AMERICAN SPINAL INJURY ASSOCIATION
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AWARD-ELIGIBLE POSTERS:

Poster 1

FashionABLE: Health Care Practitioners Perspectives on Adaptive Clothing After Spinal Cord Injury

Abstract 42

Tamila Kalimullina, BSc, University of British Columbia

Objective. Mobility impairments, presenting alongside conditions such as spinal cord injury (SCI) significantly impact the level of independence and ability to reintegrate back into the community. Clothing is closely tied to self-esteem, and the emotional preparedness to engage in social and professional activities. Naturally, clothing that is ill-fitting, causes discomfort, or does not represent personal style, is demoralizing and will decrease the likelihood of the individual engaging in the community. Functionality of clothing impacts aspect of well-being including protection, ease of donning and doffing, and ease of movement. Despite its importance, the lack of accessible, functional, and fashion-forward clothing makes it difficult to reintegrate into the community. Current resources are expensive, limited in scope, time-consuming to search out, and individuals may not know of their existence. There is an urgent, unmet need for adaptive clothing information for individuals with impaired mobility. The objective of this study was to synthesize current practices and knowledge of health care practitioners (HCPs) regarding adaptive clothing for individuals with SCI. Design/Methods. We conducted a web-based survey of health care practitioners (n=18), which included occupational therapists (OTs), physical therapists (PTs) and physicians (MDs) who have expertise working with individuals with SCI of at least 1 year. Questions included closed and open-ended prompts related to clothing challenges, perceived barriers, and common resources. Results. Of 18 participants, 83% were one of, OT, PT, or MD, working with individuals with SCI from 2-37 years (mean=11). 89% or responders were female, between the ages of 27-68 years old (mean=40). 67% of responders practice in acute/inpatient rehabilitation, while 33% practice in community settings/outpatient rehabilitation. Most practitioners have discussed or addressed the clothing needs of their clients in their practice (78%). Ease of donning and doffing and managing bowel and bladder routines were identified as the top priorities for HCPs when providing resources for adaptive clothing. Practitioners also identified long pants/jeans as the article of clothing presenting the most challenge for their clients, while skirts and shirts/blouses were identified as presenting the least challenge. Wool and spandex were the most challenging fabrics, while cotton, was reportedly the least challenging. 94% of practitioners face barriers in addressing the needs of their clients, indicating they were only somewhat satisfied in their ability to meet the needs regarding adaptive clothing and dressing. Majority of responders occasionally recommend websites and referrals but are not satisfied with the resources currently available. Conclusion. Our study has identified some common themes surrounding adaptive clothing after SCI, from the perspective of HCPs. These findings will contribute to the development of a widely accessible resource (FashionABLE), for adaptive clothing for individuals with SCI, their caretakers and HCPs. Support. Craig H. Neilsen Foundation's Creating Opportunity & Independence Community Support Grant, and the WorkSafeBC Research Training Award.

Learning Objective 1

Discuss the findings of survey of health-care practitioners regarding adaptive clothing after spinal cord injury.

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Poster 2

Work-related spinal cord injury (SCI): Does race/ethnicity matter?

Abstract 48

Huacong Wen, PhD, University of Alabama at Birmingham

Objective: To investigate the racial differences in work-related injury among people with traumatic spinal cord injury (SCI) Design/Methods: This was a cross-sectional analysis of data from National SCI Model Systems (SCIMS) database. There were 5,974 study participants (763 Hispanic, 1,478 Non-Hispanic Black, 3,484 Non-Hispanic White, and 249 other races) between the ages of 18-65 with SCI injured between October 2000 and December 2019. We compared the demographic characteristics, injury-related characteristics, and English language ability of the racial groups using the chi-square test or analysis of variance. Work-related injury was determined if the cause of SCI incurred in the course of employment. To assess the effect of race on work-related injury, logistic regression models were calculated by adjusting for demographic characteristics, injury-related factors, and English-speaking ability. We also compared the occupational categories by racial groups among people with work-related injury using descriptive statistics, including frequencies and percentage. Results: Significant differences across racial groups were noted for demographics, injury-related factors, and English language ability across racial groups. Compared to other racial groups, Hispanics tended to be younger, less educated men with less English-speaking ability and a higher rate of falls as the cause of injury. Work-related injuries were found to occur in 9.7% of the sample (n=581) with Hispanics having a higher percentage than other racial groups (15.6%, P<0.001), especially among those who are male (17.8%, P<0.0001) or injured by falls (41.5%, P<0.0001). When accounting for demographic and injury-related factors (sex, marital status, education, age, cause of injury, and severity of SCI), Hispanic people still had a higher likelihood of work-related injury when compared with non-Hispanic Black people (Odds ratio 1.59, 95% Confidence interval (CI) 1.12-2.24). After accounting for English speaking ability (self-rated from “not at all” to “very well”), the odds of work-related injury decreased to 1.254 (95% CI 0.87-1.82). Among people with work-related injury, the top one occupational category for these who were Hispanics was construction/extraction occupation (22.7%) follow by precision production, craft, and repair (20.2%) and handlers, equip cleaners, helpers, and laborers (16.8%). While transportation and material moving occupations ranked first in people who were non-Hispanic Blacks (26.6%), it ranked third in people who were non-Hispanic Whites (10.5%). There were some other top occupational categories for people with work-related injury who were non-Hispanic Blacks (construction/extraction occupation (9.6%) and install/maintain/repair occupations (9.6%)) and people with work-related injury who were non-Hispanic Whites (services occupation (11.1%) and precision production, craft, and repair (15.4%)). Conclusion: Racial differences are present in work-related SCI, and the extent of these differences may be explained by English speaking ability. The findings provide a foundation for future research to explore factors that contribute to racial differences in work-related SCI, which could aid in prevention as well as clinical management. Support: NIDILRR (#90SIMS0016).

Learning Objective 1

Discuss the role of race in the work-related injury in people with spinal cord injury.

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Poster 3

Effects of midodrine administration over a 30-day period compared to placebo, on blood pressure and cerebral blood flow velocity and cognitive performance in persons with SCI

Abstract 70

Caitlyn Peters, PhD, James J Peters VA Medical Center

Objective: Individuals with spinal cord injury (SCI) at and above T6 experience impaired descending cortical control of the autonomic nervous system, which predisposes them to blood pressure (BP) disorders including persistent hypotension. We have reported disparity between the incidence and the treatment of hypotensive disorders in Veterans with SCI, regardless of the level of injury, which is due to the largely asymptomatic nature of the disorders and the paucity of safe and effective pharmacological options available. The primary aim of this investigation was to determine the effects of midodrine, 10 mg, administered either twice (BID) or thrice (TID) daily, over a 30-day period in the home environment, compared to placebo, on laboratory assessments of BP, cerebral blood flow velocity (CBFv) and cognitive performance in hypotensive individuals with SCI. Design/Method: Fifteen individuals with tetraplegia (C4-C7) were enrolled; however, 5 participants withdrew due to adverse events after taking midodrine. In the first 30-day period (Arm 1), participants were randomized to midodrine or placebo, followed by a 14-day washout, and then they were crossed-over to the second 30-day period (Arm 2) of the study. The study drug was taken either BID or TID depending on the sleep/wake schedule of each participant. Laboratory assessments of BP, CBFv and cognitive performance were measured before and after each of the two 30-day periods. Results: As expected, systolic BP (SBP) and diastolic BP (DBP) were significantly increased following midodrine administration compared to placebo (SBP: 121 ± 22 mmHg vs. 97 ± 16 mmHg, respectively; 95% CI for time x drug interaction = 17 to 36 mmHg ($p<0.001$); DBP: 62 ± 14 mmHg vs. 59 ± 12 mmHg, respectively; 95% CI for time x drug interaction = 2 to 13 mmHg ($p<.01$)). However, there were no significant drug x time interaction effects for HR ($p=0.50$), CBFv ($p=0.70$) or cognitive scores ($p=0.66$). Conclusion: Midodrine is the most commonly prescribed anti-hypotensive medication in the SCI population. While these data indicate significant increases in BP following 30-day administration of midodrine, there were no improvements in CBFv or cognitive performance compared to placebo. We have reported impaired cognitive function in individuals with SCI who have persistent asymptomatic hypotension; therefore, identifying the effects of other anti-hypotensive treatment options on CBFv and cognitive function should be prioritized. Support: This project was funded by the Craig H Neilsen Foundation (Grant #284196), and the Department of Veterans Affairs, Veterans Health Administration, Rehabilitation Research & Development Service SPiRE award (#D1382-P).

Learning Objective 1

To determine the effects of midodrine over a 30-day period in the home environment, compared to placebo, on laboratory assessments of BP, cerebral blood flow velocity (CBFv) and cognitive performance in hypotensive individuals with SCI.

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Poster 4

The Gut Microbiome after SCI: A Preliminary Analysis of Bacterial Quorum Sensing Molecules to Identify Molecular Mechanisms of GI Dysfunction

Abstract 105

Mark Nash, PhD, FACSM, FASIA, Miller School of Medicine, University of Miami

Objective: Chronic spinal cord injury (SCI) causes secondary complications that significantly compromise health and life quality, including altered bowel function and dysfunction of the gastrointestinal (GI) tract. Current treatments for bowel dysfunction are limited and often have unwanted side effects. However, recent work examining the gut microbiome holds promise for new therapeutics by manipulating gut bacteria that alter the host's autonomic, inflammatory, metabolic, and GI state. We thus investigated the gut microbiome focusing on bacterial quorum sensing molecules (QSMs) to identify molecular mechanisms of GI dysfunction post-SCI and assess potential therapeutic targets. Design/Methods: Five persons with SCI (> 1-year post-injury, tetraplegia/paraplegia; C5-T6) and non-SCI controls provided stool samples and information to assess diet and exercise habits, prescribed medications and supplements (e.g., probiotics), frequency of bowel movements, and typical bowel routine components. Metagenomic sequencing, metabolomics, bacterial QSM detection, and levels of cytokines, chemokines, and growth factors then assessed putative mechanisms related to GI dysfunction. Results: Stool samples were assessed for four different classes of QSMs; short-chain homoserine lactones (scAHL), long-chain homoserine lactones (lcAHL), autoinducer-2 (AI-2), and 3,5-dimethylpyrazin-2-ol (DPO). Levels of scAHL, lcAHL, and AI-2 were similar in both groups, however, levels of DPO were significantly lower in the stool of individuals with SCI. These samples were then investigated for a wide range of pro-inflammatory and homeostatic cytokines, chemokines, and growth factors; G-CSF, GM-CSF; IFNs-α and γ; IL-1β and 1RA; IL-2 and 2R; ILs-4,5,6,7,8,10,12/23p40,13,15, and17; TNFα, IP-10, MCP-1, MIG, MIPs-1α and 1β, RANTES, EGF, FGF, HGF, and VEGF. While not all of these molecules were detected in stool samples, the levels of IL-12/IL-23p40 and TNFα were statistically significantly lower, and VEGF was statistically significantly higher in the stool of individuals with SCI than controls. Conclusion: Prior pre-clinical work by our group determined altered composition of gut bacteria and quorum sensing molecules (QSMs) employed by bacteria to coordinate community behaviors. While further investigation is needed, initial assessment of stool samples after SCI provides a set of four biochemical targets/pathways to evaluate as potential mechanisms for addressing GI dysfunction. Support: US Department of Defense W81XWH-20-1-0697.

Learning Objective 1

Describe gut dysbiosis after SCI.

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Poster 5

Feasibility Study of Smart Seat Cushion for Automated Interface Pressure Modulation

Abstract 120

Aida Nasirian, Research Scientist II, University of Texas at Arlington Research Institute

Objective: Pressure injuries (PI) are a major medical complication among wheelchair users with spinal cord injury (SCI). 85% of individuals with SCI will develop PIs in their lifetime, regardless of clinical strategies and products intended to reduce the duration and magnitude of loading that causes PI. This study examines the feasibility of a smart seat cushion (SSC) in reducing the magnitude and duration of pressure at the sitting interface through real-time pressure mapping performed by SSC using pressure of individual air cells. Design methods: The capability of SSC for real-time pressure mapping and performing two pressure modulation algorithms was evaluated through a study conducted in an inpatient rehab facility with a cohort of 12 wheelchair users with SCI and 12 non-wheelchair users. Interface pressure maps created with a commercial sensing mat is used to verify the pressure profile creation capabilities of the SSC using internal pressures of individual air cells. The two modulation algorithms investigated were i) Redistribution, which equalizes and incrementally reduces the pressures of all air cells of the cushion; ii) Offloading, which identifies high-pressure areas of the interface and completely deflates the air cells in the corresponding area while equalizing pressure in rest of the air cells. The usability of the cushion was evaluated using two components of Tool for Assessment Wheelchair disComfort (TAWC) questionnaires which were General Discomfort Assessment (GDA) and Discomfort Intensity Rating (DIS). Results: The pressure maps obtained during repositioning using air cell pressures of SSC and commercial pressure mat have a good agreement. An average of 15% interface pressure reduction is observed for the area corresponding to the ischial tuberosity (IT). The lowest average pressure at IT was 33.3mmHg for an individual with SCI (145lb). Data from offloading indicates the elimination of high-pressure points while equally distributing the pressure in other areas. Scoring range for GDA is 13-91, and DIS is 8-99, where higher scores indicate greater discomfort. GDA in the SCI cohort assessed during redistribution (M=46.3, SD=5.9) and during offloading (M=45.1, SD=5.6); in the non-SCI cohort during redistribution (M=49.4, SD=6.9) and during offloading (M=47.3, SD=6.5). The DIS median and interquartile range, was 9 (8.75, 18.75) for redistribution and 9 (8, 14.25) for offloading, in the SCI cohort. The DIS median and interquartile range, was 9 (8, 12.25) for redistribution and 9 (8, 9.5) for offloading, in the non-SCI cohort. Conclusion: Pressure data from the study suggest: i) SSC can be used as a continuous pressure monitoring device to provide input for real-time pressure modulation, ii) automated redistribution algorithm can reduce and redistribute the interface pressure from vulnerable areas, and iii) offloading algorithms can identify and eliminate peak pressure point at the interface without creating new high-pressure points. Preliminary results of this pilot study suggest the viability of a smart seat cushion for individuals with SCI based on pressure data and feedback from both SCI and non-SCI participants on the comfort level. Future studies will include testing the SSC during activities of daily living.

Learning Objective 1

Evaluate feasibility of real-time pressure mapping enabled automated pressure redistribution and offloading of a smart seat cushion for wheelchair users with SCI

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Poster 6

Comparative Efficacy of Four Different Transcranial Current Stimulation Modalities and Montages for Enhancing Corticospinal Excitability and Improving Upper Extremity Functional Restoration in Persons with Tetraplegia

Abstract 123

Jennifer Iddings, PhD, Shepherd Center

Objective: Following spinal cord injury (SCI), maladaptive cortical plasticity(1) and reduced corticospinal excitability (CSE)(2) limit descending corticospinal drive, further contributing to the upper extremity (UE) impairments caused by injury to the spinal tracts themselves. Stimulation to increase cortical excitability and descending corticospinal drive, such as transcranial current stimulation (tCS), could have a beneficial impact on functional restoration after SCI. Although interest is growing in the use of tCS as a neurorehabilitation tool in persons with SCI,(3) important questions remain unanswered, particularly as related to stimulation modality (continuous vs pulsed) and electrode montage (uni- vs bi-hemispheric). The goal of this sham-controlled, randomized crossover study was to determine the efficacy of four different tCS modality/montage combinations for increasing CSE and enhancing UE functional restoration in persons with cervical SCI (cSCI). Design/methods: Individuals with self-reported limitations in UE function due to cSCI (> 3 months post-injury) participated in this study. During each of the five randomly ordered sessions, participants received 22 minutes of tCS (unihemispheric transcranial direct current stimulation [u-tDCS], bihemispheric tDCS [b-tDCS], unihemispheric transcranial pulsed current stimulation [u-tPCS], bihemispheric tPCS [b-tPCS], or sham tDCS) combined with bimanual functional task practice. In unihemispheric montages, anodal stimulation was applied to the corticomotor representation of the weaker UE, and in bihemispheric montages, anodal stimulation was applied to the corticomotor representation of both UEs concurrently. Within-session changes in CSE (transcranial magnetic stimulation motor evoked potential amplitude), strength (key pinch dynamometry), and motor control (finger tapping rate) were measured bilaterally. Results: Seventeen participants with cSCI (neurologic level of injury range C3-C7) completed the study. Overall, stimulation was well-tolerated with only one participant declining b-tPCS. Mean change in thenar CSE (stronger/weaker UE) for each tCS modality/montage was as follows (in μV): u-tDCS: 59.81/107.86; b-tDCS: -277.99/-33.84; u-tPCS; -4.52/-43.94; b-tPCS: 105.23/48.50; and sham tDCS: 153.94/83.12. Mean change in wrist extensor CSE (stronger/weaker UE) for each tCS modality/montage was as follows (in μV): u-tDCS: -82.08/376.30; b-tDCS: 155.32/289.11; u-tPCS: 127.88/48.77; b-tPCS: 73.95/206.75; and sham tDCS: -239.52/-64.03. Although no significant between-group differences in CSE were detected, b-tPCS was the only tCS montage/modality that resulted in increased CSE and positive effect sizes in both intrinsic (thenar) and extrinsic (wrist extensor) UE muscles bilaterally. No significant between-group differences were observed in strength or motor control. Conclusion: The results of this study suggest that b-tPCS may be the most efficacious modulator of UE CSE among the four tCS modality/montages examined. Multiple sessions of combined b-tPCS and bimanual functional task practice are likely necessary to induce meaningful changes in UE CSE, strength, and functional outcomes in individuals with cSCI.

Learning Objective 1

Assess the efficacy of different transcranial current stimulation modalities/montages for increasing corticospinal excitability

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Poster 7

Effects of lumbosacral spinal cord epidural stimulation on plasma catecholamine concentrations during orthostatic stress in individuals with chronic spinal cord injury

Abstract 140

Siqi Wang, PhD, Kentucky Spinal Cord Injury Research Center, University of Louisville

Objective: Orthostatic hypotension (OH), defined as a substantial drop in arterial blood pressure (BP) when assuming an upright position, commonly occurs after spinal cord injury (SCI). OH in SCI is thought to result from disrupted spinal sympathetic pathways leading to a failure in maintaining BP in response to baroreceptor unloading. We previously showed that lumbosacral epidural spinal cord stimulation (scES), optimized for cardiovascular function (CV-scES), acts to stabilize BP, and mitigates the symptoms of OH in individuals with chronic, severe SCI; however, mechanisms responsible for this beneficial effect remain unclear. This study evaluated the immediate effects of CV-scES on plasma catecholamines concentrations during brief orthostatic stress in SCI individuals. Design/Methods: Ten participants with chronic cervical SCI and OH or chronic low BP had a 16-electrode array implanted over the lumbosacral spinal segments. Stimulation parameters were identified to maintain systolic BP between 110-120 mmHg without evoking lower extremity muscle activity. Optimal CV-scES parameters were individualized in terms of the anode and cathode electrodes, signal amplitude, frequency, pulse width, and number of stimulation configurations. Orthostatic tolerance was tested with a 70° head-up tilt maneuver lasting up to 30 minutes, with and without CV-scES during separate visits. During each visit, a venous blood sample was taken from an antecubital vein in the supine position without CV-scES and then at 3 and 10 minutes of head-up tilt with or without CV-scES. If the patient was unable to tolerate the head-up position, a blood sample was drawn immediately before returning to the supine position. The plasma was extracted and stored at -80°C until shipped to the assay laboratory. Plasma norepinephrine (NE) and epinephrine (EPI) were assayed by batch alumina extraction followed by liquid chromatography with electrochemical detection. Results: There were no significant inter-day differences in supine plasma concentrations of NE or EPI between visits. Supine values of all visits were 103±67 pg/mL for NE and 5.6±3.7 pg/mL for EPI which were at the lower end of known normal ranges. Compared to tilt without stimulation, CV-scES improved tilt time (30±0 vs. 10±3 minutes; $p<0.001$) and reduced the fall in systolic BP (-4±17 vs. -45±9 mmHg; $p<0.001$). The orthostatic increment in plasma NE tended to be larger with CV-scES (72.1±48.3 pg/mL) than without CV-scES (22.8±32.2 pg/mL; $p=0.0618$). The orthostatic increment in plasma EPI was significantly larger with CV-scES (5.2±4.5 pg/mL) than without CV-scES (-1.5±3.0 pg/mL; $p<0.01$). Conclusion: These preliminary data suggest that the maintenance of BP that follows immediate use of CV-scES during orthostatic stress may be due to increased sympathetic noradrenergic and adrenergic activities in individuals with chronic, cervical SCI. Thus, we speculate that CV-scES acts to facilitate improved intrinsic cardiovascular control by mitigating underlying autonomic deficits. Because of inter-individual variability in plasma catecholamine responses, a larger patient cohort is needed to draw inferences about autonomic mechanisms that may mediate BP stabilization by CV-scES in SCI. Support: Christopher and Dana Reeve Foundation

Learning Objective 1

Discuss the functional deficit in the baroreceptor reflex to control blood pressure in response to position change after SCI and role of neuromodulation in restoring this function.

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Poster 8

Multi-session Application of Transcranial Random Noise Stimulation to Improve Hand Function in Persons with SCI

Abstract 148

Anastasia Zarkou, PT, MS, PhD, Shepherd Center

Objective: Cervical spinal cord injury (cSCI) results in upper extremity (UE) dysfunction that limits functional independence and diminishes quality of life. UE impairments are attributed not only to the disruption of the ascending and descending pathways due to the initial injury but also to the resultant maladaptive cortical reorganization. Non-invasive brain stimulation (NIBS) approaches can be used to modulate cortical excitability and enhance transmission through the remaining descending corticospinal tract pathways to improve functional restoration in individuals with cSCI. Transcranial random noise stimulation (tRNS) is a new NIBS approach that increases cortical excitability and enhances motor performance in healthy adults. Compared to traditional NIBS approaches, tRNS induces more consistent and pronounced cortical excitatory effects and has excellent tolerability. Further, a single session of tRNS can induce changes in cortical excitability and improve motor control in persons with cSCI. No studies have investigated a multi-session tRNS application in individuals with cSCI. We examined the efficacy of a 3-day tRNS and functional task practice (FTP) protocol on cortical excitability, motor and sensory function in individuals with cSCI. Design/Methods: Eight individuals with chronic (> 1 year post injury), motor incomplete cSCI participated in this 2-week, wash-in control study. All participants had a neurological level of injury at C8 or above. During the first week (wash-in phase) participants completed 3 sessions of FTP while they received 22 min of sham stimulation. In the second week (intervention phase), participants received 22 min of tRNS combined with FTP in each of the 3 sessions. FTP lasted one hour and consisted of repetitive motor and sensory unimanual and bimanual tasks. Prior to and following each week, cortical excitability (amplitude of motor evoked potentials [MEP] using transcranial magnetic stimulation), motor (Grasp and Release Test [GRT] and key pinch strength measures), and sensory (tactile sensation subtest of the Graded Redefined Assessment of Strength Sensibility and Prehension [GRASSP] and revised Nottingham Sensory Assessment [rNSA]) function were assessed. Paired t-tests were computed to examine within phase changes. Results: Participants were unable to distinguish between TRNS and sham stimulation, and the stimulation was well tolerated. Cortical excitability was decreased during the wash-in phase while it remained unchanged during the intervention phase (MEP: p= 0.03, mean difference: 542.7uV, Cohen's d= 1.03). The application of tRNS resulted in improved total scores for both sensory assessments (GRASSP: p=0.07, mean difference= 1.13, Cohen's d= 0.57; rNSA: p=0.3, mean difference= 1.63, Cohen's d= 0.2). Motor performance of the tested hand was slightly better during the intervention compared to wash-in phase (GRT: p=0.3, mean difference= 2.9, Cohen's d= 0.2). No differences were observed in key pinch strength. Conclusion: Three sessions of tRNS can improve sensory function in persons with cSCI but are not sufficient to induce a persistent facilitatory cortical effect. Overall, tRNS combined with FTP may be a promising clinical tool for improved UE function in individuals with cSCI.

