessed using customized software controls of the Lokomat.

**Results:** m-iSCI participants tended to glance at the obstacle more frequently and fixated on the obstacle for longer. The increased reliance on vision was related to lower limb proprioceptive sense, self-efficacy and motor capacity. Toe clearance height in m-iSCI participants was also increased to a greater extent compared to controls when vision was obstructed. Again, this was related to lower limb proprioceptive sense.

**Conclusion:** The recovery of functional walking skills following SCI is multidimensional, requiring consideration not only of motor capacity, but also proprioceptive deficits and self-efficacy.

**Correlation between lower limb proprioceptive sense and skilled locomotor performance.** Taha Qaiser, Research Assistant, ICORD.

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It has been demonstrated that neural connections between the sensory and motor brain areas are essential for controlling movement and learning new motor tasks in humans. Likewise, proprioception, is our ability to sense limb position and movement, which is critical for learning skilled walking tasks. The aim of this project was to understand how lower limb proprioceptive sense contributes to the variability between subjects in the acquisition of a skilled walking task. We assessed lower limb joint position sense and movement detection threshold in 20 healthy humans using the Lokomat; a robotic lower limb exoskeleton. Subjects also walked on a treadmill to perform a skilled motor task where they were challenged to match their foot height to the height of a virtual obstacle displayed on a monitor in front of them. Subjects were given visual feedback on their error relative to the obstacle height after it was crossed. After 200 random obstacles, the average error of the last 20 steps was determined as their end-performance while its 95% confidence interval indicated their learning rate. When both performance and the learning rate were correlated to proprioceptive score, the relationship was found to be positive. Results of this study suggest that performance rather than learning rate of new locomotor skills is highly influenced by a person's proprioceptive ability. These findings can aid in developing new rehabilitative interventions for individuals with neurological conditions that not only take into account their level of motor paralysis, but also their degree of sensory capabilities.