Learning Objective 1

Discuss the efficacy of transcranial random noise stimulation on cortical excitability and hand function

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Poster 9

Alterations of Visual Cortex in Chronic Adult SCI: The Underpinnings of the resting state BOLD fMRI

Abstract 181

Laura Krisa, PhD, Thomas Jefferson University College of Rehabilitation Sciences

Objective: Functional visual cortices are primary contributors to the process of movement. It is important to determine whether traumatic spinal cord injury (SCI), which is a disorder that results in sensorimotor dysfunction, leads to structural and functional alterations of visual-related brain regions. Imaging studies have suggested such alterations but it is still largely unexplored. In this study, we compared resting state quantitative measures of areas involved in visual processing and perception between chronic SCI patients and uninjured healthy controls to discover the impact of SCI on visual NeuroMatrix. Materials and Methods: Resting-state functional magnetic resonance imaging (rs-fMRI) data were obtained for 7 SCI patients and 15 healthy controls. These data were preprocessed using Data Processing & Analysis for Resting-State Brain Imaging (DPABI, V5.1_201201) based on Statistical Parametric Mapping (SPM12)2 running on MATLAB R2020b. The resting state quantitative measures (Amplitude of Low Frequency Fluctuation (ALFF), fractional ALFF (fALFF), Degree of Centrality (DC), Regional Homogeneity (ReHo), and Voxel-Mirrored Homotopic Connectivity (VMHC)) were used to assess each subject's brain visual neural activity. A total of 37 Regions of interest (ROIs) were selected from customized functional atlas of human occipito-temporal visual cortex. The differences between the two groups were investigated through linear regression analysis using age and gender as confounding variables. The results were also corrected for multiple comparisons by False Discovery Rate (FDR) correction. Significance levels were set to 0.05. Results: Varying degrees of global and regional reorganizations of visual NeuroMatrix have been observed in chronic SCI participants when compared with uninjured healthy groups. These changes were bilateral and primarily focused on areas in the occipital lobe. All five resting state quantitative measures were sensitive to representative organization of the visual cortex. Regions that illustrated significance were: left mid-lateral fusiform gyrus (mFus), left occipital temporal sulcus (OTS), left middle temporal gyrus (MTG), left abstractior OTS, left middle temporal cortex (hMT), left V2 ventral, left V3 ventral, right mFus, right abstractior lateral fusiform gyrus (pFus), right OTS, right MTG, right collateral sulcus (CoS), right V2 ventral, right V3 ventral, and right superior colliculus (SC). Conclusion: Our findings demonstrated significant alterations in regional neural activity and functional connectivity in SCI patients. These results may suggest the theoretical basis behind the effects of visual feedback training SCI patients undergo in motor function rehabilitation. This could potentially lead to the future development of visual-related rehabilitation therapies that may exceed the effectiveness of the therapies available today.

Learning Objective 1

Discuss basic usage of rs-fMRI in brain imaging

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Poster 10

American Spinal Injury Association (ASIA) Impairment Scale (AIS) conversion underestimates neurological recovery following traumatic spinal cord injury

Abstract 192

Winward Choy, MD, University of California San Francisco

Objective The predominant tool used in the evaluation of neurological outcomes following spinal cord injury (SCI) includes the American Spinal Injury Association (ASIA) Impairment Scale (AIS) and motor scores within the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI). However, there are significant clinical and functional differences within AIS grades that can be better captured by full motor scores. Here we compare AIS conversion and total motor score improvement as endpoints in the evaluation of established SCI related prognostic factors. Methods 55 patients with acute traumatic SCI who underwent surgery were retrospectively analyzed as part of a prospective cohort study, Transforming Research and Clinical Knowledge in SCI (TRACK-SCI). Clinical, radiographical and treatment parameters were collected, including AIS grades and full motor scores on presentation and discharge, Brain and Spinal Injury Center (BASIC) scores. All but 2 patients underwent surgical treatment within 12 hours of presentation. Multivariable analysis was utilized to evaluate predictors of neurological recovery utilizing AIS grade and motor scores as endpoints. Results Improvement of at least 1 AIS grade from presentation was noted in 27% (15 of 55) patients with a mean improvement of 0.3 AIS grades ($p < 0.001$) upon discharge. Improvement of total motor scores was noted in 67% (37 of 55) with a mean recovery of 8.4 points. The discordance between rate of AIS grade conversion and motor score recovery was greatest in patients with initial AIS grade D, (16% vs 72%, respectively). Total motor score improvement was greatest for patients with initial AIS grade C, with a mean improvement of 20 points. Utilizing multivariate analysis, BASIC score and initial total motor score were significant predictors of motor score recovery. However, no variables were prognostic when utilizing AIS conversion as the endpoint. Conclusions AIS conversion underestimates true degree of functional improvement following SCI. Changes in full motor score is a more robust outcome metric in the evaluation of factors prognostic of neurological recovery following injury.

Learning Objective 1

analyze rates of AIS conversion following surgical treatment of acute traumatic SCI

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Poster 11

Exploratory Analyses of Factors Associated with Discharge Home after Acute SCI Inpatient Rehabilitation

Abstract 69

Elizabeth Pasipanodya, PhD, Santa Clara Valley Medical Center

Research Objective(s): To examine the influence of focal demographic and injury characteristics typically associated with health disparities (race/ethnicity, sex at birth, and insurance status) on rates of discharge home after acute inpatient rehabilitation (AIR) among individuals with traumatic spinal cord injury (tSCI). Design: Retrospective Review Setting: Acute Inpatient Rehabilitation Participants: Nine hundred and thirty individuals with tSCI admitted to AIR from 2008-2020. Main Outcome Measure(s): Discharge disposition (i.e., home vs. alternate setting) Results: Discharge to home rates were similar among males (82.7%) and females (82.8%; p=.965). Discharge to home rates for non-white tSCI patients in this cohort were also not significantly different among white and non-white individuals (81.3% vs. 84.2%, p=.254). Several logistic regression models were conducted to explore the influence of focal predictors on rates of discharge home from AIR; sex at birth, race/ethnicity, and insurance status were not significantly associated with disposition status. However, within the sex at birth model, greater total Functional Independence Measure at discharge (FIM; odds ratio [OR]: 1.06, p<.001), longer length of AIR (OR:1.05, p<.001), as well as Case-Mix Group (CMG) B assignment (OR: 1.92, p=.036) were found to significantly increase the probability of being discharged home. The race/ethnicity model similarly suggested that greater FIM (OR: 1.06, p<.001), longer length of AIR (OR: 1.06, p<.001), and CMG B assignment (OR: 1.89, p=.046) were associated with increased probability of being discharged home; conversely, older age at admission (OR: 0.99, p=.029) and CMG D membership (OR: 0.45, p=.011) were associated with lower odds of discharge home. Similar to previous findings, the insurance status model revealed greater FIM (OR: 1.06, p<.001), longer length of AIR (OR: 1.06, p<.001), and CMG B membership (OR: 1.89, p=.043), to be associated with increased probability of discharge home, while CMG D membership (OR: 0.48, p=.017) was associated with lower odds of discharge home. Conclusions: Disparities in AIR outcomes have been noted in the literature. Although sex at birth, race/ethnicity, and insurance status were not significant factors associated with disposition status in this cohort, this study identified several factors (i.e., length of AIR stay, FIM total score, CMG, and age) to be significantly related to the discharge disposition for individuals with tSCI. Further attention and work should be given to understanding disparities in rehabilitation outcomes.

Learning Objective 1

Discuss factors associated with discharging home for individuals with traumatic spinal cord injury.

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Poster 12

A Pilot Survey Identifying Gaps in Spinal Cord Injury Intervention in Post-Acute Care Settings: A Therapists Perspective

Abstract 176

Rebecca Hutton, OTS, Grand Valley State University

Background: The purpose of this study is to identify the gaps in the post-acute care interventions for clients with an SCI from an occupational and physical therapist's perspective. Surveying therapists may provide insight into gaps in the post-acute care rehabilitation intervention plan. Gaining perspective may provide insight to healthcare professionals when developing intervention plans for clients following an SCI Method. This cross-sectional descriptive study used an online pilot survey to collect data from a sample of occupational therapists, certified occupational therapy assistants (COTAs), physical therapists, and physical therapist assistants (PTAs). Participants answered questions about their demographics, the frequency of which they educated their clients with SCI on specific rehabilitation topics, and their level of confidence in their ability to educate clients with SCI on the same rehabilitation topics. Results in our sample (N=66), more than half of the therapists surveyed frequently educate their clients with SCI on topics of autonomic dysreflexia (80%) and bladder management (55%), and half (50%) of the therapists educate their clients on bowel programs and sexuality. About half of the therapists surveyed feel comfortable in their ability to educate their clients on autonomic dysreflexia (56%), and half (50%) feel comfortable educating clients on bladder management. Less than half of the therapists surveyed are confident in their ability to educate their clients with SCI on topics of bowel programs (44%), fertility (11%), and sexuality (26%). Therapists surveyed believe that ineffective caregiver training contributes to decreased quality of life for clients with SCI (88%), clients should have a longer rehabilitation stay (77%), and caregivers express lack of role preparedness related to coordinating care (71%). Conclusions This pilot study suggests gaps in post-acute care interventions for clients with SCI negatively impact quality of life and increase risk of hospital readmissions. Further research is needed to examine the origin of such gaps to improve continuity of care for clients with SCI.

Learning Objective 1

Identify education and potential training needs for occupational and physical therapy practitioners working with individuals with spinal cord injuries.

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Poster 13

Metabolites role in bio-fluids as a prognostic indicator of neurological recovery in Acute Spinal Cord Injury (ASCI)

Abstract 191

Alka Sinh, PhD, King George's Medical University

Introduction: A prospective case-control study based on serum and urine biofluids with 1H NMR spectroscopic metabolic profiling was carried out to evaluate metabolites perturbations and their relationship with recovery and to see the role of stem cells in facilitating neurological recovery. Methodology: A total of 135 subjects were enrolled in the study; 65 ASCI subjects, were divided into 2groups. Fixation alone (FA, n=34). Fixation with stem cells therapy (FST, n=31). Seventy healthy subjects (HCs) were enrolled. Serum and urine samples were collected at admission, at 6 weeks, 3, and after 6 months. NMR data of serum and urine samples were quantified and subjected to multivariate analysis using supervised OSC-PCA followed by OPLS-DA performed in the full study. This finding was further validated in the VIP scores. Result: An OSC-PCA and OPLS-DA model was created for investigating the role of metabolites in differentiation amid all ASCI subjects against healthy control at baseline as well as at final follow-up. The 3D scattered score plots represented the shifting of more ASCI subjects towards healthy control in the final follow-up, which is an indicator of a better prognosis. Conclusions: Serum and urine NMR spectroscopy reveals certain metabolites perturbations having a clear correlation with the pattern of recovery in treated ASCI subjects. The stem cells treatment group had comparatively effective recovery.

Learning Objective 1

1H NMR spectroscopic metabolic profiling was carried out to evaluate metabolites perturbations and its relationship with recovery and to see role of stem cells in facilitating neurological recovery.

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Poster 14

Changing Bowel Pattern in Young Man with Chronic Paraplegia and Neurogenic Bowel: A Case Report

Abstract 19

Kaila Yeste, DO, University of South Florida

Patient is a 30-year-old male with a history of gunshot wound through left axilla to T11 with concomitant injury to artery of Adamkiewicz resulting in T5 AIS A spinal cord injury and associated neurogenic bowel who presents with change of bowel pattern and abdominal pain for one month. He is thin in appearance and describes a ten-pound weight loss in the last year. His regular bowel regimen includes oral stimulants following by digital stimulation; however, he tried additional laxatives for four days without significant output. He began experiencing watery diarrhea every 1-2 hours which has been three weeks prior to clinic visit. He denies any changes in diet, which is low in dairy and high in vegetables. He denies any other associated symptoms. An abdominal radiograph shows possible mild fold thickening of the transverse colon which can be seen with spasms or inflammation. He is advised to decrease oral stimulant, add stool-bulking agents, and replace digital stimulation with transanal irrigation. Two weeks later, he reports ongoing diarrhea despite compliance with bowel regimen as well as new fevers and hematochezia. Outpatient workup shows a mildly elevated ESR and CRP. A few days later, his high fevers recur and he presents to the emergency department. A CT abdomen shows a fluid-filled descending colon with wall thickening and inflammation of the rectosigmoid colon and rectum as well as large, retained stool in the ascending colon and dilated small bowel loops. Urine studies show presence of a urinary tract infection and antibiotics are initiated. Fecal studies show elevated leukocyte lactoferrin. Gastroenterology recommends serial radiographs and ongoing antibiotics with coverage for possible colitis. His constipation improves on radiographic evaluation, and he is discharged with a course of oral antibiotics. Three weeks later, he develops similar symptoms and colonoscopy is attempted, showing extensive inflammation up to transverse colon, consistent with inflammatory bowel disease. While neurogenic bowel is common after spinal cord injury, practitioners should remain wary of inflammatory bowel disease, particularly in those ages 15-35 who develop hematochezia. Other causes of hematochezia can include hemorrhoids, fissures, diverticulosis, or trauma associated with digital rectal stimulation; however, fecal calprotectin is a marker useful in differentiating the cause. Delays in diagnosis or misdiagnosis can lead to detrimental complications including fistula or ulcer formation, bowel narrowing and obstruction, bowel rupture, malnutrition, toxic megacolon, and colon cancer – all of which could be life-threatening particularly in a patient with a spinal cord injury whether by way of dysreflexia or delayed treatment due to sensory dysfunction. Therefore, evaluation via endoscopy is paramount if inflammatory bowel disease is suspected. In one case-control study comparing colonic lesions in patients with SCI versus control, the most frequent lesions in the SCI group were IBD (16%) versus hemorrhoid in the control group (17%). Further information on the correlation of spinal cord injury and inflammatory bowel disease is not well documented, and this case illustrates the complexity of such diagnosis.

Learning Objective 1

Describe the initial presentation and diagnosis of inflammatory bowel disease in patient with chronic paraplegia.

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Poster 15

Exploration of Urinalysis and Urine Culture Results during Urinary Symptom State Transition in People with Neurogenic Lower Urinary Tract Dysfunction Who Use Intermittent Catheterization

Abstract 110

Allison Maxwell, BA, Rush Medical College, MedStar National Rehabilitation Hospital, MedStar Health Research Institute

Background: People with neurogenic lower urinary tract dysfunction (NLUTD) who use intermittent catheterization can experience extensive urinary symptoms.1-4 UTI diagnosis in SCI/D patients with NLUTD is complex due to altered perception of urinary symptoms.5 They also may have consistent evidence of bladder inflammation and bacteriuria when they are asymptomatic.6-8 Objective: Explore urinary symptoms, urinalysis (UA) results, and urine culture (UC) results for people with NLUTD using intermittent catheters who "transition" from asymptomatic at the time of urine sample collection to symptomatic within 72 hours after. Methods: As a subproject of a cross-sectional study aiming to define "healthy" urine in SCI/D NLUTD patients, urine was collected from asymptomatic patients when they endorsed no items on the self-administered Urinary Symptom Questionnaire for Neurogenic Bladder (USQNB) 72 hours prior to collection. We monitored patients for 72 hours after urine collection, with patients completing the USQNB at 24, 48, and 72 hours.9 "Transition" is defined as patients with no USQNB symptoms for 72 hours prior to urine collection, but who reported at least one USQNB symptom within 72 hours post-sample. Results: 12 individuals (3 females, 9 males, mean age 44 years ± 12 years) reported symptoms within 72 hours of urine collection, with 5 people experiencing this on 2 occasions (total 17 samples). New urine quality symptoms were the most endorsed USQNB symptoms emerging within 72 hours of the sample (cloudier urine: 33%, darker urine: 28%, fouler smelling urine: 22%). Bladder Specific symptoms were also noted (increased incontinence and leakage: 22%). 65% of UAs are leukocyte esterase (LE) positive (defined as greater than "trace") and 53% of UAs meet the clinical definition of pyuria.7,10 75% of UCs show bacterial growth >100,000 CFU/mL, most commonly was Escherichia coli. These patients also had 20 urine samples that were asymptomatic for 72 hours before and after the sample collection. UC results show that 60% of patients had different bacterial growth on culture while asymptomatic than in the transition phase. For instance, one participant UC grew >100,000 CFU/mL of E. coli when experiencing symptom transition, but in their asymptomatic UC only 3 weeks prior, bacterial growth on UC showed 1,000-9,000 CFU/mL of β-hemolytic Group B Streptococcus. Discussion: Consistent with previous literature, Group B USQNB symptoms are most common in NLUTD patients.11 As expected, out of UAs for patients experiencing symptom transition, 53% of individuals had pyuria and 65% were positive for LE. Yet, these results are similar to UA results for the same individuals when asymptomatic.12 Further, no single USQNB symptom was associated with any given UC or UA result. Conclusion: This is the first descriptive analysis of patient-reported symptomatic transition. These results do not find a clear trend in urinary symptoms, UA, or UC, though that may be due to the small sample size. Our team continues to explore how urobiome changes are linked with urinary symptoms in patients with NLUTD. The results suggest that UC and UA, even when considering symptoms, may not adequately capture potentially relevant transitions to symptomatic urinary states. Support: DOD #SC18021

Learning Objective 1

Describe transition in urinary symptom states using urinalysis and urine culture in the NLUTD population.

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Poster 16

Survey of US Intermittent Catheter Users shows a lack of confidence in completely emptying their bladder

Abstract 154

Melanie Goodman Keiser, PhD, Coloplast A/S (US)

Objective: The purpose of an intermittent catheter (IC) is to empty the bladder. However, post-void residual volume, one of the urinary tract infection (UTI) risk factors, can be due to product design or incorrect handling of ICs.[1] We analyzed data from a global survey asking IC users about their experience with complete bladder emptying. Design/Methods: An online questionnaire was emailed to IC users in the Coloplast global database, which includes users of locally available manufacturers, from 13 countries in March 2022. Only responses from the United States (US) were used in this analysis. The majority of questions had a predefined list of answers; however, several questions included open answers to allow respondents to type in additional answers. Results: One hundred eighty-six US IC users responded to the survey. Most respondents were male (72%) and over 50 years (79%). Twenty-one percent of responding IC users are not certain if their bladder is completely empty when they remove their catheter. The percentage of respondents that have been diagnosed with residual urine by an HCP since starting IC is 6%; however, an additional 16% don't know if they have had residual urine. While using IC, 54% of respondents experienced their urine flow stopping before their bladder was completely empty. To reposition their catheter, 69% slowly withdraw the catheter, 51% withdraw the catheter in small steps, and 11% do nothing more to empty their bladder. Among those who reposition their catheter, 95% reported that they experience their urine begins flowing again. Of this 95%, 55% say that the urine flows once, while 33% say it flows more than once. Although 75% of respondents worry about getting UTIs, almost half (46%) also worry about not emptying their bladder completely. Conclusion: Many patients using IC are worried about not fully emptying their bladder and are not certain if they are able to do so. Additionally, bladder emptying techniques are inconsistent with the majority of IC users reporting that reposition their catheters to empty their bladders. Future catheter innovations should address this uncertainty of incomplete bladder emptying that creates post-void residual volume, a known UTI risk factor. Support: This study was supported by Coloplast A/S.

Learning Objective 1

Describe how patients view post-void residual volume after using intermittent catheters.

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Poster 17

The temporal burden associated with preparing catheters for reuse among people with spinal cord injury: a cross-sectional study

Abstract 39

Liza Roik, BHSc, University of British Columbia

Background: Neurogenic lower urinary tract dysfunction is very common among individuals with spinal cord injury (SCI). Although single-use clean intermittent catheterization is recommended for routine bladder emptying, catheter re-use is commonly practiced for various reasons (e.g., environmental, financial). Barriers associated with the preparation (i.e., cleaning) of catheters for re-use in people with SCI are unknown. Objectives: To examine the barriers associated with catheter reuse in adult individuals with SCI by assessing (1) the time needed to clean a non-hydrophilic catheter for re-use, and (2) perceived catheter cleaning routine difficulty and overall catheter cleaning routine satisfaction. Methods: Twenty individuals with chronic SCI (≥1 year since injury; Group 1=10 people with tetraplegia; Group 2=10 people with paraplegia) participated in this cross-sectional study. Using a standardized procedure (i.e., Milton method), catheter cleaning was timed for each participant. Following the catheter cleaning routine, participant-reported outcomes (i.e., difficulty, satisfaction) were assessed using a 5-point Likert scale. Functional impairment was assessed with the Upper Extremity Motor Score (UEMS), light touch and pin prick sensation scores. Perceived spasticity was also assessed using the Penn Spasm Frequency Scale (PSFS). Between-group differences were determined using Mann-Whitney U tests ($p \leq 0.05$). Associations between total cleaning time and other variables were assessed using Spearman's rho ($p \leq 0.05$). Finally, hierarchical multiple regression analysis was used to identify associations between potential predictor variables identified in the bivariate correlation analysis and the dependent variable (i.e., total cleaning time) ($p \leq 0.05$). Results: Significant between-group differences were observed for time since injury, UEMS, sensation (light touch, pin prick), and PSFS (frequency subscale) ($p \leq 0.048$). Significant between-group differences were also observed for total cleaning time (Group 1=1584.1±179.8sec; Group 2=1321.0±93.8sec, $p=0.004$) and perceived difficulty [Group 1=2.6 (2, 3); Group 2=2 (1.7, 2.3), $p=0.028$] but overall satisfaction. Total cleaning time was significantly correlated with UEMS ($\rho=-0.709$, $p \leq 0.001$) and perceived difficulty ($\rho=0.468$, $p=0.037$). In the regression analysis, UEMS emerged as an independent predictor of total cleaning time ($R2=0.745$, $\beta=-0.833$, $p \leq 0.001$). Conclusions: This study showed that preparing non-hydrophilic catheters for re-use is relatively more time-intensive and difficult for people with higher SCI level, severity and more pronounced upper limb motor impairment, which was independently associated with total cleaning time. The total catheter cleaning time observed for both participant groups in this study represents a significant temporal burden that may substantially impact overall health-related quality of life among individuals with chronic SCI.

Learning Objective 1

Discuss barriers associated with intermittent catheter reuse in adults with spinal cord injury

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Poster 18

May I have this dance: A case-series on the acute cardiometabolic demand and psychosocial effects of wheelchair dancing in recreational Para-dancers with spinal cord injury

Abstract 58

Tiev Miller, PhD, International Collaboration on Repair Discoveries

Background: Wheelchair dance, also known as Para-dance, is an adaptive sport which has grown in popularity among people with disabilities and is currently under consideration for inclusion in the 2024 Paralympic Games. Competitive Para-dance can be performed in a variety of styles [e.g., ballroom (tango, waltz, jazz, Latin), classical, ballet, modern dance, ethnic/folk dance, etc] and is either done in pairs involving a wheelchair dancer and an able-bodied partner (Combi) or two Para-dancers (Duo). Despite its rising popularity, the cardiometabolic demands and psychosocial benefits associated with this activity remain understudied. The purpose of this preliminary case-series was to examine cardiovascular, metabolic and psychosocial responses during two Para-dancing routines with different tempos (i.e., slow and fast). Methods: This pilot case-series involved the use of repeated measures (i.e., pre-, during and post-dance) for three participants with non-traumatic spinal cord injuries (SCI) [males, age: 42±13 years, C3-T12, AIS D, schwannoma=1, poliomyelitis=1, ependymoma=1]. Participants were recruited through a local dance organization, with each pair of Combi dancers (i.e., one Para-dancer and one able-bodied partner) performing one slow Para-dance routine in Rumba style at a tempo of 80 beats per minute (bpm) and one fast Para-dance routine in Salsa style at a tempo of 170 bpm. Cardiometabolic variables [i.e., blood pressure (BP), heart rate (HR), relative oxygen consumption (VO2), metabolic task equivalent (MET)] and psychosocial variables [i.e., enjoyment (EES), ratings of perceived exertion (RPE), and Brunnel Mood Score (BRUMS)] were assessed. Results: All participants showed an elevated HR and relative VO2 from rest (pre) to dancing (during) with a subsequent decrease in these variables post-dance for both slow and fast Para-dance routines. Relative to the slow routine, 2 out of 3 participants demonstrated greater change in (Δ)HR, Δrelative VO2, ΔRPE and ΔEES during the fast Para-dance routine. For all 3 participants, METs ranged from 1.7-2.4 and 2.1-3.8, suggesting these Para-dance interventions were of light to moderate intensity for slow and fast dance routines, respectively. Enjoyment ratings ranged from “quite a bit” to “extremely” (EES=5-6, slow routine and EES=6-7 for the fast routine). No differences in BRUMS subscales were observed for all three participants. Conclusion: Our preliminary findings indicate this intervention elevated cardiometabolic demand and was enjoyable. Responsiveness observed among these three participants demonstrates the potential of Para-dance for promoting physical activity and improving psychological well-being among the broader population with SCI. Evaluating differences in Para-dance intensity (i.e., tempo) may also aid in the development of adaptive activity guidelines for wheelchair users.

Learning Objective 1

Define Para-dance and list the cardiometabolic and/or psychosocial differences observed between slow and fast tempo routines in this pilot study

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Poster 19

Comorbid Cardiac Disease in New Spinal Cord Injury with Successful Functional Outcome: A Case Report

Abstract 146

Zackery Billington , DO, University of Miami

Objective: 62 year old paraplegic male status post urgent T9-L1 decompression and fusion due to compression fracture at T11 with cord compression at a local outside hospital. Further past medical history consists of heart failure with reduced ejection fraction (Left Ventricular Ejection Fraction 15% 2018) secondary to ischemic cardiomyopathy, status post Drug Eluding Stent (DES) to the Left Anterior Descending (LAD) in 2014, Automatic Implantable Cardioverter Defibrillator (AICD), persistent atrial fibrillation (on amiodarone, metoprolol and warfarin), hypertension, dyslipidemia, Chronic Obstructive Pulmonary Disease (COPD) and monoclonal gammopathy (MGUS). He was admitted to the spinal cord injury unit on 11/08/21 due to a recent fall causing incomplete paraplegia T8 AIS B. Patient's hospital course was complicated by atrial fibrillation with rapid ventricular response (RVR) and associated acute hypoxic respiratory failure secondary to decompensated systolic heart failure with his level of care upgraded to the Coronary Care Unit (CCU) on 11/20/21. His bedside echo with limited views showed an ejection fraction of 10-15%. The patient was started on aggressive diuresis, heparin drip, amiodarone drip and digoxin in addition to his home regimen of metoprolol, sacubitril/valsartan, and atorvastatin. Mechanical cardioversion could not be done due to a laminated mural apical thrombus of the left ventricle on Transesophageal Echocardiogram (TEE) on 11/23/22. Patient was bridged to warfarin with cardiology recommendations to continue oral amiodarone, sacubitril/valsartan, metoprolol XL, furosemide, spironolactone, and atorvastatin. Patient was transferred to the spinal cord unit on 11/26/22 for further rehabilitation and monitoring of his complicated medical status. Patient's rehabilitation course was complicated by atrial fibrillation with rapid ventricular rate leading to subsequent acute heart failure exacerbation, cardiorenal syndrome and COPD exacerbation/pulmonary edema necessitating diuresis and subsequent monitoring. Patient's rehabilitation course was further complicated by neurogenic bowel, requiring Parasteen for continence and bowel movements, neurogenic bladder requiring Foley catheter for continence, spasticity treated with oral Baclofen and a foot wound treated by inpatient wound care team. Patient was able to reach mod I functional level with his power wheelchair while inpatient, but maintained at a dependent level with LBD, transfers and toileting and was ultimately discharged to subacute nursing facility. Conclusion: This study highlights the importance of understanding comorbid conditions in our patient population, as well as medical treatment issues that arise in this population, and how this affects their rehabilitative course. Also, with newer literature showing post-ischemic conditioning improving organ function after injury, this is likely going to increase incidence of rehab stays for this patient population.

Learning Objective 1

Learning Objectives: Discuss and examine the comorbid conditions many patients with spinal cord injury present with, highlighting the multi-disciplinary, team-based approach to their medical treatment.

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Poster 20

Risk of ischemic heart disease readmission after traumatic spinal cord injury

Abstract 164

Analisa Jia, MSc, University of British Columbia

Objective: Traumatic spinal cord injury (tSCI) causes significant personal and societal costs. Changes resulting from tSCI predispose those affected to the development of secondary complications requiring health-care services, with 95% of patients experiencing at least one associated medical condition. Readmission following tSCI hospitalization adds to the individual and public burden of these injuries. In particular, cardiovascular disease has been shown to occur early following SCI and has emerged as one of the leading causes of death among individuals with SCI. This study aims to evaluate the risk of ischemic heart disease (IHD) readmission after tSCI. Data and Methods: The 2019 Nationwide Readmission Database contains data on 60.4% of all United States hospitalizations, containing approximately 35 million (weighted) discharges. This study used population weighting to determine national estimates. Using all follow-up data up to 1 year after discharge from SCI hospitalization, Kaplan-Meier curves were constructed to estimate the cumulative risk of IHD, overall and stratified by sex. Cox proportional hazard models were used to calculate the hazard ratios and 95% confidence intervals for IHD readmission for males vs. females. Unadjusted, age-adjusted, and multivariable-adjusted models were created to adjust for confounding. Results: Using population weighting, a total of 14,589 patients with an index SCI hospitalization in 2019 were identified, of which 10,232 (70.1%) were males, and 4,357 (29.9%) were females. A total of 348 patients hospitalized for SCI were readmitted with IHD within the calendar year, resulting in a 2.4% overall readmission rate. Among those with an IHD readmission, the median time to readmission was 52 days for males (Interquartile Range [IQR] = 19-134) and 63 days for females (IQR = 24-146). By the end of the calendar year, the overall cumulative risk of IHD readmission was 4%, with no significant sex differences (log-rank p-value = 0.348). No significant sex differences were observed in the Cox models. In the multivariable-adjusted Cox model, age was significantly associated with IHD readmission (HR:1.05, 95%CI 1.04□1.06, p<0.001). Conclusion: No significant sex differences were observed in the risk of readmission within a follow-up period of up to 1-year, after adjusting for age and potential confounders. Findings reported within our study may serve to assist in the understanding of the cardiovascular risk associated with SCI. Future studies should examine cardiovascular risk in a longitudinal cohort design with a longer follow-up period to assess whether observed risks change with increasing time following SCI.

Learning Objective 1

Evaluate the risk of ischemic heart disease readmission following hospitalization for traumatic spinal cord injury using nationally representative data with time-to-event information

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Poster 21

Vascular spinal cord dysfunction survival analysis and hazard ratio 1995-2020

Abstract 41

Melanie White, DO, Mayo Clinic

Background: Vascular myelopathies are a common cause of spinal cord dysfunction but there is little data on survival. This study aggregates data from a single inpatient rehabilitation center to evaluate survival. Design: A retrospective review of 2,880 inpatient rehabilitation admissions for spinal cord injury between 1995-2020 was performed and 235 were found to have vascular etiologies that met inclusion criteria. Patients were included with a new vascular spinal cord dysfunction and admission to the inpatient rehab unit. A total of 19 patients were excluded accounting for duplicates, lack of consent, and lack of data. One additional patient was excluded due to lack of date of death, leaving a total of 234 patients analyzed. Methods: The vascular group was subdivided into hemorrhagic, vascular malformations, and ischemic etiologies. The groups were compared based on etiology in terms of overall survival and hazard ratio. Data was analyzed using Kaplan-Meier survival analysis and Cox proportional hazard ratio via BlueSky Statistics software. Results: Of the 234 vascular injuries, overall median survival for all vascular injuries was 12.38 (95% CI [8.84,13.86]) years with median follow up of 7.21 years. Survival differed significantly between groups. Ischemic myelopathies had significantly shorter survival at 7.46 years compared to hemorrhagic causes (13.86 years) and vascular malformations (15.00 years) (p=0.001). Median follow up for hemorrhagic causes was 7.70 years, malformations 7.18 years, and ischemic 7.34 years. Paraplegia had a 78.6% decreased risk of death compared to those with tetraplegia (p=0.412 95% CI [0.44, 1.40]) and incomplete injuries had a 53% decreased risk of death compared to complete injuries (p=0.04, 95% CI [0.30, 0.97]). Conclusions: Overall median survival for the 234 vascular spinal cord injuries was 12.32 years. Level of injury did not increase risk of death, but incomplete injuries had a 53% decreased risk of death compared to complete injuries.

Learning Objective 1

Discuss survival and hazard ratio in patients with vascular spinal cord dysfunction.

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Poster 22

Breastfeeding for mothers with spinal cord injury: A narrative review on the quality and availability of current guidelines

Abstract 71

Tiev Miller, PhD, International Collaboration on Repair Discoveries

Background: Breastfeeding in the postpartum period confers important health benefits to mother and child. However, for mothers with spinal cord injury (SCI), breastfeeding efficacy is affected by various mechanical (e.g., hand function, positioning) and physiological factors (e.g., autonomic dysreflexia triggered by suckling, engorgement, or mastitis). Although these barriers to breastfeeding are common, there are no gold-standard guidelines for mothers with SCI and their healthcare providers to refer to. The purpose of this review was to examine the quality of currently available breastfeeding guidelines for mothers with SCI, and identify whether gaps exist across clinical recommendations. Methods: An environmental scan was performed to identify existing postpartum and breastfeeding guidelines. A PubMed keyword search (terms: breastfeeding, lactation, nursing, postpartum, guidelines, SCI, physical disability, disability) was conducted to identify relevant resources, and all collaborators and appraisers were asked to share national and/or al guidelines for their country and/or health authority. Guidelines were evaluated using the AGREE II tool by a group of 13 raters consisting of clinicians and researchers (n=10) as well as mothers with lived (i.e., breastfeeding) experience after SCI (n=3). A total of 7 guidelines were identified and evaluated using Domain 1 to determine applicability for mothers with SCI and Domains 2-7 if the guideline specifically focused on mothers with SCI. Scaled scores were calculated for each domain. Kappa coefficients with 95% confident intervals (95% CI) and percent agreement (%) were used for determining inter-rater agreement. Results: Of the 7 guidelines appraised, only one mentioned SCI (Postpartum Care in SCI from BC Women's Hospital, scaled score=34.5%). There was large variability between domains with none being >50%, suggesting substantial limitations in guideline recommendations. Overall agreement ranged from 15.81% to 67.31% with slight to good inter-rater agreement between appraisers (n=13, kappa range=0.02–0.62, 95% CI: -0.05–0.80). All other guidelines were appraised for Domain 1 only (scaled scores range=0.5%–17.7%). Overall agreement ranged from 47.01%–93.33%, with fair to excellent inter-rater agreement between appraisers (n=10–13, kappa range=0.38–0.92, 95% CI: 0.03–1.00). Conclusions: Overall, most guidelines did not meet the needs of mothers with SCI in the postpartum period. Only one guideline mentioned mothers with SCI which was found to have substantial global deficits. The development of new comprehensive guidelines are needed moving forward.

Learning Objective 1

Describe the common barriers to breastfeeding among mothers with spinal cord injury and list the current breastfeeding guidelines which specifically focus on mothers with spinal cord injury.

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Poster 23

Retrospective analysis of the treatment of BPPV in persons with sub-acute spinal cord injury

Abstract 115

Ryan Koter, PT, DPT, Shepherd Center

Purpose/hypothesis Rehabilitation after spinal cord injury (SCI) necessitates progression of individuals' functional mobility and activities of daily living through physical and occupational therapy. Benign paroxysmal positional vertigo (BPPV) can commonly cooccur with traumatic SCI and can negatively impact tolerance of therapy, tolerance of frequent changes of position in bed, and individuals' progression towards independence with mobility. Standard screening and treatment procedures for BPPV require cervical range of motion and body positioning often not tolerated or feasible after acute spinal stabilization. The purpose of this study is to determine safety and effectiveness of modified BPPV treatment and discuss feasibility in its application to clinical practice. Design/Methods Nineteen individuals with SCI participated in this retrospective analysis. All persons were undergoing inpatient rehabilitation within 3 months of initial injury. Screening and treatment occurred between January 2020 and April 2021. Patients experiencing vertigo were referred to a clinician with advanced vestibular rehabilitation competency. The therapist obtained a thorough oral history and collected demographic information including: age, sex, International Standards for Neurological Classification of SCI (ISNCSCI) classification, mechanism of injury, relevant comorbidities, presence of spinal precautions or bracing, and other relevant history which may have affected treatment tolerance (e.g. pain, postural deformity). Vestibular examination was performed in accordance with the most recent Clinical Practice Guideline for BPPV. The Dix-Hallpike test, supine roll test, and canalith repositioning procedures were modified to ensure that head angles with respect to gravity remained similar to standard procedures while maintaining spinal stability. Among equipment utilized were a tilt table, hospital bed with Trendelenburg feature, mat table, and foam wedges. Additional clinicians were present to provide assistance as needed. Results Positive BPPV tests were present in 16 of 19 patients (84%). Successful treatment with full reduction of vertigo symptoms occurred in 15 persons (94%), with average two to three clinicians needed to assist with screening and treatment. The majority of patients (n=14) had abstractior canal canalithiasis. Most patients' BPPV resolved within 2 treatment sessions. Most persons with BPPV had incomplete tetraplegia (40%) or complete paraplegia (33%). Nearly half (46.6%) had documented brain injury. Conclusions Results support that BPPV is not uncommon after SCI. BPPV treatment modifications were safe and effective , using common SCI rehabilitation equipment and with secondary hands-on support from additional clinicians. Providers and clinicians working in SCI rehabilitation settings should be prepared recognize the signs and symptoms of BPPV and treat individuals using modified procedures as needed. SCI programs should provide clinicians with adequate training and resources to safely perform modified treatments with an appropriate number of assisting staff members to maximize treatment effectiveness while reducing physical strain on treating clinicians.

Learning Objective 1

Illustrate the incidence of BPPV in an inpatient SCI rehabilitation setting

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Poster 24

Differences in Personal Characteristics and Hospital Utilization Among Ambulatory and Non-Ambulatory Adults with Traumatic Spinal Cord Injury.

Abstract 126

Nicole DiPiro, PhD, Medical University of South Carolina

Objective: Spinal cord injury (SCI) is a heterogenous population, with multiple subgroups according to etiology, time since injury, level, and severity. Further divisions may be made based on function and disability, for example ambulatory versus non-ambulatory. Two-thirds of SCI are incomplete, and many of these individuals maintain or regain the ability to walk. There are noticeable differences among those who are ambulatory, but there has been limited research directly comparing the characteristics of those who are ambulatory to those who are not, and how ambulation relates to long-term health and well-being. Our objective was to compare personal characteristics and hospital utilization based on ambulatory status among a population-based cohort of individuals with chronic SCI. Design/Methods: Prospective cohort study linked to administrative data. Participants in the SCI Prospective Cohort Study were identified through the South Carolina SCI Surveillance System Registry, a surveillance system of all non-military cases of SCI in the state. Eligible participants were adults (>18 years old) with chronic (>1-year), traumatic SCI. Between 2011-2018, 1,060 participants completed self-report assessments (SRA). The SRA included demographic, injury and disability characteristics, as well as health, psychological, behavioral, participation and quality of life variables. We linked to administrative billing data to assess hospital utilization, including Emergency Department visits (EDV) and inpatient (IP) admissions (through the ED and direct IP) in non-federal state hospitals in the year following the SRA. This analysis includes data from 1,051 participants. Results: A greater percentage of ambulatory participants were white, married, uninsured, earned more than $35k per year, and lived in urban locations. More ambulatory adults reported having major depression, chronic conditions, and inadequate sleep. Fewer ambulatory adults had current pressure injuries or past year urinary tract infections and fevers. Ambulatory adults reported lower resilience and perceived support. Fewer ambulatory adults reported taking medication for pain, spasticity, sleep, or stress, but they had more days that pain interfered with usual activities. More ambulatory adults currently smoked and reported having 5+ alcoholic drinks per day in the past month. Ambulatory adults reported needing less physical assistance, spending more hours out of bed, and more days per week out of the house. There were significant differences in hospital utilization. In the year after the SRA, ambulatory adults had fewer EDV (36% vs 44%), IP admissions through the ED (11% vs 25%) and IP only admissions (9% vs 19%), and spent fewer days in the hospital for admissions through the ED (0.9 vs 4.6 days) and IP only admissions (0.7 vs 3.1 days). They also reported having fewer past year EDV (44% vs 62%) and IP admissions (34% vs 52%). Conclusions: This study identified differences in personal characteristics, EDV and IP admissions between ambulatory and non-ambulatory adults with SCI. It provides a better understanding of the characteristics of those with SCI and suggests the need for separate analyses based on ambulatory status when assessing long-term health outcomes including hospital utilization.

Learning Objective 1

Describe the differences in personal characteristics and hospital utilization, including ED visits, ED related admissions, and inpatient only admissions between ambulatory and non-ambulatory adults with chronic SCI identified through a population-based surveillance system.

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Poster 25

Utilization of machine learning techniques in prediction of hospital readmission during one year after spinal cord injury

Abstract 177

Salma Aly, MD, University of Alabama at Birmingham

Objective: The primary purpose was to generate a machine learning (ML) model to predict rehospitalization during 1-year post spinal cord injury (SCI) based on the patients' assessments at the time of discharge from the rehabilitation center including demographic characteristics, trauma etiology, age at injury, presence of vertebral or associated injuries, use of mechanical ventilation at time of discharge, the method of bladder management, history of comorbidities as diabetes, hypertension, arthritis, and hyperlipidemia, history of depression or anxiety, Functional Independence Measure (FIM), level of neurological injury and ASIA Impairment Scale. The specific aim was to identify the predictors for rehospitalization with detecting the modifiable risk factors versus protective ones. Design/Methods: Data were collected from National Spinal Cord Injury Database which is submitted to the National Spinal Cord Injury Statistical Center (NSCISC) at the University of Alabama at Birmingham (UAB). Subjects were those participants with a date of injury from 2011 till 2021. For study, the subjects were divided into 2 groups, rehospitalization, and non-rehospitalization groups. The total sample was 4172 participants, out of them 1438 experienced rehospitalization during 1-year post-injury. Random oversampling was used to treat the class imbalance. Iterative-imputer was used for replacing missing data and one-hot encoding was used for dealing with categorical variables. The data was then split into 80% training data and 20% test data. Random oversampling is used to treat the class imbalance. Seven ML classification models (XGboost, Support vector machine (SVM), Random Forest (RF), logistic regression, Catboost, Decision tree (DT), and Naïve Bayes (NB)) were assessed to predict rehospitalization. Dimensionality reduction and feature selection were done using recursive feature elimination (RFE). The initial number of features included in the model was 98 and reduced to 48 features taking rank one by RFE. The SHAP method was used to interpret predictions. To control model overfitting, data splitting and five-fold cross-validation were performed. Results: Out of the seven models tried, the XGBoost classification model was the best performing with the following evaluation metrics: average accuracy score of 75.5 ± 1.1%, F1 score equals 78.5% with sensitivity of 81.2%, and specificity of 72.3%. The area under the curve (AUC) was 76.7%. According to SHAP results, the top predictors in the model were age at the time of injury, residence in a group living situation, the performance of spinal surgery during initial rehospitalization, presence of associated injury, FIM score, and history of hyperlipidemia, arthritis, diabetes, and hypertension. Conclusion: The XGBoost has the ability of 81.2% to rule in the patients who will be readmitted after SCI (81.2%) based on the assessment at the time of discharge from rehabilitation. Based on the SHAP values, older age at the time of injury, performing spinal surgery, having hyperlipidemia, arthritis, diabetes, and hypertension as comorbidities, and the presence of associated injury are considered to be risk factors for rehospitalization. On the other hand, the higher the FIM score is considered to be a protective indicator.

Learning Objective 1

Create a machine learning prediction model for rehospitalization after spinal cord injury to be used in the clinical setting.

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Poster 26

The influence of concomitant traumatic brain injury on the survival, and neurological and functional recovery after acute traumatic spinal cord injury: A retrospective cohort study using data from the NASCIS-3 trial.

Abstract 76

Julio Furlan, MD, LLB, MBA, PhD, MSc, FRCPC, FAAN, KITE Research Institute & Toronto Rehabilitation Institute, University Health Network; University of Toronto

Background: Concomitant traumatic brain injury (TBI) is relatively common among individuals with acute traumatic spinal cord injury (SCI). In a recent meta-analysis, the mean frequency of concomitant TBI among individuals with acute traumatic SCI was estimated to be 32.5% (Pandrich et al, 2020). Nonetheless, the potential effects of TBI on the outcomes after SCI remain under-studied. This study examined the potential effects of concomitant TBI on clinical, neurological and functional outcomes at 1 year following acute traumatic SCI. Methods: This retrospective cohort study included all 499 individuals who were enrolled in the Third National Spinal Cord Injury Study (NASCIS-3). TBI was defined as a Glasgow coma score below 15 at admission. Individuals with dual diagnosis (SCI+TBI) were compared with the individuals with traumatic SCI alone regarding survival, and neurological and functional outcomes within the first year following SCI. Survival was analyzed using Kaplan-Meier curve and log-rank test. Data on neurological recovery (i.e., NASCIS motor, sensory and pain scores) and functional recovery (i.e., FIM score) were analyzed using multiple regression models adjusted for the major potential confounders (i.e., age at the SCI onset, individuals' sex, NASCIS protocol, level and severity of SCI, and blood alcohol level at the admission). Results: Of the 499 participants of the NASCIS-3, there were 76 females and 423 males with mean age of 35.7 years (range age of 14 to 92 years) who were grouped into individuals with traumatic SCI (n=413) and individuals with SCI+TBI (n=86) who were admitted in an acute care facility with an initial GCS between 10 and 14. Both groups were comparable regarding age (p=0.7101) and sex distribution (p=0.6207). However, the dual-diagnosis group had higher proportion of complete (p=0.0059) and cervical SCI (p=0.0031) and more often received 48-hour methylprednisolone treatment (p=0.0384) than SCI-only group. There was no significant difference between the groups regarding survival following traumatic SCI (p=0.7676). Among the survivors, the dual-diagnosis group showed significantly lower neurological scores and functional scores at 1 year after traumatic SCI than the SCI-only group. After adjusting for the major potential confounders, neurological outcomes (motor, sensory and pain scores) and functional outcome (total FIM score) at 1 year following traumatic SCI were not significantly affected by the concomitant TBI. Conclusions: Individuals with SCI+TBI had more severe SCI and more often sustained cervical tSCI that resulted in less favorable neurological and functional outcomes than individuals with tSCI alone. Nevertheless, the coexistence of TBI and SCI did not appear to intrinsically affect their survival, and neurological and functional recovery within the first year after trauma when data analyses were adjusted for major confounders. Prospective observational studies are required to confirm those findings, when individuals with traumatic SCI are properly screened for symptoms and signs of mild TBI (including cerebral concussion) at hospital admission.

Learning Objective 1 Discuss the effects of concomitant TBI on survival within the first year after traumatic

Learning Objective 2 Discuss the effects of concomitant TBI on neurological recovery within the first year after traumatic SCI.

Learning Objective 3 Discuss the effects of concomitant TBI on functional recovery within the first year after traumatic SCI.

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Poster 27

The State of Spinal Cord Injury Rehabilitation in Youth in Latin America

Hernandez Jimenez, Isaac

Abstract 143

The State of Spinal Cord Injury Rehabilitation in Youth in Latin America Objective:As a developing region, Latin America (LA) faces many challenges in providing care for individuals with spinal cord injuries/dysfunctions (SCI/Ds), including children and adolescents. Physical Medicine and Rehabilitation (PM&R) is a relatively young field in this area, with only 0.25 (Brazil) to 3 (Uruguay) physiatrists per 100,000 habitants. Despite more than 100 PM&R residency programs in LA, SCI Medicine does not exist as a subspecialty. Only Mexico offers neurorehabilitation as a 1-year fellowship opportunity, and only 3 countries offer pediatric rehabilitation as formal subspecialty training. Physical therapists, therefore, are often responsible for directing SCI rehabilitation programming. This lack of SCI specialists, particularly pediatric providers, leads to fragmented care and hinders the rehabilitation team's ability to provide early intervention after SCI onset and establish consistent long-term care with these individuals, thereby minimizing secondary health conditions. Therefore, this study aimed to assess current healthcare providers' needs with regard to providing pediatric SCI rehabilitative care to identify gaps in knowledge and areas to target when developing education training programs. Design/Methods: Healthcare providers (PM&R attendings and residents, non-PM&R specialists, physical and occupational therapists) responded to a 10-question online survey related to the current state of pediatric SCI rehabilitation in LA. Results: 341 healthcare providers from 17 countries participated in the survey. The average age of responding providers was 41 years old (range: 22-67), with the majority (75%) female providers. Slightly over 50% were PM&R specialists, and nearly one-fourth were PM&R residents. Seventy-two percent of those surveyed work with youth with SCI/D, half working in public institutions, 25% in private settings, and 25% in both. Most see less than 5 patients with SCI/D per year, with spina bifida (80%) being the most common diagnosis, followed by trauma, spinal atrophy, cancer (either primary or secondary), and transverse myelitis. The most common age at which care is established is before age 5. Only 10% of the health care providers surveyed reported receiving formal training in pediatric SCI; however, the majority (71%) have an interdisciplinary team structure to assist in their care. Nearly all those surveyed (93%) expressed interest in wanting more information on how to best care for these children and adolescents. Health care providers face multiple challenges in providing care to youth with SCI/D, including lack of human and financial resources, lack of specialized training, lack of awareness of the field's ability to improve health outcomes, inadequate infrastructure, non-accessible environments, and limited and inconsistent resources. Conclusion: There is a need for and interest in providing high-quality pediatric SCI/D care in LA; however, health care providers face many barriers. Results from this survey identify gaps in knowledge and training, suggesting an opportunity for experts in the field from developed countries to increase their involvement in promoting and expanding pediatric SCI/D training and rehabilitation in LA.

Learning Objective 1

Explain the current state of rehabiliation in Latin America in general

Learning Objective 2

Describe the specific state of rehabilitation of pediatric and youth patients with SCI in Latin America

Learning Objective 3

Identify areas of opportunity and strategies to promote and expand knowledge in this topic for providers in Latin America.

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Poster 28

Wheelchair Rugby participation in Spinal Cord Injury individuals in Argentina

Hernandez Jimenez, Isaac

Abstract 157

Objective: People with a spinal cord injury (SCI)) face significant challenges and barriers in their daily living, having a significant impact on their ability to participate in adaptive sports, including wheelchair rugby (WCR). This is an adapted sport that can be played by people with cervical SCI; however, in order to do so, customized durable medical equipment (DME) is required. In Argentina, WCR is played in 4 of its provinces and in 2020 through a national state program players had the option apply for a rugby wheelchair that they, otherwise, would be unlikely to have access to. Design: WCR players answered an online survey in Spanish with 32 questions. Inclusion criteria were: older than 18 years and having a spinal cord injury. Of note, within this survey there was a section only for those who participate in the national program's for rugby wheelchairs. Results: Twenty eight SCI rugby players from Argentina answered the survey. They were on average 34 years old (range: 23-51. With all of them being male. According to their self-reported neurological level of injury: 24 had a cervical injury, 2 thoracic, 1 lumbar and 1 did not know. Twenty four had SCI due to trauma, 11 required minimal assistance, 8 moderate assistance, 1 total assistance and 8 were independent. Twenty four of them have been injured for more than 3 years. Only 8 of them started playing rugby due to the recommendation of a healthcare professional (physical therapist in all cases). All have noticed some positive change since they started doing sports, mainly in the physical aspect and secondly in the psycho-emotional aspect. All agree that engaging in sports has had a positive impact on their quality of life. Eight of them experienced complications due to pressure ulcers and musculoskeletal issues. Twenty two of them have a special wheelchair to be able to do the sport, with most of them (13) self-funding their chair. All respondents agree that it is important to have a trained healthcare provider in SCI and/or sports medicine as part of their rugby team. The most common barriers identified were: lack of promotion of adapted sports, lack of adequate equipment, lack of knowledge from healthcare professionals and lack of spaces to practice adapted sports. Currently only 13 of them are undergoing neurorehabilitation. Conclusion: WCR is a widespread sport for people with SCI; its adaptability and beneficial effects make it a valid option when prescribing an adapted sport for individuals with SCI. Having trained healthcare professionals in the area improves performance and reduces possible complications. Access to this sport remains limited, at least in part due to the required DME. Having access to the right and best DME, leads to more and safer participation. Highlighting the benefits of the sport, enhancing training for providers, increasing access and promoting physical activity in general can lead to further interest, funding and promotion of WCR.

Learning Objective 1

To describe the state of wheelchair rugby for individuals with spinal cord injury in Argentina

Learning Objective 2

To discuss the impact of wheelchair rugby on individuals with spinal cord injury

Learning Objective 3

To explain the process and benefits of obtaining a customized rugby wheelchair through a national program in Argentina

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Poster 29

Preliminary findings for a sequential multiple assignment randomized trial (SMART) to increase adherence to home exercise in people with spinal cord injury

Abstract 98

Jereme Wilroy, PhD, University of Alabama at Birmingham

Objective: Few people with spinal cord injury (SCI) engage in an adequate amount of physical activity to acquire health benefits because of a myriad of personal and logistic barriers that restrict their participation. Traditional exercise interventions, which have been designed and delivered using a “one-size-fits-all” approach, have not been successful in people with SCI (e.g., low levels of adherence to the programs, high rates of dropouts). The primary aim is to assess the feasibility of a tele-exercise program targeting increases in adherence to the exercise program and physical activity participation among 30 adults with SCI, using a novel experimental design principles – Sequential Multiple Assignment Randomized Trails (SMART). The study will primarily assess rates of recruitment/enrollment, adherence and retention, timing to identify non-responders, data completeness, and of outcomes (physical activity, exercise self-efficacy, range of motion). Design/Methods: The SMART-HEALTH (Home-based Exercise And Lifestyle Tele-Health) trial includes adults with SCI (18 years of age and above; injury level C5 or below; currently physically inactive) across the United States. Enrolled individuals complete home-based assessments (physical function and a health-related questionnaire packet) pre/post. Upon the baseline completion, participants receive exercise/testing equipment (wrist weights, Fitbit, electronic spirometry) and are randomized into two exercise groups. Participants in Group 1 and Group 2 undergo 3- and 6-week exercise program, respectively, using pre-recorded Movement-to Music (M2M) exercise videos (2 to 3 times per week, each session ranging 15 to 50 minutes). The exercise program is supplemented with weekly newsletters highlighting principles of behavior change. Participants who did not achieve the desired adherence rate (>95% of video watch minutes) will be re-randomized into either M2M-Live (switch of the program) or individualized behavioral coaching (augmented with the exercise program). The study will qualitatively evaluate acceptability to the study using semi-structured exit interviews. Results: Recruitment procedures started on June 2022. To date, a total of 15 participant are enrolled in the trial (mean age of 49.80 [SD 10.30], ranging 29 – 65). Participants are predominantly female (n=12, 80%) and Caucasian (n=12, 80%). There are 6 participants with cervical level injuries and 7 participants with thoracic level injuries (both complete and incomplete). Based on the adherence rate, 1 out of 7 participants in Group 1 are re-randomized into M2M-Live group, whereas 2 out of 8 participants in Group 2 are re-randomized into behavioral coaching group. The average steps per week of participants is 15,627 (SD 21,440), ranging 0 to 102,624. All data are expected to be collected by April 2023. Conclusions: The trial serves to inform development of adaptive interventions, including whether, how, or when to alter treatment intensity, type, or delivery. Also, this can determine the efficacy of home-based exercise strategies delivered as part of SCI-specific physical activity programs to improve adherence to the program therein potentially increasing physical activity. Support: Craig H. Neilsen Foundation (Grant Number 645335)

Learning Objective 1

To understand the potential benefits of a sequential multiple assignment randomized trial using a tele-exercise intervention in people with spinal cord injury.

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Poster 30

Three Months of Blood Flow Restriction Training Improves Gait Capacity in Chronic Incomplete Spinal Cord Injury

Abstract 172

Jane Alkhazov, PT, DPT, LSU Health Shreveport

Objective: Motor rehabilitation programs following spinal cord injury aim to maximize aerobic intensity to drive neuroplastic changes and central nervous system recovery. A recent clinical practice guideline for chronic SCI supports high-intensity gait training reaching intensities of 75-85% of HRmax improves gait outcomes. On a physiologic level, when the appropriate intensity is reached, activity upregulation of brain-derived-neurotrophic factor (BDNF) and α-amino-3-hydroxy-5-methyl-4-isoxazole propionic acid (AMPA) receptor mobility can impact the growth of new neuronal synapses, synthesis of new proteins, and modification of existing synapses. BFRt is another emerging intervention purported to promote neuroplasticity, resulting in improvements in corticomotor excitability, early recruitment of fast-twitch motor units, increased flow-mediated dilation, cross-sectional area, muscle endurance, and strength in individuals with iSCI. Given that increased lower extremity strength has been correlated with higher serum BDNF in neurologic populations, this case report attempts to translate neuroplasticity evidence bench to bedside through the question, “can the combination of two intensity-driven approaches (HIGT + BFRt) improve gait capacity in an individual with chronic iSCI?” Design/ Methods: The patient was a wheelchair-bound 58-year-old male community wheelchair user with a 17-year history of non-traumatic iSCI. Initial evaluation indicated subjectively impaired balance confidence - Activities-Specific Balance Confidence Scale (ABC = 7%), quality of life - World Health Organized Quality of Life-BREF (WHOQOL-BREF = 38 physical, 31 social, 75 environmental), and walking ability - Patient-Specific Functional Scale (PSFS = 4 for gait). Objective measures indicated impaired walking capacity - 6 Minute Walk Test (6MWT = 143m), gait speed - Ten Meter Walk Test (10MWT = .37 m/s), falls risk - Timed Up and Go (TUG = 39s) walking assistance - Walking Index for Spinal Cord Injury II (WISC-II = 14). The patient completed 21 sessions over 3 months; 1 month of BFR strengthening + BFR recumbent stepping and 2 months of BFR strengthening + BFR during HIGT. Intensity was ensured by maintaining ≥14/20 on the Borg Perceived Exertion Scale. Results: No adverse events occurred. At 3 months there were significant objective improvements in gait capacity (6MWT increased 50m ; MDC= 45m), gait speed (10MWT increased .16m/s; MCID= .13m/s), decreased level of walking assistance (WISC-II improved 5 levels; MDC= 1), and decreased fall risk (TUG decreased 21 seconds; MDC= 10.8 sec). Significant subjective improvements were noted for physical, social, and environmental quality of life subscales (WHOQOL-BREF increased 18, 34, 13; MDC= 5.37 points), balance confidence (ABC-16 increased 19%; MDC= 14.87%), and patient goals for walking (PSFS increased 3; MDC=3). Conclusion: This study reports statistically significant subjective and objective improvements following a novel combination of BFRt +HIGT. The combination of these intensity-driven interventions may induce neuroplasticity to improve gait capacity. Future research should consider investigating physiologic markers of neuroplasticity following combination of BFRt+ HIGT.

Learning Objective 1

Discuss a novel 3-month BFRt +HIGT rehabilitation program with statistically significant improvements in gait capacity.

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Poster 31

Integrating Activity Based Therapy into Subacute Spinal Cord Injury Rehab

Abstract 9

Catherine Farrell, PT, NCS, Shepherd Center

Neurological rehabilitation is crucial after a spinal cord injury (SCI). In the subacute setting, goals of therapy are often learning compensatory strategies to address functional loss and improve independence and safety upon discharge. Activity based therapies (ABT), or interventions based on the principles of use dependent neural plasticity, are important to activate spinal circuitry and drive changes in the neuromuscular system above and below injury level. These types of interventions are often underutilized as clinicians are constrained by lengths of stay, limited resources, medical complications, insurance reimbursement, and more. With the appropriate resources and support, a specialized ABT team is beneficial. The goal of this multi-disciplinary team, consisting of physical therapists/assistants, occupational therapists/assistants, and exercise physiologists, is to administer individualized, task-specific, repetitive interventions that drive changes in the nervous system to support restoration of lost function. These interventions include functional electrical stimulation (FES) via upper extremity (UE) and lower extremity (LE) cycling; weightbearing and gait training with bodyweight support (BWS) harnessing; FES-assisted dynamic movement patterns; and individualized aerobic and strength training. At this time, around 40 patients are seen at a frequency of 1-4 times per week. These sessions are in addition to regularly scheduled therapy provided by the patients' primary teams. The use of FES cycling promotes muscle hypertrophy, ROM improvements, spasticity reduction, and improvements in blood flow. For those with active movement, cycling also allows for strength gains and massed practice of patterned motor activation. Functional skills such as sit to stand or forward reach and grasp are targeted through multi-channel FES devices. Patients are more easily able to progress through LE weightbearing, pre-gait, and gait activities with the use of dynamic BWS systems. Patients also have increased opportunity for cardiovascular and muscular conditioning with regularly scheduled exercise. The benefits of ABT, massed practice, and increased frequency of therapy after SCI are known, but not many subacute rehab facilities have the resources to allow for dedicated ABT staff or therapy. Within a traditional rehab setting, the incorporation of ABT and neuroplasticity principles is still important and feasible. Regardless of setting or resources, tasks should be salient to patients to better drive neuroplasticity. Resistance, cardiovascular, and neuromotor types of exercise should be performed, per the ACSM guidelines for SCI. FES, either via handheld units or other devices, can be combined with functional skills such as sitting balance, fine motor tasks, or early weightbearing through standing frame or tilt table. The use of BWS allows for earlier and safer advancement of standing skills. Having dedicated staff and resources for ABT is advantageous to both patients and rehab programs. However, this is likely not possible in all rehab settings. Regardless of resources, the principles of ABT and neuroplasticity should be highlighted throughout subacute rehab in order to best promote function, independence, and recovery in patients with SCI.

Learning Objective 1

Translate neuroplasticity principles into activity based interventions within subacute SCI rehabilitation

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Poster 32

Spinal Cord Injury Enrollment Experiences in Studies Using Overground Exoskeleton Gait Training During Inpatient Rehabilitation

Abstract 156

Faith Meza MPH, CPH, Baylor Scott & White Research Institute

Purpose: Advanced technology has facilitated a recent rise in the adoption of overground robotic exoskeletons into clinical practice within the inpatient rehabilitation setting. However, there is limited knowledge regarding the eligibility of patients with subacute spinal cord injury (SCI) to participate in overground exoskeleton gait training (OEGT). Our purpose was to describe the feasibility of enrolling patients with subacute incomplete SCI in clinical studies using OEGT during inpatient rehabilitation. Methods: Our large, urban inpatient rehabilitation hospital is currently conducting two investigator initiated randomized controlled trials (RCT) [NCT04781621; NCT05218447] examining the use of OEGT in patients with traumatic and non-traumatic incomplete SCI (American Spinal Injury Association Impairment Scale [AIS] B, C, and D or equivalence score). Inclusion criteria for both studies include patients less than 6 months post-SCI, medically stable as deemed by physician, continence of or on a program for bladder and bowel management, and able to meet manufacturer determined robotic exoskeleton frame limitations. Exclusion criteria include presence of moderate to severe traumatic brain injury, degenerative diagnosis, pre-morbid developmental disability, significant psychological diagnosis, or other cognitive impairment. All patients admitted to our inpatient rehabilitation hospital with a medical diagnosis of SCI are screened with eligible patients approached by a member of the research team for informed consent. Enrollment metrics of admission data, screen failure rate, reasons for screen failures, enrollment rate, and refusals were recorded. Results: Over the past 16 months 315 patients with a medical diagnosis of SCI were admitted to our inpatient rehabilitation hospital and were screened for eligibility. Seventy-nine percent (n=249) of patients screen failed due to 1) non-incomplete SCI diagnoses [n=153 (49%); AIS A n=70, myelopathy n=33, degenerative disorder n=30, post-orthopedic spine surgery n=20], 2) not meeting exoskeleton frame limitations [n=82 (33%)], and 3) greater than 6 months post-SCI [n=61 (24%)]. Of the patients deemed eligible [n=66 (21%)], we were able to enroll 83% (n=55) into our RCTs. Commonly expressed reasons for refusal to participate were 1) having no interest in study participation, 2) feeling overwhelmed, 3) wanting the opportunity to participate in OEGT (if randomized to control group), 4) concerns over access to transportation (for follow-up appointments), 5) unease of additional caregiver burden, and 6) desire to prioritize other activities. Patients who enrolled into the RCTs were middle aged (49.3±17.7 years), male (84%), non-Hispanic (80%), White (69%), traumatic SCI (67%), tetraplegic (56%), and AIS B (15%), C (27%), D (58%). Conclusion: Patients admitted to inpatient rehabilitation after SCI may demonstrate interest in participation in OEGT trials. While a majority may not be eligible for such trials, those who did meet eligibility criteria were likely to enroll.

Learning Objective 1

Describe enrollment experiences of patients with SCI into exoskeleton gait training studies during inpatient rehabilitation.

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Poster 33

Cortical areas of activation following the ISNCSCI test of injury completeness: a pediatric fMRI study

Abstract 85

Laura Krisa, PhD, Thomas Jefferson University

Objective: The International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) are internationally accepted standards used to determine and classify the extent of motor and sensory impairment along with severity following spinal cord injury (SCI). There is a serious void in the health care literature on validity of the anorectal examination as an indication of SCI severity. Furthermore, it was found that children as old as 10 may have difficulty with this testing procedure. Functional magnetic resonance imaging (fMRI) measures brain activity by detecting changes in blood flow (hemodynamic response) within the brain when there is motor and/or sensory input to this region. The primary objective of this work is to use an established fMRI protocol as a neurodiagnostic tool to determine if the anorectal examination is a valid method for evaluating the neurologic consequence of SCI. Design/Methods: We measured cortical areas of activation is 11 pediatric participants (9 males and 2 females) with chronic (<1 year post injury) SCI using a 3.0 Tesla Siemens Verio Scanner. The average age at enrollment was 15.1 years and the severity of injury classified by the American Spinal Injury Association (ASIA) impairment scale (AIS) consisted of: AIS A (2), AIS B (3), AIS C (2), and AIS (3). One participant was not able to be classified. Following the collection of the injury classification via the ISNCSCI, participants were positioned into a partial sidelying position in the MRI scanner where they underwent data collation in a block design for S4/5 light touch (LT) and pin prick (PP) in addition to Deep Anal Pressure (DAP). Data was analyzed using SPM 12 (Functional Imaging Laboratory, London) with a significance level set at $P<0.01$ uncorrected with extent threshold of 5 voxels. BioImage Suite (Yale BioImage Suite version 1.2.0) was used for coordinate conversion into Brodmann Areas and cortical location identification. Results: Group results including all study participants show significant areas of cortical activation during all three task (LT, PP, and DAP). The greatest amount of activated occurred during LT stimulation and includes activation in all four lobes. There were less areas of activation during PP and DAP however, both included areas involved with memory. Further analysis in underway to compare participants with traumatic injuries compared to non-traumatic injuries in addition to motor complete and motor incomplete injuries, to obtain a more homogenous profile of the cortical areas of activation. Conclusion: This study demonstrates the feasibility of collecting fMRI data during the clinical assessment of SCI severity in a pediatric population. Future analysis will provide more insight as to the difference in the cortical and subcortical areas involved in groups with a different degree of impairment and also different etiology of injury.

Learning Objective 1

Discuss how fMRI can be used to determine differences in areas of cortical activation in the pediatric participants with different severity and etiology of SCI.

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Poster 34

Perturbations of BOLD fMRI signal of human occipito-temporal visual cortex in chronic pediatric SCI population

Abstract 132

Laura Krisa, PhD, Thomas Jefferson

Objective: Intact visual centers are essential in order for the brain to produce a representation of the body. Resting-state functional magnetic resonance imaging (rs-fMRI) can be used to measure fluctuations in the BOLD signal to investigate visual functional defects, among others, in Spinal Cord Injury (SCI) patients. It is crucial to discover whether SCI leads to functional alterations of visual-related brain regions in the pediatric population due to its ability to advance to life threatening neurological deficits. Previous MRI studies demonstrated such alterations but it is still largely unexplored. In this study, we compared resting state quantitative measures of visual cortices between pediatric SCI patients and uninjured healthy subjects to determine the impact of SCI on visual NeuroMatrix. Materials and Methods: Rs-fMRI data were obtained for 6 SCI patients and 6 healthy controls. These data were preprocessed using Data Processing & Analysis for Resting-State Brain Imaging (DPABI, V5.1_201201) based on Statistical Parametric Mapping (SPM12)2 running on MATLAB R2020b. The resting state quantitative measures (Amplitude of Low Frequency Fluctuation (ALFF), fractional ALFF (fALFF), Degree of Centrality (DC), Regional Homogeneity (ReHo), and Voxel-Mirrored Homotopic Connectivity (VMHC)) were used to assess each subject's brain visual neural activity. A total of 37 Regions of interest (ROIs) were selected from customized functional atlas of human occipito-temporal visual cortex. Linear regression model was used to compare the 5 resting state quantitative measures between Typically Developing (TD) and pediatric chronic SCI. Age and gender were used as predictors in the model and False Discovery Rate (FDR) with a significance level of 0.01 was used to correct for multiple comparisons. Results: A multitude of global and regional reorganizations of visual NeuroMatrix have been observed in pediatric SCI participants when compared with TD. These alterations were bilateral and largely focused on areas in the occipital lobe. ReHo and VMHC were most sensitive to representative organization of the visual cortex. Regions that demonstrated significance were: left occipital temporal sulcus (OTS), left inferior temporal gyrus (ITG), left lateral occipital sulcus (LOS), left inferior occipital sulcus (IOS), left V2 dorsal, left V3 ventral, right abstractior lateral fusiform gyrus (pFus), right OTS, right ITG, right V2 dorsal, right V3 dorsal, and right V3 ventral. Conclusion: Our findings suggest that children with SCI possess functional alterations in visual-related brain regions, including regional and bilateral neural activity defects. Further studies need to be done to correlate these findings with formal vision tests in order to confirm the efficacy of quantitative imaging in detecting subtle visual alterations.

Learning Objective 1

Discuss basic usage of rs-fMRI in brain imaging

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Poster 35

Functional MRI exploration of the sacral spinal cord: a bulbocavernosus reflex task-based stimulation

Abstract 163

Charles Mazeaud, MD., Houston Methodist Hospital

Introduction: Lower urinary tract (LUT) is under the control of the central nervous system and every signal passes through the spinal cord. Functional MRI (fMRI) is designed to explore neuronal activity, however, its application at the level of the spinal cord has been challenging and not explored. The bulbocavernosus reflex (BCR) is a reliable means of assessing the integrity of the spinal cord, particularly at the sacral level of the LUT control. The BCR is usually triggered by a gentle squeezing of the penis glans or the clitoris, especially with a full bladder. A similar and more convenient method is to tap on the midline of the suprapubic region when the bladder is full. The objectives of this project are twofold: (1) to establish a feasible and MRI compatible BCR assessment within the MRI scanner, (2) to assess the feasibility of spinal cord fMRI during a full bladder BCR in regard to LUT control in healthy individuals and then in individuals with spinal cord injury. Methods: An MRI compatible hammer was designed and generated to deliver the stimulation within the MRI tunnel to elicit BCR (Figure1). A healthy male with no previous history of LUT symptoms or spinal cord injury was recruited for this trial. The participant was instructed to consume 500ml of water and empty his bladder immediately before entering the MRI. When he reported a full bladder, he underwent a task-based fMRI of four blocks of 40 seconds of tapping (BCR) and 40 seconds of control (rest). The regions of interest (ROIs) involved in the BCR, were defined as the area of the terminal cone that corresponded to the S1-S4 roots (vertebral level L1) known to be involved in LUT control. The blood level oxygen-dependent (BOLD) signal within ROIs was analyzed with the FSL software. Results: The ROIs identified in the sacral spinal cord (Figure 2) showed a significant increase in signal upon BCR stimulation. Despite movement artifacts, BOLD activations were present and time-related to the stimulation period (Figure 3). This is the first study to demonstrate that: (1) There is a feasible and modest approach to elicit BCR within the MRI to assess spinal cord integrity in regard to LUT control. (2) The activity of the sacral spinal cord during the BCR stimulation can be revealed in fMRI. These preliminary results pave the way for further study of the functional role of the spinal cord in larger cohorts of healthy individuals and in individuals with spinal cord injury.

Learning Objective 1

Utilize BCR within the MRI to assess spinal cord integrity in regard to LUT control

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Poster 36

Feasibility of conducting the International Standards to document Autonomic Function following Spinal Cord Injury (ISAFSCI) in Newly Injured Patients with SCI

Abstract 64

Ivani Proano, MBS, Icahn School of Medicine at Mount Sinai

Objective: The ISAFSCI is used to test for cardiovascular, sudomotor, bronchopulmonary, thermoregulatory function, and sacral autonomic reflex control to the lower gastrointestinal, genitourinary, and sexual-reproductive systems following spinal cord injury (SCI). We conducted the ISAFSCI in nine newly injured patients with SCI upon admission and prior to discharge from the hospital to document changes in autonomic function throughout the acute inpatient rehabilitation (AIR). Design/Methods: The ISAFSCI evaluation began by acquiring ten consecutive supine and ten consecutive seated blood pressure (BP) and heart rate assessments and two (if within 0.2 □C) or three oral temperatures. Next, three forced vital capacities (FVC) were collected using a hand-held spirometer while the patient was seated. A clinician then assessed for the presence of the bulbocavernosus and anocutaneous reflexes. Lastly, the patient was asked questions related to their current sweating ability, bladder and bowel sensation, ability to prevent urine and stool leakage, and their levels of psychogenic and reflex arousal, erectile, and orgasmic function as compared to before injury. Results: Here, we report on the feasibility of conducting the ISAFSCI during AIR. Bedside testing was undertaken to optimize patient comfort throughout the examination. Eight of nine patients were able to tolerate supine and seated positioning with assistance. The use of a BP monitor with an automated one-minute cycle capability improved the efficiency of the testing. In order to maximize efficiency and prevent confounded results, it became routine practice to reserve questions and speaking unrelated to the ISAFSCI testing itself until after vital signs had been acquired. Bronchopulmonary FVC testing required a brief introduction on how to perform the maneuver. Lastly, lower gastrointestinal, genitourinary, and sexual-reproductive system questions needed to be rephrased from the published versions to ensure patient understanding. Conclusion: This study documents the feasibility of conducting the ISAFSCI examination during AIR in newly injured patients with SCI. More widespread documentation of autonomic impairments following injury and changes over the course of AIR will improve the clinical care of patients with SCI.

Learning Objective 1

To use the ISAFSCI to test for cardiovascular, sudomotor, bronchopulmonary, thermoregulatory function, and sacral autonomic reflex control to the lower gastrointestinal, genitourinary, and sexual-reproductive systems following spinal cord injury (SCI).

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Poster 37

ISNCSCI: A Living Standard

Abstract 111

Kristin Myers, OT/L, University of St Augustine; Myers Therapy Team

For most, spinal cord injury is a life long journey of recovery stages, but how does the individual know that changes are occurring if they are not grossly perceptible? This course will bring attention to the dynamic nature of the ISNCSCI when used accurately and intermittently. As the gold standard for classification of diagnostic status, it should be relevant and current to maximize resource access, accuracy in medical care, and to engage the client in motivated participation in wellness, fitness, and community involvement. The preliminary findings of the ongoing research study titled: Hope and Recovery in SCI will be presented, and relevance discussed. Suggestions will be made regarding frequency of assessment throughout recovery which is the rest of their lives potentially.

Learning Objective 1

Discuss the role of the ISNCSCI in diagnostics, treatment strategy, reimbursement, and documenting recovery

Learning Objective 2

To illustrate role of intermittent assessment in goal progression, resource access, and motivation for the client

Learning Objective 3

Present preliminary study findings related to ISNCSCI documentation and representation of recovery

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Poster 38

Ultrasound Evaluation of Infralesional Muscle Integrity Following Cervical Spinal Cord Injury

Abstract 27

Hannah Ro, Fourth-Year Undergraduate Student, University of British Columbia

Objective: Cervical spinal cord injury (SCI) results in devastating impairments of volitional motor control. Past investigations of SCI lesion patterns in high tetraplegia reveal a greater likelihood of concurrent lower motor neuron (LMN) injury in proximal arm muscles. Given that LMNs directly innervate skeletal muscles, damaging these nerve fibres exacerbate muscle degeneration. Skeletal muscle denervation from SCI causes atrophy and fibrosis which limits treatment options and increases the probability of health complications. Despite the clinical implications associated with poor muscle health, it is not routinely assessed following SCI. Ultrasound (US) is a non-invasive imaging modality that has the potential to be used more regularly for SCI muscle assessment. We hypothesized that in the sub-acute period after injury, cervical SCI patients would exhibit reduced US markers of muscle size and greater echogenicity values compared to able-bodied controls in functionally relevant upper limb muscles. Design/methods: Five individuals (36.8 ± 8.4 years; 1F, 4M) with motor complete (AIS A or B) and neurological levels of injury C4-C6 were recruited for US assessment a mean of 3.9 ± 2.1 months post-injury. Each limb was analyzed as a single event. Cross-sectional B-mode images were captured bilaterally for four upper extremity muscle groups: extensor carpi ulnaris (ECU), extensor indicis (EI), flexor pollicis longus (FPL), and first dorsal interossei (FDI). Muscle cross-sectional area (CSA) and thickness (MT) measurements were normalized to forearm circumference (n = 10 limbs). Able-bodied controls were scanned for comparison (36.4 ± 7.1 years; 1F, 4M). Results: SCI individuals demonstrated reduced CSA for all muscles: ECU ($p = .03$), EI ($p = .002$), FPL ($p = .01$), and FDI ($p = .006$). Differences in MT were observed for ECU ($p = .04$), EI ($p = .04$), and FPL ($p = .01$). Echogenicity values were higher in FPL ($p = .03$). Conclusion: At a mean of 4 months post-injury, SCI participants demonstrated atrophy of functionally important forearm and hand muscles supplied by C8-T1 myotomes. Evidence of muscle fibrosis was observed in FPL. Selective fibrosis may be influenced by disproportionate cortical representation and cortical reorganization following SCI. These results underscore the importance of incorporating muscle evaluation in cervical SCI assessment to optimize rehabilitation outcomes.

Learning Objective 1

Discuss infralesional muscle health in functionally important upper limb muscles of cervical SCI early after injury.

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Poster 39

Setting up a platelet-rich plasma protocol for pressure injury management in a spinal cord injury/disorder unit

Abstract 52

Kevin Suarez, MD, VAMC Syracuse

Objective: Pressure injury has a negative impact on quality of life and a majority of people (50-80%) with spinal cord injury (SCI) tend to develop pressure injury (PI) at some point in their lifespan. Various advanced biophysical modalities (cellular/tissue-based products, negative pressure wound therapy, therapeutic ultrasound, etc.) are being studied and used for the treatment of PI. Cost-effectiveness and easy applicability are essential when considering such advanced therapeutic options. Autologous platelet-rich plasma (PRP) has various applications including the treatment of chronic wounds and can be an effective and easy technique in the management of PI. Methods: An extensive literature review was conducted focusing on the mechanism and utility of PRP in wound healing and various principles & methods of preparation. Centrifuge machines available with the wound nurse and research wing were enlisted and respective manufacturer's instructions were reviewed. Two different 2-spin techniques were studied to compare the extracted concentration of platelets after centrifugation using 13.5cc of whole blood mixed with 1.5cc sodium citrate (3.8%) in a Sorvall™ ST 8R benchtop centrifuge. Settings were configured using the manufacturer's guide/specifications and a standard formula g = (1.118 × 10-5) R S2. The proposed 2-spin technique for PRP extraction along with supporting literature was presented and discussed as a quality improvement project with the al review board, and approval was obtained. Results: A technique with a first spin at 900g for 5 minutes (2300rpm) and a second spin at 1500g for 15 minutes (3000rpm) yielded a 4 times higher concentration of platelets in extracted plasma of 2.8-3ml with only 13.5cc of whole blood. Considering this technique, a standard of work to use autologous PRP for local application over a wound bed was created in collaboration with the SCI wound nursing team. The protocol involved targeting an SCI population with stages 2,3, and 4 PI without any active local or systemic infection or ongoing acute illnesses. Immediate local application of PRP with a total procedure duration (blood draw, centrifugation, and dressing wound with PRP) of less than 30 minutes was planned. A spinal cord injury pressure ulcer monitoring tool was included as the assessment tool. An SCI physician, an SCI wound nurse, and an inpatient SCI nurse were the intended proceduralists. The use of PRP was discussed with and cleared by an infectious disease team. Conclusion: This process assessed the use of a simple benchtop centrifuge without complex functionality and minimal whole blood extraction, unlike other techniques which use 30-50cc of whole blood. This process provided up to 2.8cc of PRP extraction with therapeutic concentration sufficient for wound healing and regeneration (3-5 times higher than whole blood). The establishment of a simple and easy-to-implement protocol for the application of PRP in PI management in the SCI population is possible with teamwork and an understanding of the available literature and technology. Further use and implementation of such protocol would help understand the effectiveness and application of this technique in routine SCI care.

Learning Objective 1

To establish an efficient, easy and effective platelet-rich plasma protocol for the management of pressure injury in SCI patients.

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Poster 40

Wearable Sensors to Measure Shoulder Motion in the Free-Living Environment in Wheelchair Users with SCI: Technical Challenges and Recommendations

Abstract 90

Melissa Morrow, PhD, University of Texas Medical Branch

Objective: The ability to accurately quantify shoulder motion in the free-living environment in manual wheelchair users with SCI is important for answering research questions related to the development of shoulder pain and pathology. Miniaturized wearable inertial measurement units (IMUs) directly measure the linear acceleration and angular velocity of body segments to which they are attached, and if equipped with onboard storage or another data logging configuration, enable measurement of shoulder motion in the free-living environment. However, there are challenges in using IMU-based data to estimate traditionally used measures of shoulder motion from lab-based motion capture. The objective of this project is to present the technical challenges associated with measuring shoulder motion in the field, suggest IMU-based measures that are less sensitive to experimental design and algorithm choices, and make recommendations for applying IMUs to this use case including responsible reporting in publications. Design/Methods: The development of challenges and recommendations were based on the collective experience of deploying IMUs and developing algorithms for capturing shoulder motion and arm function during daily life in wheelchair users with SCI from 2016-2022. To date, we have performed 145 data collections across 50 individuals with SCI who use manual wheelchairs (average ±SD age: 42.2 ±12.5 years, 10 women/40 men, level of injury: 9 cervical, 21 high/mid thoracic, 20 low thoracic/lumbar, average ± SD (range) time since injury: 12 ± 13.1 years (0-45 years). Participants wore IMUs (Opal, APDM Inc., Portland, Oregon, USA) on their chest and bilateral upper arms for two consecutive days during their daily life. Participants were required to charge the sensors overnight and perform a calibration procedure before donning the sensors. The IMU sensors collected synchronously at 128Hz. Results: The technical challenges in using IMUs to quantify shoulder motion during unsupervised free-living include: (1) securing IMUs to the thorax and upper arm, (2) defining sensor-to-body segment alignments, (3) calculating the orientation of the IMU, (4) Ensuring that IMU orientations are resolved into a common inertial reference frame, (5) necessity of validation studies, (6) defining standards for IMU-based analyses, and (7) proprietary algorithms. We offer recommendations including: (1) leveraging raw measurements or first order metrics from raw data, (2) utilizing metrics calculated based on estimates of IMU orientation, (3) documentation of the protocol and algorithm choice, and (4) technical implementation aspects including battery life and calibration. Conclusion: IMUs provide rich data that can provide nuanced information about free-living movement in wheelchair users to better explore the relationship between daily arm use and shoulder pain and pathology. We hope discussing the challenges and recommendations can help in promoting rigorous and responsible use of IMUs for improved understanding of arm function during daily life.

Learning Objective 1

Discuss the common challenges to capturing unsupervised IMU data in the free-living environment and recommendations for responsible use of the data.

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Poster 41

Measurement of Magnetization Transfer Ratio in Typically Developed Pediatric Spinal Cord: Clinical feasibility, Assessment of Normative Data, and Age Correlation.

Abstract 112

Laura Krisa, PhD, Thomas Jefferson University

Objective: In this study, we propose automated atlas-based analysis of magnetization transfer (MT) scans. We report normative data and variability across the cervical spinal cord in the pediatric population. Design/Methods MT scans of 20 healthy pediatrics (6-16 yrs) participants were acquired from the cervical spinal cord using a 3.0T MRI scanner. The protocol was developed on the basis of methods previously used by one of the authors (J.C.-A.) Parameters: voxel size = 0.9x0.9x5 mm3, TR=35ms, TE=3.1ms. All data were processed using Spinal Cord Toolbox (SCT) Initially the MT data were segmented and were then registered to the PAM 50 template Next using non-rigid deformations, a series of affine transformations were estimated between the MT image and the template. The combined transformations were then used to co-register PAM50 white matter atlas to the subject specific space. Then, magnetization transfer ratio (MTR) was computed by co-registering MT0 and MT1 images. The MTR is measured for the specific white matter (WM) tracts as well as the whole WM across the cervical cord (C2-C7). The tracts are as follows: left and right fasciculus gracilis, and fasciculus cuneatus and the lateral corticospinal tract. The mean, standard deviation and variability of the measurements were then compared between tracts using COV (coefficient of variations). Linear regression analysis was used to investigate the relationship between age and the MT ratios. Results: The MT images were successfully collected and MTR maps created for each individual subject. The normative MTR values show little to no variation (low COV~ .05) between selected tracts as defined above. No significant difference were seen between MTR values across the levels in each tract (P>0.05). Results of linear regression analysis shows positive correlation between age and MTR in all the specific tracts as well as whole WM. Conclusions: Reliable multiparametric assessment of pediatric spinal cord microstructure is possible by using clinically suitable methods. (i.e MT images). A strong positive correlation between MTR and the degree of myelination exists in our pediatric study population. We believe this result establishes the potential for improving diagnostics, objectively monitoring disease progression, and predicting outcomes in spinal pathologies in children.

Learning Objective 1

To understand how the use of magnetization transfer (MT) imaging can be used to look at the degree of myelination in the pediatric spinal cord.

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Poster 42

Increasing Falls and Alcohol: Changes in the Etiology of Traumatic Spinal Cord Injuries in the Upper Midwest United States

Abstract 188

Ben Johnson (N/A), Mayo Clinic

Abstract Topic: Changing epidemiology of traumatic Spinal Cord Injury Objective: Prior research asserts that alcohol consumption has been increasing. Safety measures and other advances could be leading to different distributions of the causes of Traumatic SCI (TSCI) over time. The goal of this retrospective study was to examine the changes in the causes of TSCI between 2011 and 2021 as well as the rate of alcohol related TSCI during the same time period. Methods: This was a retrospective medical record review of patients with TSCI discharged from inpatient rehabilitation between January 1, 2011 and December 31, 2021 (N = 276). 26 individuals declined to allow retrospective review of their medical records for research and were excluded from the study. Demographic and injury mechanism data was collected from the medical record. Multinomial regression was performed to determine if the causes of TSCI distribution changed by year. An ANOVA was used to calculate whether the rate of alcohol related TSCI changed by year. Results: The final sample size was 229 patients. The average age at injury was 50.9 years. 75% of cases were male. There was a significant change ($p<0.001$) in the causes of TSCI by year, with Falls increasing, and Motor Vehicle Accidents (MVA's) decreasing. Average age at injury increased from 40 to almost 60 ($P=0.03$) and the rate of alcohol related TSCI also increased significantly over time ($P=0.009$). Conclusions: Average age of traumatic SCI continues to increase, and now approaches almost 60. Concurrent with increasing age, falls have become the leading cause of traumatic SCI in this population from the upper midwestern United States. Unfortunately, the rate of substance abuse in association with traumatic SCI has increased dramatically as well. Discussion: The patient population was predominantly located in the Midwestern United States. A larger, multicenter study will be needed to confirm changing epidemiology of traumatic SCI in other regions.

Learning Objective 1

Describe changes in the causes of traumatic SCI between 2011 and 2021.

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Poster 43

Ultrasound Evaluation of Diaphragm Function in Patients with SCI: Lessons learned, Future Directions

Abstract 152

Philippines Cabahug, MD, Kennedy Krieger Institute; Johns Hopkins School of Medicine

Diaphragm ultrasound (DUS) is a non-invasive imaging technique that assesses diaphragmatic function. DUS allows for direct, reproducible evaluation of diaphragm function that is convenient, safe and radiation-free. It has been used in medical, surgical and intensive care settings. Clinical applications include identification and prognosis after diaphragm paralysis, assessment and prediction of weaning from ventilator, confirmation of needle placement in electromyography of the diaphragm, and adjusting diaphragmatic pacemakers. Our clinic has incorporated DUS in the evaluation of adults and children with spinal cord injury/dysfunction (SCI/D) requiring respiratory support. The evaluating team is comprised of the physiatrist/sonographer, respiratory therapist, and a child life specialist (for children). Information from DUS in turn has aided the rehabilitation team to guide ventilator weaning and adjustment, adjustment of diaphragm pacers, diaphragm conditioning and planning for long term respiratory management. We present 3 cases to illustrate the technique, protocol, utility and benefit of doing diaphragm ultrasound in our outpatient clinic for adults and children with SCI/D requiring respiratory support.

Discuss the benefit of diaphragm ultrasound in evaluation of SCI patients requiring respiratory support.

Describe our clinic's protocol to evaluate diaphragm function in pediatric and adult SCI patients.

Present 3 cases using diaphragm ultrasound in evaluation and management of respiratory function of SCI patients requiring respiratory support.

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Poster 44

A brain-computer interface neuromodulation intervention to reduce neuropathic pain after spinal cord injury

Abstract 8

Negin Hesam-Shariati, PhD, University of New South Wales

Background: Neuropathic pain is a debilitating secondary condition for many individuals with spinal cord injury (SCI). SCI neuropathic pain is often minimally responsive to existing pharmacological and non-pharmacological treatments. A growing body of evidence supports the potential for brain-computer interface (BCI) systems to reduce SCI neuropathic pain via electroencephalography (EEG) neurofeedback. However, further studies are needed to provide more definitive evidence about the efficacy of this intervention. Objective: The objective of this trial is to evaluate the efficacy of a multi-day course of BCI-based neuromodulation (BCI-N) in a gaming environment to provide pain relief for individuals with SCI neuropathic pain. Methods: We have developed a BCI-N system for SCI neuropathic pain. This system includes an interactive gaming interface, and a neuromodulation protocol targeted to suppress theta (4-8 Hz) and high beta (20-30 Hz) frequency powers, and enhance alpha (9-12 Hz) power. A single-case experimental design (SCED) with multiple baselines will be used to test the efficacy of our BCI-N intervention for SCI neuropathic pain. We will recruit three participants with SCI neuropathic pain. Each participant will be randomly allocated to a different baseline phase (7, 10 or 13 days), which will then be followed by 20 sessions of 15-min BCI-N intervention over a 4-week period. Primary (pain intensity) and secondary (pain interference) outcome measures will be assessed daily during the baseline and intervention phases. Generalisation measures (including quality of life, sleep quality, anxiety, depression, and resting-state EEG) will be assessed prior and following each phase. There will be two additional assessment phases to monitor possible changes after the intervention. The first will start immediately after completion of the intervention and the second will be after three months. For each of these assessments, participants will continue reporting the primary and secondary outcome measures daily for a one-week period. A SCED trial is particularly effective for evaluating technology-based interventions, because it can address the case specific intervention effects at the individual's level. Power in a SCED trial derives from the repeated measurement of the outcome measures across the phases of a study. The key to the multiple baselines method is the random allocation to a staggered baseline to control confounding variables such as the environment and time-related factors that may otherwise influence the results. Results: This trial is approved by the Human Research Ethics Committee of the University of New South Wales, and is registered at Australian New Zealand Clinical Trials Registry. The trial has been planned to be finalized by end of 2022, and the findings will be presented at American Spinal Injury Association in April 2023. Conclusions: This trial using SCED methodology has been designed to evaluate the efficacy of a novel BCI-N intervention for people with SCI neuropathic pain. SCEDs are considered a viable alternative approach to randomized clinical trials to identify evidence-based practices in the field of technology-based health interventions when recruitment of large samples is not feasible. Support: Neilsen Foundation #639898

Learning Objective 1

The objective of this trial is to evaluate the efficacy of a multi-day course of BCI-based neuromodulation (BCI-N) in a gaming environment to provide pain relief for individuals with SCI neuropathic pain.

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Poster 45

Implantable Health Monitoring for Spinal Cord Injury

Abstract 62

Kevin Kilgore, PhD, Case Western Reserve University and MetroHealth System

We are working to develop an implanted health monitoring device with the goal of increasing life-expectancy for individuals with spinal cord injury (SCI) by providing early warning of critical complications, enabling early detection and increasing the efficacy of medical intervention. To achieve this goal, we are developing an implanted device that can measure health status and predict disease states. The proposed implanted device, called the "Lifeline", senses health-related parameters, including temperature, electrocardiogram, photoplethysmogram, inertial measurement, and acoustic signals. It is sized to fit inside a vascular tunneler sheath for surgical placement. The Lifeline device will be incorporated into an existing modular implant system, the Networked Neuroprosthesis (NNP) System, that is already being evaluated to provide motor function for individuals with SCI. The expected outcome of the Lifeline-enhanced NNP System is the capacity to provide advanced warning regarding the top causes of increased mortality in individuals with SCI, enabling earlier detection and medical intervention that may ultimately increase overall life expectancy. The causes of early mortality include pneumonia, urinary tract infection (UTI), pulmonary embolism (PE), and autonomic dysreflexia (AD), which are unique to, or more prevalent in, people with SCI (particularly tetraplegia). The addition of the Lifeline device to the NNP System is the first step towards an implantable "life-saving neuroprosthesis". Specifically, our long term goal is to utilize the NNP System's modularity and multi-modal input-output features to not only sense impending adverse health events with the Lifeline, but also to intervene by implementing disease-treating and life-saving measures directly using the anticipated sensing and activation features of the NNP. This includes utilizing electrical modulation of the autonomic nervous system to relieve AD and other targeted treatments that are currently under development by our team and others. The overall benefit of the Lifeline-enhanced NNP System for SCI is twofold: 1) the high expectation of a functional benefit from the motor neuroprosthesis (original NNP System), and 2) the potential life-extending features of the implanted health monitoring (Lifeline). In summary, the relative risk of the added Lifeline implantation is very low and the potential benefit is extremely high. At the completion of this project, we anticipate having a single modular system that will be capable of providing both improved health and improved function for anyone with SCI, thus prolonging life while, at the same time, increasing independence and quality of life. This system will also provide the foundation to begin broader assessment of the risk-benefit profile of implanted health monitoring in at-risk populations.

Learning Objective 1

Describe the potential impact of continuous health monitoring in chronic SCI.

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Poster 46

Axial Damage Ratio May Relate to Standing Performance Following Percutaneous Epidural Stimulation in Persons with Spinal Cord Injury

Abstract 74

Ahmad Alazzam, B.S., McGuire VA Medical Center

Objective: to describe independent standing ability in persons with chronic, motor-complete spinal cord injury (SCI) enabled by percutaneous spinal cord epidural stimulation (SCES). Independent standing ability is described in relation to lead locations, SCES configurations, and magnetic resonance image (MRI)-derived axial damage ratios, a biomarker indicative of spared tissue at the injury site. Design/Methods: Two males with chronic SCI (C7, AIS A, 6 years post-injury; T11, AIS B, 9 years post-injury) were implanted with two percutaneous SCES leads to enable motor control below the level of injury. Lead placement for the C7 participant was at the T11-L1 vertebrae; scarring and spinal hardware for the T11 participant necessitated staggered placement of the left lead at the T12-L1 vertebrae and of the right lead at the L1-L2 vertebrae. Axial T2- weighted MRIs were acquired to calculate axial damage ratio. An axial damage ratio of 1 indicates no spared tissue, whereas a ratio of 0 indicates fully intact spinal tissue (i.e. no presence of lesion). SCES-evoked recruitment curves of critical hip, knee, and ankle flexor and extensor muscle pairs were used to determine SCES configurations (i.e., anode-cathode arrangements) that were optimal to enable leg extension for standing. Independent standing ability was assessed by whether participants needed external assistance from study staff at the trunk, hips, or knees to maintain a standing position in parallel bars. Results: Following implantation, standing SCES configurations were determined during mapping. The participant with C7 injury had an axial damage ratio of 0.92. Three SCES configurations, all with caudal cathodes and rostral anodes were delivered simultaneously to enable standing, and the participant achieved standing without external assistance at the trunk but needed external assistance at the hips and knees. The participant with T11 injury had an axial damage ratio of 0.80. Two SCES configurations, both with rostral cathodes and a mix of rostral and caudal anodes were delivered simultaneously to enable standing, and the participant achieved standing using his arms without any external assistance from the research team between parallel bars or using a standard walker. Conclusion: Standardized mapping procedures yielded individually optimized SCES configurations for standing, yet both participants achieved different levels of independence in SCES-enabled standing. Lead placement may have affected standing independence, however lead placement may also be limited by factors such as scar tissue or spinal hardware. Given that the participant with a lower axial damage ratio achieved greater standing independence, axial damage ratios might be important to consider when predicting standing independence using percutaneous SCES in persons with SCI. Further research on the use of axial damage ratios to predict other percutaneous SCES-enabled functional outcomes is also warranted. Support: DoD-CDMRP clinical trial program award number # W81XWH-20-1-0845 (SC190107 CDMRP W91ZSQ) and Department of Veteran Affairs-SPiRE Program (B3456-P).

Learning Objective 1

Describe standing ability with percutaneous epidural stimulation based on MRI-derived axial damage ratios

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Poster 47

Effects of Transcutaneous Spinal Stimulation versus Whole Body Vibration on Quadriceps Spasticity in Persons with Spinal Cord Injury

Abstract 96

Evan Sandler, PT, DPT, Shepherd Center, Crawford Research Institute, Hulse Spinal Cord Injury Lab; Georgia Institute of Technology, School of Biological Sciences, Applied Physiology

Spasticity following spinal cord injury (SCI) is often difficult to manage with minimal benefit reported from pharmacological intervention.(1,2) Therapeutic interventions, including afferent stimulation, provide non-pharmacological interventions to spasticity management. Afferent stimulation, in the form of transcutaneous spinal stimulation (TSS) and whole body vibration (WBV), has been shown to influence spasticity in persons with spinal cord injury.(3,4) No direct comparison of the effects on spasticity has been made between the two robust forms of afferent stimulation. WBV activates muscle spindles through mechanical stimulation, while electrical stimulation of TSS directly activates dorsal roots. Subsequently, the primary aim was to compare the effects on quadriceps spasticity of the two approaches. We hypothesized the more focused effect of TSS on spinal circuits underlying spasticity may result in a larger effect. Individuals with chronic SCI with injury level at or above T12 with self-report of at least mild spasticity affecting the legs were recruited. As part of a larger study comparing dosing of WBV, participants received a single session of TSS. The effects of TSS were then compared to those of the WBV dose with the largest effect on spasticity. WBV consisted of 8 45-sec bouts of standing with 1-min rest between bouts. TSS was administered through one 5cm round cathode over the T11-12 spinous interspace and one large anode over the umbilicus. Tonic, charge-balanced, biphasic stimulation was delivered with a pulse width of 400μs at 50Hz for 15min. Stimulation intensity was set to evoke paresthesia in the legs without visible muscle contraction. Quadriceps spasticity was evaluated using the first swing excursion (FSE) angle of the pendulum test prior to intervention, immediately, 15-min, and 45-min after intervention. The leg self-reported as most spastic at the time of enrollment was tested. Thirty-two participants were included in analysis. Participants were subgrouped based on FSE into high (<46.6°) and low (>46.6°) spasticity. In the high spasticity subgroup, there was significant difference in FSE compared to baseline immediately post-TSS ($p=0.036$, $n=18$), but not post-WBV ($n=13$). At 15-min post-intervention, significant difference from baseline was identified post-WBV ($p=0.014$), and only approached significance post-TSS ($p = 0.10$). At 45-min post-intervention, only TSS ($p=0.035$) demonstrated significant change in FSE. Differences in FSE between baseline and post-TSS were only found in the high spasticity subgroup. Significant negative change from baseline was found in the low spasticity subgroup post-WBV at 15- and 45-min. No significant differences in change of FSE from baseline between TSS and WBV were found at any time point for either the low or high spasticity subgroups. Both TSS and WBV are clinically feasible non-pharmacological therapeutic interventions. TSS and WBV are associated with reduction in spasticity, as measured by the pendulum test, with persistent effects on spasticity for at least 45-min post-intervention for individuals with high spasticity. TSS demonstrates a significant, immediate effect on quadriceps spasticity in contrast to the delayed effect of WBV.

Learning Objective 1

Illustrate differences in effectiveness on quadriceps spasticity between transcutaneous spinal stimulation and whole body vibration.

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Poster 48

Quantifying Neuromodulation In Persons with SCI: A Comparison of Modulatory Responses to Low-Frequency Depression Versus Paired-Pulse Stimulation

Abstract 137

Charles Creech, PT, DPT, Georgia Institute of Technology

Objective: With the growing interest in clinical applications of neuromodulation, ability to assess effects of different modulation approaches is increasingly important. Monosynaptic spinal reflexes exhibit rate-dependent depression with repeated activation, offering insights into modulatory mechanisms. Following spinal cord injury (SCI), changes in reflex modulation are associated with spasticity and impaired motor control, contributing to decreased functional mobility. Low-frequency depression (LFD) of H-reflex excitability is commonly used to quantify homosynaptic inhibition, wherein the amplitudes of reflex responses elicited by a train of conditioning pulses are compared to that of an unconditioned (control) pulse. Alternatively, some studies have used paired-pulse depression (PPD) in place of more time-consuming extended stimulation trains. While both protocols induce similar amounts of H-reflex depression in neurologically intact individuals, the same may not be true for persons with neurologic injury in whom reflex modulation is often impaired. Design/Methods: H-reflex recruitment curves and the maximal M-wave were obtained from participants (n=20; 10 women) with incomplete SCI at or above the level of T12. The stimulus intensity corresponding to 10-30% of the M-max amplitude was identified and was utilized for the LFD trains. Each LFD train consisted of 11 stimuli delivered with a 1-second inter-pulse interval (i.e., 1 Hz); 10 LFD trains were obtained in total. To accommodate for variability in test H-reflex amplitudes, the 1st 4 trial sequences with control H-reflex (H1) amplitudes meeting the criterion (i.e., between 10-30% of M-max) were analyzed. We compared H-reflex depression following PPD (calculated as the H-reflex amplitude following the 1st conditioning pulse (H2) normalized to H1) to that observed following an 11-pulse LFD (calculated as the average of H2-11 normalized to H1) protocol in persons with SCI. Additionally, to determine whether an abbreviated pulse train could replicate outcomes of the11-pulse train, we assessed the relationship between the H-reflex depression elicited by pulse trains of various lengths and the depression elicited by the 11-pulse LFD protocol. Results: In participants with incomplete SCI, we found significant differences between the amount of H-reflex depression evoked by PPD compared to an 11-pulse LFD train ($p < 0.001$; mean difference = 0.137, $d = 1.161$). Additionally, the 5-pulse train was highly correlated with the 11-pulse train ($r = 0.905$, $R^2 = 0.818$). Conclusion: We recommend the use of a 5-pulse train for assessing LFD in persons with SCI, as it elicits modulation similar to the conventional 11-pulse train and requires fewer stimuli thereby reducing testing time and enhancing participant comfort.

Learning Objective 1

Discuss different methods of assessing reflex modulation in persons with spinal cord injury and their implications on research methodologies

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Poster 49

Optimizing Transcutaneous Spinal Stimulation Through Efficient Assessment of Abstractior Root Muscle Reflex Excitability

Abstract 141

Oliver Daliet IV, MS, Shepherd Center

Objective: Transcutaneous spinal stimulation (TSS) demonstrates promise to enhance function(1) and manage spasticity(2,3) in persons with spinal cord injury. However, identifying optimal stimulation parameters is necessary for effective treatment. Fortuitously, in addition to the value of TSS as an intervention, paired pulses of TSS can be used to elicit abstractior root muscle reflexes (PRMRs), which allow for the assessment of evoked potentials in multiple lower extremity muscle groups concurrently.(4) While PRMR recruitment curves offer an objective measure of spinal reflex excitability, little is known about minimum intervals of stimulation intensity required to achieve reliable curve fitting. In this study, we assessed the differences in Boltzmann curve fitting for data sets comprised of different stimulation intervals (5 mA, 10 mA, 15 mA, 20 mA) as compared to a full dataset containing all data points. We hypothesized that it would be possible to identify a curve fitting interval that would approximate the goodness of fit of the full dataset, in addition to similarities between respective values derived from the fitted equations. Design/methods: PRMR recruitment curves were obtained by measuring soleus peak-to-peak response amplitude in the dominant leg of neurologically intact individuals (n=15) beginning at 10 mA. Repetitions of 3 stimuli were completed starting at either 30 mA or the stimulation intensity at which consistent subthreshold responses (~50 μV) were observed, whichever value was lower. To determine reflex threshold (RT), stimulation intensity was increased in increments of 1 mA until responses ≥ 100 μV were obtained in at least 3 of 5 stimuli. Once RT was obtained, repetitions of 5 stimuli were completed in increments of 5 mA until a response plateau was observed or 100 mA was reached. For each complete recruitment curve, a Boltzmann equation was fit to all data points obtained (full dataset). Four subsets of data were then created from each full dataset by selecting points collected in intervals of 5, 10, 15 and 20 mA, and a Boltzmann equation was then fitted to each subset of data. To assess the goodness of fit, R2 values were calculated for the curves obtained from each of the 5 datasets. Additionally, RT was derived from the Boltzmann equation for each of the 5 datasets. Results: Complete recruitment curves were obtained from 10 participants. The mean R2 values for the Boltzmann curve fitting for each interval were as follows: full dataset: 0.983, 5 mA: 0.970, 10 mA: 0.973, 15 mA: 0.958, and 20 mA: 0.919. The data subsets for intervals of 5 and 10 mA were not significantly different when compared to the full data set ($p = 0.28$ and 0.1, respectively). The mean RT (expressed in mA) derived from the Boltzmann curve fitting for each interval were as follows: full dataset: 35.0, 5 mA: 31.2, 10 mA: 32.4, 15 mA: 30.2, and 20 mA: 30.0. No statistical differences were found between the RT derived from the full data set and any interval subset ($p > 0.05$). Additional statistical analyses are currently underway. Conclusion: Based on our preliminary analyses, utilizing 10 mA intervals to obtain PRMR recruitment curves is an efficient and reliable method to assess spinal reflex excitability while reducing unnecessary stimulation.

Learning Objective 1

Identify an optimal stimulation interval for abstractior root muscle reflex recruitment curve fitting

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Poster 50

Optimizing Deep Brain Stimulation of the Midbrain Locomotor Region for Gait Control After Incomplete Spinal Cord Injury in a Translational Large Animal Model

Abstract 178

Brian Noga, PhD, Miami Project To Cure Paralysis, University of Miami

Objective: Deep brain stimulation (DBS) of the mesencephalic locomotor region (MLR) is a potential neuromodulatory technique to improve locomotor function following incomplete spinal cord injury (SCI). Evidence for this concept arises from experiments involving small animal models of SCI. However, larger animals, such as the micropig, are better suited for preclinical tests of novel neuromodulation technology [1] because of their larger brain (which allows the use of conventional human-sized DBS electrodes and imaging), and their resemblance to human neurophysiology and incomplete SCI. To achieve maximal clinical benefit from DBS, electrodes need to be placed at the target and the stimulation parameters must be optimized for SCI applications since damage to the descending locomotor pathways is substantial. The MLR is highly complex and heterogeneous and a well-controlled locomotor inducing effect can be difficult to achieve. To optimize the effectiveness of MLR-DBS, the objective of this study is to develop a diffusion-tensor image (DTI)-based stimulation model of the MLR for eventual testing in an SCI model. Localizing the position of the electrode in relation to subject-specific tractography derived from DTI data and incorporating computational modeling, using finite-element modeling (FEM), enables us to predict the relative levels of neural activation across target pathways and to characterize the optimal stimulation parameters for initiating locomotion. Design/Methods: A diffusion-weighted image (DWI) was acquired to generate the DTI after preprocessing in MRtrix3 software [2]. A preoperative T2-weighted MRI was used to calculate the coordinates of the target MLR site. Directional DBS leads were implanted bilaterally and tested intraoperatively to verify general accuracy of targeting. A postoperative CT scan was used to identify and co-register lead locations into the subject-space. Stimulation parameters initiating locomotion were empirically identified during manual treadmill testing. DTI-based FEMs were used to compute the electric potential field induced by stimulation and to determine the volume of tissue activated (VTA). The overlap of this VTA and the tractography indicates the fiber pathways potentially stimulated. MRtrix3 was utilized to filter out tracts outside the VTA and to sort different tracts within the VTA. The common elements found in stimulation spaces of effective contacts defines circuits responsible for generating locomotion. Results: Midbrain sites inducing locomotion were found within the cuneiform nucleus (CnF) of the traditionally defined MLR and the periaqueductal grey (PAG), known for evoking escape behavior. Stimulation effects were optimized with directional leads. Based on the tractography, projections originating from the VTA encompassing the CnF were seen to course toward the medial reticular formation, known to relay signals to the spinal locomotor circuits. PAG projections were observed to connect to the CnF. Conclusion: This method allows for the identification of fiber pathways activated during MLR-DBS in a large animal model and will inform clinical applications for steerable, human DBS of this important brainstem site for gait facilitation in SCI. Department of Defense. DoD SC200294

Learning Objective 1

Discuss strategies to optimize DBS targeting of the midbrain for gait control after SCI.

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Poster 51

Single lead midline epidural stimulation immediately restored trunk control and standing in a person with complete paraplegia

Abstract 6

Ashraf Gorgey, MPT, PhD, Hunter Holmes McGuire VA Medical Center

A 25-year-old male with T3 complete AIS A was implanted with percutaneous spinal cord epidural stimulation (scES; 8 contacts each) leads and Medtronic Prime advance internal pulse generator. The two leads were placed at midline level to cover the region of T11-T12 vertebrae. Five days after implantation, x-ray showed complete migration of the left lead outside the epidural space. Two weeks after implantation, reprogramming of the single right lead resulted in target activation of the abdominal muscles and allowed immediate restoration of trunk control during seated position and even with upper extremity perturbation. This is followed by achieving immediate standing after setting the single right lead at -3 for the cathode and +6 for the anode using stimulation configurations of 20 Hz and 240 μs. The results were confirmed with electromyography (EMG) of the rectus abdominus and lower extremity muscles. Targeted stimulation of the lumbosacral segment using a single lead with a midline approach immediately restored trunk control and standing in a person with complete paraplegia.

Learning Objective 1

Discuss the feasibility of using percutaneous epidural stimulation (ES) to restore motor recovery in persons with SCI

Learning Objective 2

Highlight research findings regarding midline compared to lateral approach when using percutaneous ES

Learning Objective 3

Describe detailed mapping procedures to either enable or target the lumbo-sacral segments responsible for trunk and standing control

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Poster 52

Utilizing Neuromodulation in the Treatment of Spinal Cord Injury: An Assessment of Clinical Trials from the National ClinicalTrials.gov Database

Abstract 26

Moshe Shalom, BS, Tel Aviv University, Sackler Faculty of Medicine

Objectives: Spinal cord injury (SCI) is responsible for approximately 18,000 trauma cases each year in the United States, and often results in debilitating motor and autonomic disability. Neuromodulation is a rapidly growing field of interest in the neurosurgical field and has additionally shown promise in the treatment of SCI. Therefore, the authors of this study aim to characterize all clinical trials to date of neuromodulation in the treatment of SCI. Methods: The ClinicalTrials.gov database was queried using the search terms “neuromodulation” and “spinal cord injury” on ClinicalTrials.gov. Trials were excluded if they were not yet recruiting, suspended, terminated early, or of unknown status. Results: In total, 33 clinical trials were included in this study. Of the 33 trials, eight were completed and one had available results. Most trials studied deficits of motor function (60%) and bladder control (37%) post SCI. Of the modalities tested, 15 studies (46%) utilized transcutaneous spinal stimulation (tSS), seven (23%) utilized epidural electrical stimulation (EES), and six (19%) utilized tibial nerve stimulation. There was an uptrend of clinical trials studying SCI indexed on PubMed, which was comparable to the increased number of publications indexed overall (Pearson correlation, p<001). Of these, only one study regarding home tibial nerve stimulation for neurogenic bladder had published data, which was performed with no adverse events. Conclusions: Neuromodulation in SCI studies currently assess tSS, EES and tibial nerve stimulation. There is currently one completed study suggesting feasibility of home neuromodulation techniques without adverse events.

Learning Objective 1

Analyze current clinical trials that relate to the use of neuromodulation in spinal cord injury

Learning Objective 2

Describe the current status of neuromodulation in the context of spinal cord injury

Learning Objective 3

Guide future research in the field of spinal cord injury treatment

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Poster 53

Effects of repositioning angle on interface pressure using automated bed in spinal cord injury patients

Abstract 168

ONYOO KIM, MD, National Rehabilitation Center

Background: Pressure injury is a major complication of patient with spinal cord injury. Repositioning and reducing interface pressure is standard care for PI. This study aimed to compare interface pressure and total area of sacral region in different positions including small angle changes in spinal cord injury(SCI)SCI patients. Also, we analyzed clinical factors affecting pressure to identify PI high risk group. Methods: This was analytical, a cross-sectional study including 30 paraplegia(n=30) with SCI. On the 1st and 2nd trials, Interface pressure and total contact area of sacral region were recorded from different large and small angled positions using the automatic repositioning bed which can change angle of back, lateral tilt and knee. Kruskal-Wallis test and ANOVA were used for differences in pressures and contact area between the positions. Multiple regression model was used to assess the possible risk factors affecting pressure and contact area. Results: 2nd trial positions with A statistically significant differences was found in average pressure, peak pressure and contact area among large angled positions($p<0.001$). However, combinations of ssmall angled changes under 30°(back/tilt/knee) and position 11(back/tilt/knee, 15°/15°/15°) had no significant differences in average pressure, peak pressure and contact area, respectively. ($p=0.168$, $p=0983$, $p=0.475$, respectively). Duration of injury($\beta=0.51$, $p=0.010$) and NLI ($\beta=-0.47$, $p=0.020$) were significant independent predictors of average pressure. Likewise, duration of injury($\beta=0.64$, $p=0.001$), K-SCIM-III ($\beta=-0.52$, $p=0.017$) and BMI ($\beta=-0.34$, $p=0.041$) were significant independent predictors of peak pressure. Conclusions: For repositioning, small angle changes under 30° with combinations of back raise, lateral tilt and knee raise is sufficient in SCI patients by reducing pressure on sacral region. Lower body mass index(BMI), longer duration of injury, lower functioning score and neurological level of injury(NLI) T7 or above are high risk factors of pressure injury(PI)PI high-risk groupwho have these risk factors require strict management to prevent PI., so management of those factors is important.

Learning Objective 1

to compare interface pressure and total area of sacral region in different positions including small angle changes in spinal cord injury(SCI) patients

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Poster 54

Community Evaluation of a Novel Real-Time Pressure Sensing and Pressure Relief Activity Feedback System for Manual Wheelchair Users with Spinal Cord Injury: A Focus Group Analysis

Abstract 107

Jack Janett, B.S., University of Southern California

Objective: For individuals with spinal cord injury (SCI), approximately one in three patients are diagnosed with pressure sores, and infection of these pressure injuries contribute to the second leading cause of death. Recently, technological systems incorporating wearable sensors with biofeedback have been developed in order to support positive health changes, but there is a lack of evidence and adoption for these interventions. We are therefore developing a system for manual wheelchair users (MWCUs) with SCI that provides monitoring, feedback, and training to facilitate the performance of pressure relief activities to prevent pressure injuries. Our objective was to obtain from MWCUs with SCI, their caregivers, and clinicians: 1) information related to current approaches and challenges related to pressure injury prevention and 2) initial impressions of a prototype feedback and training system. Design/Methods: We conducted a single focus group consisting of six bi-monthly sessions. The group included four MWCUs with paraplegia, two SCI clinicians, and two caregivers for individuals with SCI. In addition to focus group participation, MWCUs and caregivers completed the Satisfaction With Life Scale (SWLS) and Technology Attitudes Questionnaire. Virtual discussion sessions progressed in content based on the key stages of the participatory design process: exploration, discovery, and prototyping. All sessions were recorded and transcribed. Results: Participants had a mean age of 40 (SD 9.1) years and an average SWLS of 24/35 (slightly satisfied). They had an average score of 5.5/7.0 on the Technology Attitudes Questionnaire, indicating a positive attitude towards and moderate comfort with using new technologies. Focus group discussions revealed that MWCUs with SCI and their caregivers expressed interest in a holistic health/wellness coach that is portable, waterproof, and pressure detecting (mentioned 10, 6, and 21 times, respectively). Participants did not express a need for community features, such as competitions, to stay engaged with the technology. Conclusion: This study provides insight into improving the acceptance of new technologies targeting MWCUs with SCI. The information will be immediately used to refine our current prototype system but also has broad relevance to the design of other wearable sensor/biofeedback systems aimed at improving the lives of MWCUs with SCI.

Learning Objective 1

Discuss desired attributes for and challenges associated with technologies to prevent pressure injuries SCI individuals.

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Poster 55

Measuring Pressure within Pressure Ulcers - A Biomechanical Approach

Abstract 158

Gregory Dimas, MD, James A. Haley Veterans' Hospital

Objective: Pressure ulcers often are a challenging complication after spinal cord injury (SCI). Pressure ulcers (PUs) are among the leading causes of hospitalization in chronic SCI and also may complicate acute rehabilitation. It's well known that prolonged pressure on skin, subcutaneous tissues, and muscle (especially over bony prominences) causes PUs. Insensate skin, smoking, and poor nutrition also are predisposing factors. It's also well known that proper periodic body turning and/or repositioning relieves pressure which prevents PUs and may facilitate healing. It's unknown, however, if increased pressures occur within wound bed of existing ulcers and if increased pressures within the wound bed contribute to exacerbation of PUs and/or prevent healing. Furthermore, dressings often are placed into PUs for treatment, including combination dressings (cotton gauze with saline, H20, or dilute chlorine bleach) or commercially-available wound-care products (which also may be combined with gauze). Such dressings sometimes are tightly packed into PUs. in addition, hospitalized patients may be placed onto commercially air-fluidized beds which may or may not induce additional pressure onto dressed wounds. It is unknown how dressings impact the pressure profile at the wound site. Pressure changes near the wound site have been associated with adverse wound healing.1 Methods: Measurements were made on a pressure ulcer manikin developed by the VISN 8 Patient Safety Center of Inquiry in collaboration with Moore Medical Models. The torso model has three pressure ulcers over the greater trochanter, ischium, and abstractior superior iliac spine. Manikins are preferred over human subject testing for consistency, at least in preliminary testing2. Pressure measurements were taken using the Tekscan Pressure Mapping software. Sensors were placed into the wound bed. The manikin was prepared in multiple ways, no wound dressing, gauze and saline, and alginates and saline. Pressure measurements were taken supine, and 30 degrees lateral lean to each side. Results: Pressure measurements were obtained from the model wound bed. This represents the first known measurement of the impact of wound dressings on interface pressure at the wound bed. Conclusions: Wound dressings have an impact on pressure applied at the wound site and could potentially impact wound healing. Live tissue will respond differently than model tissue, and pressure is one factor of many which impact healing. Further exploration is needed to understand the role pressure at the wound site may play in healing.

Learning Objective 1

Attempt to measure pressure(s) within wound bed(s).

Learning Objective 2

Measure pressures within wound beds using different dressings.

Learning Objective 3

Measure pressures within wound beds using different solutions placed onto dressings.

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Poster 56

Evaluating independent in-bed mobility during sleep after acute spinal cord injury to assess the risk of pressure injuries

Abstract 170

Jean-Marc Mac-Thiong, MD, MSc, Hospital du Sacre-Coeur de Montreal

BACKGROUND: After a spinal cord injury (SCI), the presence of motor, sensory, and autonomic dysfunction puts individuals at highest risk for pressure injuries. During acute care, the risk is further increased when patients are bedridden due to pain or restrictions from spine surgery, hemodynamic instability and/or complications. Current guidelines recommend that assessing the risk of pressure injuries is important to identify prevention strategies. Using an actigraphy-based method, our recent findings suggest that patterns of independent repositioning in bed during sleep may be an important predictor of pressure injuries during acute SCI care. GOAL: This project investigates the patterns of independent repositioning in bed during sleep and their association with the occurrence of pressure injuries during acute SCI care. We hypothesize that there are specific patterns of in-bed repositioning during sleep is associated with decreased incidence of pressure injuries during acute care. METHODS: We used two actigraphs place at the torso and hip to assess in-bed repositioning during sleep on a cohort of 6 patients with acute spinal cord injury. The number of independent (spontaneous weight shifting by patient while sleeping) and assisted repositioning (performed by caregivers) were analyzed for a night of sleep. RESULTS: The American Spinal Injury Impairment Scale (AIS) severity grade and neurological level of injury (NLI) were the following: Patient 1) NLI C4, AIS grade A; Patient 2) NLI C3, AIS grade B; Patient 3) NLI C8, AIS grade D; Patient 4) NLI C4, AIS grade C; Patient 5) NLI C4, AIS grade D; Patient 6) NLI T12, AIS grade B. Pressure injuries in the sacral region occurred in Patients 1 (grade 2), 2 (grade 3) and 5 (grade 2). The following number of repositioning during sleep was observed: Patient 1) 0 independent, 1 assisted; Patient 2) 0 independent, 4 assisted; Patient 3) 27 independent, 3 assisted; Patient 4) 5 independent, 1 assisted; Patient 5) 0 independent, 1 assisted; Patient 6) 7 independent, 2 assisted. DISCUSSION: None of the 3 patients (C8 grade D; C4 grade C; T12 grade B) capable of independent repositioning during sleep developed a pressure injury. On the opposite, all 3 patients (C4 grade A; C3 grade B; C4 grade D) unable to reposition independently during sleep developed a pressure injury. Our actigraphy-based method could become an objective clinical evaluation tool to assess the risk of pressure injuries, and could help determine the level of assistance required for assisted repositioning during sleep.

Learning Objective 1

Assess importance of repositioning

Learning Objective 2

Assess importance of pressure injuries

Learning Objective 3

Acknowledge importance of repositioning to decrease pressure injuries

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Poster 57

Implementation of a formal education program for caregivers and youth with SCI/D

Abstract 11

Kristen Wagner, PT, DPT, Children's Healthcare of Atlanta

Objective: To discuss the components of a successful education program for caregivers and youths with SCI/D at Children's Healthcare of Atlanta Comprehensive Inpatient Rehabilitation Unit and to continue to improve current practice. To assist others in implementing formalized education programs. Introduction: In House et al. (2009) only 17% of caregivers sighted education as being a meaningful factor to contributing to their child's return to participation in school and community activities. In Espino et al 2018 they found caregivers express challenges with understanding medical terminology, understanding functional outcomes and appropriate/supported expectations for recovery. Some even felt unprepared to leave rehabilitation due to lack of resources/understanding benefits and social services, accessibility issues, and lack of training with transfers and ADLS. SCI caregiving has been linked to increased depression and anxiety, decreased marital satisfaction, and decreased quality of life for the caregiver. Mental health of caregivers with SCI is related to the mental health and quality of life of youth with SCI. Can we improve these things with better education during the acute/inpatient rehab portion of recovery? Methods: Initial program development included surveys and interviews with providers from adult and pediatric SCI facilities, and from research which indicates the need to target multidimensional education. Results: A structured, formal education program utilizing the Paralyzed Veteran's Association "Yes, You Can" manual as the foundation and incorporating support for caregivers, psychological support for the child, transition to school, assistance with finding recreational activities, peer support, and assistance with home modifications was developed. The program divides medical information, specific aspects of care (skin, bowel/bladder), and social considerations into modules that are presented via powerpoint to the caregiver and when appropriate, the child. Modules are presented weekly in 1 to 1.5 hour one on one session over the course of the patient's admission to inpatient rehab. Discussion: Future research is warranted to give quantitative data to the success of this program. Future aspirations include formation of group education classes to allow for interaction between caregivers.

Learning Objective 1

Participate will discuss components of a successful education program for patients with SCI/D in the pediatric setting.

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Poster 58

Positive psychosocial changes relating to physical activity behavior after participation in a group tele-exercise program for individuals with SCI

Abstract 43

Laura Baehr, PT, DPT, PhD(c) (defense 2/2023), Drexel University

Objective: Physical activity is crucial for health maintenance of individuals with SCI, yet 50% of this population lead sedentary lives. Digital health technologies, such as tele services, offer a method to address these obstacles, but SCI-specific evidence is needed. We developed a novel 8-week synchronous group tele-exercise program for individuals with SCI grounded by Social Cognitive Theory (SCT) to address barriers to exercise in order to influence individual determinants of physical activity behavior. Our pilot study demonstrated excellent feasibility with participant reports of increased exercise knowledge, confidence, and motivation. The purpose of this next critical step was to assess if participation in the group tele-exercise program could change psychosocial determinants of physical activity behavior. Design/Methods: Participants with chronic SCI volunteered for a synchronous group tele-exercise program that met biweekly via Zoom over 8-weeks. Classes were co-instructed by a physical therapist/adapted exercise instructor and a study team member living with an SCI. Each session focused on meditation, body awareness, mobility, shoulder and trunk stability, cardiovascular and strength training. This study employed a pre-post-test, single group design examining effects of participation on SCT personal factors of physical activity behavior including exercise self-efficacy (Exercise Self-Efficacy Scale for SCI), exercise outcome expectations (Multidimensional Outcome Expectations for Exercise Scale), leisure time physical activity weekly minutes (Leisure Time Physical Activity Questionnaire for SCI), and SCI-Quality of Life Measurement System (Participation in Social Roles, Satisfaction with Social Roles, Self-Esteem, Resilience, Depression). Within participant change over time (baseline to post-program) was assessed with Wilcoxon singed rank test ($p \leq 0.05$). Cohen's d effect sizes were calculated and defined as small = 0.20, medium = 0.50, and large = 0.80. Results: Eleven adult volunteers (male/man=5, female/woman=6, age 48.6+15.1 years) with chronic SCI (injury duration 6-50 years) participated. Post-program the cohort demonstrated significantly improved exercise self-efficacy ($p=0.49$, $d=1.47$). Additionally moderate-large effect sizes post-program were found for improved social ($d=0.78$) and self-evaluative ($d=1.29$), exercise outcome expectations, participation in ($d=0.56$) and satisfaction with ($d=1.33$) social roles, improved self-esteem ($d=0.81$) and resilience ($d=0.82$) as well as reduction in depression ($d=0.90$). Moderate effect was observed for increased moderate-vigorous intensity weekly leisure physical activity minutes ($d=0.74$). Conclusion: Our group tele-exercise program improved exercise self-efficacy, a personal factor critical to physical activity behavior for individuals with SCI. Program participation also shows promise to significantly improve additional psychosocial measures linked to physical activity behavior and quality of life. Participation appears to increase physical activity behavior aligned with national guidelines for individuals with disabilities to maintain health.5

Learning Objective 1

Discuss impact of participation in group tele-exercise program

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Physical and psychosocial features of exercisers vs. non-exercisers with SCI enrolled in a group tele-exercise program

Abstract 44

Laura Baehr, PT, DPT, PhD(c) (defense 2/2023), Drexel University

Objective: It is estimated that individuals with SCI are 1.5 times more likely to be sedentary compared to the general population. Inactivity exacerbates development of several secondary conditions as well as medical costs and hospitalizations. Assistive care relating to treatment of these conditions directly contribute to the $45 billion SCI-related annual costs in the United States. By contrast, individuals with SCI who engage in regular physical activity might realize lifetime cost savings of more than $400,0004 due to early functional improvements, in addition to physical and mental benefits. From individual and healthcare management perspectives, it is therefore imperative to develop and evaluate innovative facilitation strategies for physical activity behavior in this population. An insightful first step to creating tailored physical activity strategies for individuals with SCI it to evaluate characteristics of those who choose to engage in exercise. However, little evidence exists elucidating baseline differences across individuals with SCI by their exercise behavior. We aim to begin to answer this question by examining baseline characteristics across individuals with SCI enrolling in a group exercise study. Design/Methods: Participants with chronic SCI enrolled in a non-randomized controlled trial to evaluate physical and psychosocial features of physical activity behavior before and after participation in a group tele-exercise program. This cross-sectional analysis of participants at baseline (pre-program) evaluates features of individuals who are regular exercisers vs. non-regular exercisers as defined by the American College of Sports Medicine (20-30 minutes, 2-3 times per week). Demographics characteristics were assessed with Chi Square and t-tests, as indicated, with between group differences for psychosocial and physical activity related outcomes assessed using Mann-Whitney U Test ($p<0.05$) at baseline. Results: Twenty-seven adult volunteers enrolled in the study (exercisers=14, non-exercisers=13). Groups were comparable for distribution of biological sex, gender identity, self-reported racial group(s) as well as current age. Exercisers demonstrated a significantly shorter duration of injury compared to non-regular exercisers ($p=0.012$). Exercisers also exhibited significantly higher exercise self-efficacy ($p=0.017$), outcome expectations about exercise ($p=0.048$), and increased reported weekly minutes spent doing vigorous leisure time physical activity ($p=0.029$). Conclusion: Individuals with chronic SCI who do not engage in regular physical activity demonstrate reduced personal factors imperative to initiation and maintenance of exercise behavior compared to age-matched peers. These factors should be addressed in the design and delivery of SCI-specific exercise programs to increase likelihood of physical activity behavior over time. Non-exercisers also demonstrate a longer duration of injury compared to age-matched peers. Further investigation is warranted to determine potential reasons for this difference. Additionally, SCI-related exercise education and opportunities should be prioritized for individuals with longstanding injury.

Learning Objective 1

Distinguish demographics of regular vs. non-regular exercisers with SCI

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Pain and Life Satisfaction: The Role of Emotional Support and Social Participation in Adults with Pediatric-Onset Spinal Cord Injury

Abstract 139

Alison Oh, MS, Illinois Institute of Technology

Objective: Pain characteristics, such as frequency, duration, intensity, interference with day-to-day activities, and sleep disturbance due to pain, in adults with pediatric-onset spinal cord injury (SCI) and their impact on life satisfaction require further investigation.1 Considering that adults with pediatric-onset SCI experience diverse trajectories and differ substantially in their life satisfaction, it is critical to evaluate specific factors, such as pain, emotional support, and social participation, and how they can improve life satisfaction for these individuals.2,3 The objective of this study is to examine the association of demographic, injury, pain, emotional support, and social participation with life satisfaction in adults with pediatric-onset SCI. Design/Method: A total of 206 adults who had sustained a spinal cord injury before 19 years of age completed interviews that included medical information and a comprehensive pain questionnaire to assess the duration, frequency, intensity of current/general pain, use of pain medication, interference with day-to-day activities, and sleep disturbance due to pain. Additionally, participants completed standardized measures including the Satisfaction with Life Scale, the Craig Handicap Assessment and Reporting Technique (CHART), and the Brief COPE Inventory. Only the subscale scores of the social integration of the CHART, used to measure social participation, and the emotional support subscale of the Brief COPE Inventory will be used for this analysis. Results: Mean age of the participants was 36.92 years (SD = 8.32, range = 19-54). 60% of the participants were male, 85% were white, 93% had non-traumatic etiologies, and 68% had complete injuries. A hierarchical multiple regression assessed the variance in the outcome contributed by each criterion variable in successive steps.4 After controlling for the covariates (e.g., age, sex, injury characteristics), the regression model revealed that higher levels of interference with day-to-day activities and sleep disturbance due to pain were associated with lower levels of life satisfaction (β=-.321, t=-3.53, p =<.001, β =.277, t=2.89, p =.004, respectively). Secondly, when pain and injury characteristics were accounted for, higher levels of emotional support, defined as comfort or understanding from another individual, was positively associated with life satisfaction (β=.154, t= 2.18, p<.05, sr2=0.02). Lastly, higher levels of social participation were positively associated with life satisfaction (β=.246, t=3.53, p< .001, sr2=0.06). Conclusion: These findings suggest that clinicians should evaluate various pain characteristics, particularly sleep disturbance and interference with day-to-day activities, and recognize its negative impact on life satisfaction when treating individuals with SCI. Additionally, clinicians should highlight the positive role of social participation and emotional support on life satisfaction and to implement strategies to increase the frequency and quality of these factors (e.g., support groups, SCI programs). Future research should continue to focus on the development of interventions that emphasize emotional support and social participation in order to optimize long-term outcomes for adults with pediatric-onset SCI.

Learning Objective 1

Examine the role of emotional support and social participation on pain and life satisfaction among adult with pediatric-onset SCI.

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Frequency of employment and factors related to labor activity inclusion in patients with Spinal Cord Injury at the National Institute of Rehabilitation in Mexico

Abstract 165

Karla Zarco Ordóñez, MD, National Rehabilitation Institute in Mexico

Introduction: People with spinal cord injury (SCI) may experience changes in their employment circumstances, that will also directly affect their quality of life. Little is known about the prevalence of employment among patients with a diagnosis of SCI in Mexico, despite its importance in order to guarantee inclusion to society. Objective: measuring the frequency of employment among patients with SCI who have been evaluated at the National Rehabilitation Institute in Mexico (INR) and identifying the factors that contribute to employment. Design/Methods: An observational, cross-sectional, and descriptive study was conducted to investigate the prevalence of employment among patients diagnosed throughout the period from 2016, to 2021, at the INR. Patients with SCI of any kind and neurologic, regardless of gender or age, were included. Results: 1284 patients were included, primarily men 66.2%. The mean age was 42.23 years old (range: 16-88 years old). The majority had complete injuries, AIS A in 42.7%, followed by AIS D in 28.9%, AIS C in 14.5%, AIS B in 11.1%, and AIS E in 2.8%. The majority presented low paraplegia (39.5%), followed by the high paraplegia (26.9%), low tetraplegia (16.9%) and high tetraplegia (15.8%). The majority were traumatic injuries (64.8%). Most patients (72.9%) did not now work. Of the individuals who worked, the majority had a formal job. The results showed a statistically significant correlation between employment and life satisfaction and independence, evaluated with LISAT-9 and SCIM-III. We found a statistically significant association between employment and SCI severity and neurologic level in such a way that the frequency of individuals with motor incomplete injuries and low neurologic levels was higher in the group of people with employment (p 0.001 for both). Also, individuals without complications were more frequently employed (p=0.001). Conclusion: We found that, like the rest of the world, most patients with SCI do not have employment. We also found similar associations between employment and SCI characteristics to those described in the literature. To our knowledge this is the first study that proved an association between SCIM-III and LISAT-9

Learning Objective 1

Measuring the frequency of employment among patients with SCI who have been evaluated at the National Rehabilitation Institute in Mexico (INR) and identifying the factors that contribute to employment.

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Problem Solving and Collaborative Involvement among Adolescents with Spinal Cord Injury and their Caregivers

Abstract 174

Olivia Clark, MA, Loyola University Chicago

Objective: Adolescents with spinal cord injury (SCI) may face several challenges with regard to activities of daily living and independent functioning. Thus, adolescents with SCI often require assistance from a caregiver, which many times is a parent. Problem solving is a skillset that enables adolescents to best care for their SCI, develop self-advocacy, and protect against psychosocial difficulties. In other pediatric populations, parent problem solving has also been associated with improved health-related quality of life. Helpful, productive collaboration between adolescents and their caregivers regarding chronic medical condition care has also been associated with effective health management, which may support avoidance of secondary medical complications and psychiatric problems. The purpose of this study was to examine caregiver-related predictors of adaptive problem solving in adolescents with SCI. Design/ Methods: As part of a larger study examining psychosocial outcomes in youth with SCI, adolescents with an SCI of at least one-year duration and their primary caregivers were recruited from a pediatric rehabilitation care system in North America. Adolescents and caregivers completed the Social Problem Solving Inventory, revised, short form (SPSI-R:S) to examine problem solving orientation and style. Adolescents completed the Collaborative Parent Involvement in SCI Care Scale (CPI-SCI) to examine collaborative care. Hierarchical multiple regression models were used to examine associations among caregiver problem solving, adolescent problem solving orientation, and adolescent rational problem solving style. Results: 73 adolescents, with an average age of 15.9 years (SD= 1.6 years), and 73 primary caregivers, aged 45.2 years (SD= 6.7 years) participated in this study. Adolescents were male (56%), White (67%), and had an SCI resulting in paraplegia (64%). All primary caregivers were unpaid parents with the majority being mothers (82%), White (67%), and approximately half were married (52%). Both adolescents and their caregivers reported moderate positive problem solving orientation and rational problem solving style. Caregivers generally reported low negative problem solving orientation, impulsive/careless problem solving style, and avoidant problem solving style. Adolescents reported positive perceptions of collaborative involvement in SCI care with their primary caregiver. In adolescents with SCI, effective primary caregiver problem solving and adolescent perceptions of more collaboration with their primary caregivers are associated with positive adolescent problem solving orientation and rational adolescent problem solving style. Conclusion: This study examined predictors of constructive problem solving among adolescents with SCI. Fostering effective problem solving skills and collaboration between adolescents with SCI and their caregivers appears to be an important factor in supporting positive, effective problem solving strategies in youth, which may include believing that problems are solvable and engaging proactively in problem solving rather than avoiding it. This study has important clinical implications for caregiver involvement in the rehabilitation process following SCI and identifies potential opportunities for intervention.

Learning Objective 1

Examine associations among primary caregiver problem solving strategies and collaboration and adolescent problem solving approaches in the context of pediatric SCI.

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Poster 63

Developing a Community Based Peer- Mentoring Program for Adolescents and Young Adults after Spinal Cord or Brain Injury

Abstract 12

Shari McDowell,

Response to acquired neurological injury requires that the family unit adapt to rapid changes in functioning and prepare for a “new normal” while facing increasingly shorter lengths of stay in acute and post-acute rehabilitation. During this brief time, families are expected to acquire an overwhelming set of skills and knowledge to help manage complicated medical regimens, utilize adaptive equipment, and learn to navigate their world and overcome barriers. The gravity of these changes may not impact the family until after hospital discharge and return to their communities. This necessitates the development of community-level interventions that monitor and provide directions for families post-discharge. Peer mentoring programs have been shown to be effective at promoting self-efficacy and reducing unplanned hospital admissions in adults with SCI. However, adolescents and young adults face a rapid set of changes in physical, neurological, and psychosocial development as they mature into adulthood that are unique to the age group. There is a paucity of literature for peer support for adolescents, and a lack of comprehensive programing specifically directed for this age group. The aim of the current study is to develop a peer-led support program utilizing trained mentors within this age group (13-23) to help identify risks, resources, and promote successful psychosocial recovery, adaptation, and healthy community re-integration. This presentation outlines stages to program development including: evolution of focus groups for adolescent needs assessment, identification of training and resources for adolescent peer supporters, recruitment of peer mentors and training processes, developing collaborative relationships with outside stakeholders, and identification of next steps for implementation. Findings from the focus groups will be shared and the lessons learned from on-boarding the first peer mentors will be discussed. The outcomes chosen for the project will be shared and if available, follow up information from one early enrollment participant will be shared. Future plans to build a mobile application for peer-mentoring navigation system will be introduced.

Learning Objective 1

Discuss the scope of the 3-year project with emphasis on the development of the focus groups organization and findings.

Learning Objective 2

Explain the peer-led mentoring concept as applied to this project.

Learning Objective 3

Describe the on-boarding process for recruitment and training for the peer mentors.

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Recruitment Challenges in a Tele-Psychology Intervention for Persons with Spinal Cord Injury

Abstract 129

Cria-May Khong, BS, Santa Clara Valley Medical Center

Objective: To i) summarize reasons for declining to enroll in a telepsychology study for individuals with spinal cord injury (SCI) and ii) investigate clinical and demographic factors associated with consenting for screening and full study participation. Methods/Design: The telepsychology study was a single-center controlled (treatment vs. usual care) study with, block randomization by etiology of injury (nontraumatic vs. traumatic SCI). Eligible individuals were adults 18 years or older with SCI at any level of injury who were English-speaking and within one year of date of injury. Exclusion criteria were medical instability, acute psychosis, active suicidal ideation, and inability to provide informed consent. Potential participants were screened using the Patient Health Questionnaire-9 (PHQ-9) and the Montreal Cognitive Assessment (MoCA). Participants were enrolled if they had PHQ-9 total scores between 5-14 and had intact cognitive status, based on full scale MoCA scores >=25 or MOCA-Blind >=17. Results: A total of 340 participants met eligibility criteria to be screened and were approached to enroll in this study. One hundred and sixty-three persons (47.9%) declined to enroll in the study with the following reasons: not interested (49.1%), passive refusal (32.5%), other commitments (9.2%), no symptoms of depression by self-report (3.1%), desire to focus on SCI therapy (1.8%), dislike for technology (1.8%), and other (2.5%). Remote recruitment efforts are ongoing for fifty-three individuals (15.6%) and the remaining 35 individuals (10.3%) were not enrolled due to planned re-admissions, early discharge, invalid contact information for remote recruitment, and change in medical status (e.g., expired). Among the eighty-nine participants who consented for screening, 40 participants (44.9%) failed the screening criteria as follows: PHQ-9 score was too low (47.5%), PHQ-9 score was too high (10.0%), MoCA score was too low (17.5%), MOCA score was too low and PHQ-9 score was too high (2.5%), both PHQ-9 and MoCA scores were too low (20.0%), and positive active suicidal ideation (2.5%). Logistic regression analyses revealed that individuals who were older (OR: .985, p=.031), recruited later (i.e., after the COVID pandemic) in the study (OR: .604, p=.001), and had tetraplegia (OR: .568, p=.035) were less likely to consent for screening. Of the individuals who agreed to be screened and met eligibility criteria, a higher PHQ-9 total score (OR: .725, p=.004) was associated with a decreased likelihood to enroll for the full study and more recent recruitment (OR: 4.55, p=.018) was associated with a higher likelihood to enroll for the full study. Conclusions: Although Tele-CBT has promising evidence behind its use, this project had a high refusal rate (48%) to participate, which is in line with other telehealth CBT studies (36-60%). Common identified reasons for declining participation in this tele-psychology project were “not interested” and “other commitments.” Reducing the perceived inconvenience and/or stigma of participating in research, support from potential participants’ treatment teams, and improving familiarity with technology may increase the rate of enrollment in tele-psychology projects.

Learning Objective 1 Summarize reasons for declining to enroll.

Learning Objective 2 Discuss possible barriers and challenges to participating in tele-psychology counseling

Learning Objective 3 Investigate factors associated with consenting for screening and full study participation

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Identifying Gaps in Spinal Cord Injury Treatment During Inpatient Rehabilitation: A Patient's Perspective

Abstract 53

Maddie Liss, Occupational Therapy Student, Grand Valley State University

Abstract Objectives: The purpose of this study is to evaluate and understand the patient perceptions of occupational therapy services and their impact on the clients functional abilities, as well as identifying where gaps in treatment may be. This study design was chosen as the best fit to gain the patient's perspective and obtain subjective data to make inferences. Methods: A 26 question survey was designed by researchers. The survey themes included training in sexuality, training in cooking, and training in self-care. The respondents were located via a facebook group for people with spinal cord injuries and a physiatrist office. Inclusion criteria included those who were 18+ years of age who have had a traumatic SCI injury resulting in tetraplegia or paraplegia and were discharged from occupational therapy services. Participants were excluded from the study if they did not meet these demographics, have a history of multiple sclerosis, cerebral palsy, stroke, guillain barre, transverse myelitis, or moderate and severe traumatic brain injury. Data was analyzed using Qualtrics. Results: The survey was initiated by 36 participants who indicated they had either paraplegia (N=19) or tetraplegia (n=17). Based on analysis of the Qualtrics data, potential gaps in occupational therapy services were indicated for individuals who receive spinal cord injury rehabilitation. Results of the survey indicated that more than half of participants wish they had more training in sexuality, cooking, and self-care (dressing, bathing, toileting, and grooming). Conclusions: The results of this study indicate there are gaps in occupational therapy rehabilitation services for persons with a spinal cord injury. Further research is needed to examine the high incidence rate of bladder infections despite survey responses indicating adequate ADL training. Potential exists for improvement in this service area with the collection of further data. Keywords: Spinal cord injury, paraplegia, quadriplegia/tetraplegia, rehabilitation, quality of life

Learning Objective 1

Discuss gaps in care for spinal cord injuries

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A Lifestyle Intervention Trial Targeting Enhanced Health and Function for Persons With Chronic SCI in Caregiver/Care-Receiver Relationships

Abstract 117

Gregory Bigford, PhD MSBA, University of Miami Miller School of Medicine

Objective: The trial structure seeks to: i. determine in people with chronic SCI the health and functional impact, and user acceptance and satisfaction, of a 6-month comprehensive lifestyle intervention adapted from the Diabetes Prevention Program (DPP) and ii. determine the impact and user acceptance/satisfaction of a complementary caregiver program on SCI caregiver health and function. Design: Multi-center randomized trial with repeated measures testing and wash-in control. Participants/Methods: Dyadic couples: 1: men and women (18-65 years) with SCI (>1 year; AIS A-C; C5-L1) and 2: men and women (18-65 yrs.) who are healthy caregivers all receive: (1) Lock-step circuit resistance training (CRT); (2) a calorie restricted Mediterranean-style diet and (3) 16 educational sessions (8: diet/exercise goals and self-monitoring; 8: psychological and social challenges to behavioral modifications, cognitive behavioral therapy, and motivational interviewing) in a one-on-one format with a personal lifestyle coach. Cardiorespiratory fitness, cardio-endocrine risk, and inflammatory stress; multi-dimensional function and pain; life quality and independence and self-efficacy, program acceptance, and life satisfaction are measured variables for SCI participants. Multidimensional function and pain; and QoL and independence, the latter including perceived caregiver burden are measured variables for caregiver participants. Results: We report successful implementation of study design objectives: (1) Exercise prescription modification from DPP to a lock-step CRT clinical intervention for each dyadic participant, (2) Nutritional prescription modification from DPP to a predetermined /defined Mediterranean-style diet and calorie restriction for each dyadic participant and using population-relevant adjusted BMI for SCI, and (3) Behavioral and psychosocial education and curriculum modifications from DPP for each Dyadic participant and addressing unique population-relevant barriers to exercise, nutrition, and well-being for SCI. Conclusions: With current achievements in study design and participant adherence and satisfaction, we are testing for success in enhancing health and function outcome variables. Support: This project was funded by a NIDILRR Multicenter DRRP 90DP0074.

Learning Objective 1

Evaluate the utility of a therapeutic intervention for Cardiometabolic Risks in chronic SCI

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Lifestyle Intervention for Caregiver/Care-Receiver Dyads in Chronic Spinal Cord Injury

Abstract 118

Gregory Bigford, PhD MSBA, University of Miami Miller School of Medicine

Objective: Chronic spinal cord injury (SCI) results in impaired health and function, increased prevalence of obesity-related cardiometabolic (CM) risk factors, and an accelerated risk of cardiovascular disease (CVD) and diabetes. Several lifestyle hazards including physical inactivity and hypercaloric nutrition (relative to daily need) contribute to these risks. Declining health and function throughout the lifespan of people with chronic SCI also has significant effects on health and function of current-day caregivers. This study examined effects of a therapeutic lifestyle intervention (LI) program adapted from the Diabetes Prevention Program (DPP) on body mass (BM), body mass index (BMI), and cardiorespiratory fitness for persons with chronic SCI and their caregiver partners. Design: Two center collaborative intervention trial with repeated assessments. Participants/Methods: SCI participants: Adult m/f, n=6, Age 46.1 ± 10 yrs.; Duration of injury 15.7 ± 9.1 yrs.; Level of injury C5-T7; AIS A/B; obese; and pre-diabetic, Caregiver participants: Adult m/f, n=6, Age 39 ± 11.3 yrs. All underwent a 6-month LI program incorporating 3x weekly circuit resistance training, Mediterranean-style calorie restricted nutrition (1200-2000 kcal/day), and 16 behavioral educational sessions with a lifestyle coach. Results: Data were analyzed using a mixed model for repeated measures ANOVA (alpha = 0.05). The primary outcome measure (BM) was non-significantly reduced after LI compared to baseline by 3.4% for SCI participants and significantly reduced by 18.5% for caregiver participants. BMI was reduced after LI by 5.3% for SCI and 4.4% for caregiver participants. Cardiopulmonary endurance on graded arm ergometry (as VO2Peak) was significantly increased after LI for both SCI (24.5%) and caregiver (18.9%) participants. Upper extremity dynamic strength was significantly increased after LI for SCI subjects in both butterfly press (27.5%) and latissimus pulldown (21.5%), and for caregivers in both chest press (11.4%) and latissimus pulldown (15.4%). Conclusions: Significant reduction in the DPP BM criterion for diabetes prevention (i.e., > 7% BM reduction) was observed in the non-SCI partner, along with improved cardiorespiratory fitness, and dynamic strength in both dyadic members. Non-significant, yet desirable mass loss was observed in the SCI partner. These adaptations favor reduce risks for CVD and co-morbid disorders as dyads age together with a disability. Exploration of other CM risks, and co-occurring behavioral and life quality benefits, are indicated. Support: This project was funded by a NIDILRR Multicenter DRRP 90DP0074.

Learning Objective 1

Discuss the efficacy of therapeutic intervention on reducing Cardiometabolic Risks in chronic SCI

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SPINE: Specialized progression of independence and wellness for adolescents with a spinal cord injury

Abstract 175

Caitlin Jones, PT, DPT, Board-Certified Clinical Specialist in Neurologic Physical Therapy, Children's Healthcare of Atlanta

The annual incidence of spinal cord injury (SCI) in the pediatric population is estimated to range from 14-25 per million in the US. When children are injured, their parents and caregivers often take the lead on decision-making and medical care2, 3. The transition to independent adulthood can be difficult for persons who sustained a SCI as a child, resulting in a decreased likelihood to be employed, live independently, or have life satisfaction equal to that of their peers4. Mental health issues, such as depression, can also be more likely in adults who sustained SCIs as children6. It has been found that occupation or involvement in meaningful activities, such as employment, studies, or leisure activities are predictive of life satisfaction in adults with a pediatric-onset SCI4. Pressure ulcers and medical complications are associated with decreased life satisfaction4. SPINE was created to serve as a community outreach program to progress independence and wellness for young persons with a SCI through therapeutic modalities, unique community outings, and education targeting areas that have been identified to facilitate a successful transition to adulthood4, 5. SPINE is a one-week long program that is led by a PT, OT, and CTRS. The requirements for participants include: 1) SCI diagnosis AND must primarily use a wheelchair or assistive device for mobility; 2) >6 months since injury; and 3) ages 16-21. In 2022, a total of 8 participants attended the program. Program curriculum and education focused on topics including: advanced wheelchair skills, seating and mobility, driver's rehabilitation, higher level mobility skills, peer support, community and financial resources, educational opportunities, vocational rehabilitation, adult medical care, health and wellness, adapted sports, accessible travel, and mental health. Guest speakers were invited to provide expertise on the topics, including a driver rehabilitation specialist, a panel of SCI peer mentors, a social worker, and a pediatric health psychologist. Unique community outings were integrated into the program to provide hands-on learning opportunities, including job simulation at a local grocery store, travel on a public transportation train, exercise at a community gym, and partnership with Delta to practice boarding an airplane at the Atlanta airport. Pre- and post-program surveys were utilized to measure effectiveness of the program for improving functional mobility skills, confidence with self-care and responsibilities as an independent adult, preparation for a job and traveling, knowledge of specific resources, peer mentorship, and self-advocacy in community settings. Overall, participants reported positive improvements in these areas on the survey and indicated increased independence with adult life skills, which serve as positive predictors for a successful transition into adulthood. The SPINE program served as a successful community outreach program that met educational and therapeutic needs of the adolescent SCI population in our community. In future program planning, the plan is to incorporate larger recruitment efforts in order to increase number of participants, as well as further promote SCI awareness and education through partnerships with the community during the program.

Learning Objective 1

To discuss the innovative SPINE program which was developed at Children's Healthcare of Atlanta in 2022 and aims at progressing overall independence and wellness for young persons living with a spinal cord injury through therapeutic modalities, unique community outings, and structured educational opportunities.

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Satisfaction With Life In Patients With Spinal Cord Injury At The "Luis Guillermo Ibarra Ibarra" National Rehabilitation Institute In The Period 2015-2020

Abstract 190

Bryant Martinez, MD, National Rehabilitation Institute

Background: Spinal cord injury results in severe and permanent disability. According to the WHO data between 250,000 and 500,000 people is diagnosed with spinal cord injury each year worldwide. The quality of life in these patients can be affected by multiple factors, such as: psychological, social, work, intellectual, environment, treatment, and complications. Objective: To evaluate life satisfaction in patients with spinal cord injury at the National Rehabilitation Institute "Luis Guillermo Ibarra Ibarra" treated between 2015 and 2020. Material and Methods: A retrospective, observational, cross-sectional and descriptive study was performed. The LiSat-9 questionnaire was used to assess satisfaction with life in people with spinal cord injury, the results of each patient were collected from electronic medical records. Result: 822 patients with traumatic spinal cord injury were included, 73.7% were men, with a mean age of 38.16. The mean score on the Lisat-9 was 38.12 (SD 8.19); due to independence measurement, the average SCIM-III was 76.17. 452 patients with non-traumatic spinal cord injury were studied, mostly men (52.4%), with average age of 49.73 years old. The mean score on the Lisat-9 was 38.6 (SD 8.29); Regarding independence, the average SCIM-III was 77.58 (SD 29.2). We found a positive correlation between SCIM-III and LISAT-9 forward Life satisfaction in SCI patients. Conclusion: A higher life satisfaction is observed in subjects with incomplete injuries compared to subjects with complete injuries, this difference was statistically significant for both traumatic and non-traumatic origin. Describing life satisfaction in SCI patients represents the effort and need to identify factors that can be modified and provide adequate support and advice for comprehensive treatment after spinal cord injury.

Learning Objective 1 to evaluate life satisfaction in patients with spinal cord injury at the National Rehabilitation Institute "Luis Guillermo Ibarra Ibarra" treated between 2015 and 2020.

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Changes in employment, health, participation, and quality-of-life and the relationships with survival after spinal cord injury

Abstract 72

Yue Cao, PhD, Medical University of South Carolina

Objective: Identify the relationship between survival status and employment, health, participation, and quality-of-life (QOL) among people with chronic spinal cord injury (SCI), and to compare the five-year interval changes of employment, health, participation, and QOL between the alive and the deceased participants. Design/Methods: This cohort study was conducted by an academic medical center in the Southeastern United States. There were 1,157 adult participants with traumatic SCI of at least 1-year duration and completed two self-report assessment measures separated by a five-year interval. Results: The survivors had higher employment percentage, better health, higher social participation and better QOL compared to the deceased at the baseline measures. During the five-year interval, the survivors had significant declines in employment percentage and social participation, while the deceased participants had significant undesirable changes in all four areas of employment, health, participation, and QOL before their death. Using the survivors as the control group, the deceased participants experienced more hospitalizations, had less nights away from home, and lower global satisfaction score before their death. Conclusion: People with chronic SCI have experienced significant more hospitalizations, less nights away from home, and lower global life satisfaction before their death. It will be important for health care professionals to identify these changes at the earliest possible.

Learning Objective 1

To identify aging related changes in employment, health, participation, and quality-of-life among participants with SCI

Learning Objective 2

To examine the survival status among people with SCI and its relationship with employment, health, participation, and quality-of-life

Learning Objective 3

To compare the amount of change between those surviving and those not surviving until follow-up

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Poster 71

Enjoyment of Gamified Electromyographic Biofeedback Therapy for People with an Incomplete Spinal Cord: A Pilot Study

Abstract 36

Benjamin Petrie, MD, McGaw Medical Center of Northwestern University/Shirley Ryan AbilityLab

Introduction/Objective: Therapy is imperative for people with acute spinal cord injuries to maximize return of voluntary muscle activation and functional gains, and generally produces a greater benefit with greater dosing. Greater engagement with therapies has also been associated with higher efficacy. The use of biofeedback via surface electromyographic (EMG) sensors placed over target muscles has been shown to improve voluntary muscle activation and even functional outcomes. We designed several biofeedback games that can be played on a smartphone where participants control the games with voluntary muscle activity measured with wearable sensors to make this therapy more engaging and easy to deliver. Our primary aim in this pilot study was to determine if these games were enjoyable and worthwhile for acute spinal cord injury inpatients. Design/Methods: People with incomplete cervical spinal cord injuries undergoing acute rehabilitation at a large, urban acute rehabilitation center were enrolled in the study. Inclusion/exclusion criteria included: adults age 18-100, <3 months since traumatic spinal cord injury , able to consent to the study, able to cognitively attend to the study, and had detectable motor activity of either triceps, biceps, wrist pronators or extensors by EMG. Surface EMG sensors were placed over at least one muscle group per upper extremity, and baseline maximal muscle activity was elicited. Patients then played 10 minutes of either “Space Flight” or “Power Hammer” per muscle group. Maximal muscle activity was then repeated. At the conclusion of the session patients were administered the Physical Activity Enjoyment Scale (PACES), a validated survey assessing enjoyment of rehabilitation activities. Results: Participants were consistently able to play and control biofeedback games via EMG recorded from paretic muscles by wearable sensors. They were typically able to complete at least 10 minutes per muscle, often completing 100s of repetitions, and reported feeling like their muscles got a good workout. PACES scores showed that participants found both games enjoyable, invigorating, physically good, and a worthwhile use of their time. There were no adverse events. Conclusions: The use of gamified EMG biofeedback to facilitate voluntary muscle activity was enjoyable and worthwhile for acute incomplete spinal cord injury patients. This is important to establish to ensure patient engagement in this novel rehabilitation technology, and may provide an innovative approach for patients to independently perform large doses of therapy. Ongoing studies will determine if this technology improves arm function in this patient population. Support: Craig H Nielsen Foundation

Learning Objective 1

Assess the satisfaction of acute spinal cord injury participants playing biofeedback therapy games

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Poster 72

Virtual Outings: Merging Technology and Community Training

Abstract 30

Katie Murphy, CTRS, Shepherd Center

Community integration is a key part of health and wellness, especially among populations with chronic medical conditions and disabilities. Recreation therapists across all settings understand the importance of community integration for individuals with chronic illness or disability. Being able to problem solve those skills outside of a clinical or classroom setting is an essential part of successful community integration. Currently, individuals are limited in their opportunities for community integration training by COVID-19 and the resulting precautions necessary. Beyond COVID-19, there are a number of other situations that limit community training, including but not limited to: medical complications, budgetary restraints, lack of transportation, and even lack of access to various community settings like restaurants, airports, arenas, movie theaters, etc. As a response to the need for community reintegration training for individuals who are not able to enter the community for any number of the above reasons, Shepherd Center and AETOS IMAGING have developed a virtual community reintegration platform that allows for individuals to take three dimensional, interactive tours of community locations that include various training points for how to problem solve a wide range of barriers and situations that individuals may encounter in the community. This technology has the potential to be used by clinicians in a variety of settings for a low-cost, high-return training option for patients with a range of disabilities, medical conditions, and other life challenges.

Learning Objective 1

Describe at least 3 benefits of community reintegration training in their treatment setting

Learning Objective 2

Identify at least 3 barriers to successful community reintegration training

Learning Objective 3

List 3 benefits of virtual community reintegration training

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Poster 73

Restoring Upright Posture Using Wheelchair Mounted Buttons

Abstract 21

Kevin Foglyano, BSE, Louis Stokes Cleveland VA Medical Center

There are approximately 3.7 million wheelchair users in the United States and wheelchair safety is of great importance since falls from wheelchair can often have devastating consequences. These falls can often result from excessive leaning to grab objects out of their safe workspace, such as from the floor or a low or high shelf. Users with severe trunk impairment or weak upper extremities may be unable to return to an upright posture from a completely forward or side flexed position and can be stuck in that position until a caregiver provides assistance. They also may be unable to pick up objects with extended reach since they rely on their upper extremities to return to upright. Seatbelts or straps can secure the user from falling; however, many users reject these restraints due to the difficulties of donning and doffing and the restrictions they place on trunk movements and minimizing of the user's functional workspace. In this case study, a command interface was developed and tested for the recipient of an implanted neural stimulation system with lower extremity paralysis and trunk weakness due to adult onset Leukodystrophy. Implanted electrodes activated his gluteus maximus, hamstrings, erector spinae, and quadratus lumborum to assist trunk stability. Three command buttons were secured to the left, right, and front side of the wheelchair via 3D printed enclosures located at accessible locations when the user assumed a flexed position in each corresponding direction. The buttons were interfaced to a wireless transmitter, which broadcasted the switch closures to the external controller for his implanted stimulation system via a 900MHz communication channel. If the user were to lean in a way where he could not right himself, pressing one of the buttons activates a stimulation pattern programmed to restore him to an erect posture. For example, pressing the left button would activate the right-side erector spinae, quadratus lumborum, hamstrings, and gluteus maximus to pull his trunk to the right and restore him to erect sitting centered in the wheelchair. Similarly pressing the right button activates the left side muscles while pressing the aft button after a fully forward lean activates all trunk extensors. This system can be used to assist with picking up items such as boxes or bags from the floor from any direction and returning to sitting. This "posture restoration system" is always available while the system is powered on in case of a forward fall that he is unable to recover from during his daily activities at home, or to retrieve items from the floor. He is an avid gardener, and this allows him to more easily reach the low planters to weed and tend to his crops. Although this is used with an implanted system, the application can easily be applied to surface stimulation electrodes since all the target muscles are easily accessible from the surface. Alternatively, the system could be applied to control a mechanical restoration system consisting of springs, pulleys or robotic actuators.

Learning Objective 1

Discuss a wheelchair-mounted posture recovery system

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Poster 74

Correlation between muscle mass and function in individuals with long standing spinal cord related paralysis

Abstract 33

Isabella Ferrara, BS, Johns Hopkins University

Introduction: The relationship between muscle mass and function has previously been documented in multiple able and differently abled populations. Because preserving and increasing muscle mass is in the very achievable realm of rehabilitation (no matter time from onset of neurologic deficit), we decided to evaluate the relationships between level of injury, muscle and bone mass and functional abilities in a large cohort of individuals with chronic, long-standing paralysis related to spinal cord injury and diseases (SCI/D). Methods: Retrospective analysis of a cohort of 516 individuals aged 18-65 years with SCI/D related paralysis seen in one specialized academic center between January 1, 2005 and June 30th, 2022. Body composition measures, including muscle and bone mass (obtained by DXA), severity of injury (International Standards for Neurological Classification of Spinal Cord Injury examination ISNCSCI) and day to day function (Spinal Cord Independence Measure SCIM, BERG balance scale, functional reach, Walking Index for Spinal Cord Injury WISCI, 6 min walk and Timed Up and Go TUG) were measured within 6 months around dual energy absorptiometry (DXA) date were recorded. Results: SCIM total scores were found to be directly corelated to decile changes in muscle mass (Total Lean Body Mass index TLBM). TLBM, bone mass (Bone mineral Content BMC) and day-to-day function (SCIM) were also found to directly correlate in individuals with tetraplegia (C1-T1, but not in paraplegia (T2-S5). In ambulatory individuals, TLBM correlated with gait ability and scores. Conclusions: Higher muscle mass is associated with increased function among persons with SCI/D related paralysis. The strong correlation between muscle mass and day-to-day function argues for the value of preserving/increasing it at any time throughout the post paralysis state, irrespective of etiology.

Learning Objective 1

Evaluate correlation between muscle mass and functional status in individuals with long standing spinal cord related paralysis

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Poster 75

Denervation impacts muscle quality and knee bone mineral density compared to upper motor neuron injury after spinal cord injury

Abstract 75

Ahmad Alazzam, B.S., McGuire VA Medical Center

Objective: Spinal cord injury (SCI) results in skeletal muscle atrophy and dramatic changes in body composition. Upper motor neuron (UMN) injury primarily results in the disruption of the corticospinal tract, which can lead to loss of voluntary motor control, and paralysis. Moreover, the final motor pathway remains undamaged as the peripheral skeletal muscle is still innervated by lower motor neurons (LMN). However, LMN injury can result from trauma to the spinal cord anterior horn cells, nerve roots, and peripheral nerves, resulting in denervation. Denervation is characterized by an irreversible disconnection of skeletal muscle fibers from their damaged innervating motor neurons. However, most of the work in SCI has been focused on innervated individuals and little is known about LMN injury. The purpose of the work is to compare muscle size, body composition, bone mineral density (BMD), and metabolic profiles in denervated versus innervated individuals with spinal cord injury. Design/Methods: Sixteen males with chronic (> 1-year post injury) SCI were matched for age, weight, body mass index (BMI), time since injury (years), and injury classification. Seven participants in the denervated group were AIS A, while one participant was AIS C. In the innervated group three participants were AIS A, two AIS B, and three AIS C. Body composition, BMD, muscle size, and metabolic parameters were collected using dual energy x-ray absorptiometry, magnetic resonance imaging, and fasting blood samples, respectively. Results: Percent differences of the whole thigh muscle cross-sectional area (CSA; 38%), knee extensor CSA (49%), Vasti CSA (49%), and rectus femoris CSA (61%) were smaller in the denervated group ($P<0.05$). Leg lean mass (28%) was also lower in the denervated group ($P<0.05$). Whole muscle intramuscular fat (IMF%; 15.5%), knee extensor IMF% (22%), and %fat mass (10.9%) were significantly greater in the denervated group ($P<0.05$). Knee distal femur (18-22%) and proximal tibia BMD (17-23%) were significantly lower in the denervated group ($P<0.05$). Certain indices of metabolic profile were more favorable in the denervated group though were not significant. Conclusion: Denervated participants exhibited significantly lower leg lean mass and muscle CSA, greater muscle IMF, and reduced knee BMD compared to innervated participants. Future research is needed to explore therapeutic treatments for the denervated muscles after SCI. Support: DoD (NCT02660073) and VA Merit Program (NCT03345576)

Learning Objective 1

Compare muscle size, body composition, bone mineral density, and metabolic profiles in denervated versus innervated persons with spinal cord injury

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Neurophysiological and Functional Changes after Motor-Evoked Potential Operant Conditioning in Upper Extremity Muscles in Individuals with Spinal Cord Injury: A Case Series

Abstract 81

Blair Dellenbach, MSOT, Medical University of South Carolina

OBJECTIVE: This case series aimed to investigate whether operant up-conditioning of the Motor Evoked Potential (MEP) can increase muscle activity and improve upper extremity (UE) function in individuals with chronic incomplete cervical SCI. The participants included a 39-year-old male 1.5-years post C5 injury; a 62-year-old male 1-year post C5 injury; 49-year-old male 1-year post C6 injury; and a 51-year-old male 2-years post C7 injury. MEPs were up-conditioned in extensor carpi radialis (ECR) in the former 3 participants, and in extensor digitorum (ED) in the latter participant. METHODS: All participants were exposed to 6 baseline and 24 MEP up-conditioning sessions (3 sessions/wk over 10 wks). In all sessions, ECR or ED MEPs were elicited at 10% above motor threshold while the participant maintained a pre-set absolute amplitude of background EMG activity (~30% baseline maximum voluntary contraction (MVC) level as measured by EMG). In all 225 MEP trials of baseline sessions and the first 20 trials of each conditioning session, the participant received no feedback as to MEP size. Then, in 225 conditioning trials of each conditioning session, the participant was asked to increase MEP size, and received immediate feedback as to whether MEP was larger than a criterion (i.e., whether the trial was a success). MVC was measured at the start of each conditioning session. Assessments of UE impairment and function were administered at baseline, after 12 conditioning sessions, and after 24 conditioning sessions (post-training) in all participants. RESULTS: All four participants demonstrated within-session increase in MEP amplitude, and three participants increased MVC in the target muscle and decreased silent period (SP) duration. Specifically, the 39-year-old male increased within session change in MEP amplitude from 0.02 to 0.10 mV, decreased SP duration by 45%, increased MVC by 302%, and increased Box and Block Test (BBT) score from 1 to 7. The 62-year-old male demonstrated increased within session change in MEP amplitude from -0.02 to 0.02 mV, decreased SP duration by 28%, increased MVC by 25%, increased BBT score from 6 to 10, increased Action Research Arm Test (ARAT) score by 5 points, and progressed from unable to place a single peg during the Nine Hole Peg Test, to placing and removing all pegs in 6 min 12 s. The 49-year-old male demonstrated within session change in MEP amplitude from 0 to 0.02 mV; and a 4-point increase on the ARAT. The 51-year-old male who trained ED demonstrated an increase in within-session change of MEP amplitude from 0.04 to 0.23 mV, cumulatively increased MEP amplitude over the course of the study by 200%, decreased SP by 28%, and increased BBT score from 24 to 28 blocks. CONCLUSION: The results support our hypothesis that MEP operant up-conditioning can increase activation of the target muscle in the UE and improve UE function in individuals after SCI. We plan to enroll additional participants to continue to examine the effects of MEP operant conditioning on ECR and ED activity and UE function in individuals post-SCI. SUPPORT: Neilsen Foundation, Doscher Neurorehabilitation Research Program

Learning Objective 1

Discuss the technique and results of MEP operant conditioning in the upper extremity.

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A Case Series: Ziconotide for Spinal Cord Injury-Related Pain and Motor and Sensation Recovery

Abstract 108

David Ho, DO, University of California, Irvine

Introduction: Multimodal management for chronic pain has been extensively studied with gabapentinoids and selective serotonin reuptake inhibitors for neuropathic pain and physiotherapy, non-steroidal anti-inflammatory drugs, and opioids for nociceptive pain. New medication like Ziconotide, an N-type voltage-gated calcium channel inhibitor, has been studied due to its involvement in inhibiting synaptic transmission in primary pain pathways and providing neuroprotection by preventing calcium-mediated damage seen in rodent studies with traumatic brain injuries and spinal cord ischemia. This study aims to provide insight that Ziconotide may provide motor and sensory regenerative benefits to spinal cord injury patients not otherwise mentioned in current literature. Case Description: A retrospective review of three patients was conducted. P1 is a 45-year-old male with a 10-year history of L5 ASIA C spinal cord injury (SCI) after a motor vehicle accident (MVA) presenting with radiculopathy, hypoesthesia to light touch, and pinprick in his legs, lower extremity weakness with motor strength rated 4-/5, and dependency using a front-wheeled walker. P2 is a 53-year-old female with an 8-year history of T12-L1 ASIA C SCI after an MVA presenting with radiculopathy, hyperalgesia, hypoesthesia to light touch, pinprick, and pressure, and weakness rated 3/5 throughout her legs. P3 is a wheelchair-bound 44-year-old female with a 29-year history of T12 ASIA C SCI after an MVA presenting with paraplegia, radiculopathy, hyperalgesia, and aesthesia in the left extremity and hypoesthesia to the lateral right thigh. MS 3/5 at bilateral hip flexors and 0/5 starting at L4 dermatomes and below. Each patient was managed for chronic lumbar radiculopathy with differences in post-laminectomy syndrome and pelvic pain (P1) and central pain (P2 and P3) respectively. All three patients received intrathecal infusions of average bupivacaine 3.3 mg/day and hydromorphone 5.3 mg/day before the start of Ziconotide. Ziconotide was started at a dose of 25 mcg/mL and titrated to a mean dose of 6.79 mcg/day. Discussion: Since starting Ziconotide, all three patients had a reduction in pain. Pain intensity scores decreased by an average of 53.3%. The mean time to onset of pain relief was 13.3 months. The mean time for sensory and motor recovery was 23.67 months. P1 had improved sensation to light touch, pinprick, and pressure with his left lower extremity. His motor strength was 4+/5, and he transitioned to using a single-point cane. P2 had enhancement to light touch, pinprick, and pressure only to bilateral S1 regions. Motor strength improved to 4-/5 in hip flexors allowing her to stand without assistance for greater than 5 minutes. P3 had greater sensations to light touch through L3 – S1 dermatomes. Muscle strength in the right leg was rated 3/5 at hip flexors and 2/5 throughout and the left leg was 2/5 throughout. Conclusions: Ziconotide exhibits utility for chronic pain management and possible neurologic regenerative recovery. Ziconotide should be continually evaluated in larger, longitudinal studies, particularly with spinal cord injury patients.

Learning Objective 1

Discuss the efficacy of Ziconotide in chronic spinal cord injury-related pain and its potential improvement in motor and sensory recovery

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Poster 78

Personalized fitting of a K5 wheelchair positively affects posture and upper extremity mechanics during manual wheelchair propulsion in the community

Abstract 144

Philip Requejo, PhD, Rancho Research Institute

Objective: Personalized wheelchair (WC) configuration is a promising approach for improving posture and upper extremity mechanical demand during manual WC propulsion. Decisions made by a seating center clinician regarding WC adjustments are often made in combination and how WC adjustments affect posture, pressure relief, and stability. Personalized configuration consistent with clinical guidelines requires the ability to modify seat height, seat dump, seatback angle, and axle position. Currently, this level of adjustability is only found in ultralight weight manual WCs (K5). Design/Methods: In this study, we used a case-study approach to determine how posture and upper extremity mechanics during WC propulsion on a sidewalk performed at self-selected fast speed were affected by personalized adjustments aligned with current clinical recommendations. We hypothesized these personalized adjustments would lead to more upright posture, indicated by a more vertical torso angle and upper extremity kinematics with an elbow angle between 100-120 degrees when the wrist was at top-dead-center without an increase in shoulder net joint moment (NJM) impulse during push. Manual wheelchair users (25 male, 1 female) with paraplegia (T2-L3) volunteered to participate in accordance with the al Review Board. The time since injury occurrence ranged from 2 months to 25 years. All participants had been using their new or replacement wheelchair at baseline for at least one month. Each participant (n=26) WC propulsion at a self-selected fast speed on a level sidewalk at baseline and one-month post-WC reconfiguration were characterized using measurements from 6-10 propulsion cycles. Reaction force (RF) generated at the push rim were measured using an instrumented wheel secured to the individual's WC. Frontal and sagittal plane kinematics were recorded simultaneously (60 Hz video). Wearable inertial measurement unit sensors secured to the wrist and upper arm measured upper extremity kinematics. Differences in median values of torso angle and elbow angle at wrist top-dead-center as well as shoulder NJM impulse during push were calculated and compared for each participant pre- and-post configuration. Confidence intervals for the probability associated with each scoring outcome in relation to clinical guidelines were computed using R. Results: Across participants, torso angles (24 of 26) were more upright or unchanged and elbow angles either stayed within or shifted towards the recommended range after personalized WC configuration. Resultant shoulder NJM impulse during push likely remained unchanged from pre-to-post WC configuration. Reductions in mechanical demand imposed on the shoulder when observed resulted from several interacting factors including push duration, resultant reaction force magnitudes and orientation relative to the forearm. Conclusion: The results of this study demonstrate that personalized WC configuration afforded by K5 WCs enabled trained seating center clinicians to positively affect posture and upper extremity mechanics during push, without detrimental increases in shoulder demand. Support: Office of the Assistant Secretary of Defense for Health Affairs, through the Spinal Cord Injury Research Program under Award No. W81XWH-14-1-0560

Learning Objective 1

Discuss the positive effects of personalized wheelchair configuration on posture and upper extremity demands during manual wheelchair propulsion.

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Poster 79

Long duration, low-concentration topical capsaicin diminishes the development of central sensitization

Abstract 136

Lukas Linde, PhD, University of British Columbia

Background: The development of chronic pain is predicated by neuroplastic changes within the spinal cord in response to persistent noxious stimuli, termed central sensitization. Sensitization increases the sensitivity of neurons directly in contact with an initial noxious stimulus, termed primary hyperalgesia, as well as those in the adjacent regions, termed secondary hyperalgesia. TRPV1 receptors, found throughout the spinal cord and periphery, are key contributors to the development of sensitization. Defunctionalization of TRPV1 receptors, via high concentration capsaicin treatments (>5%), diminishes primary sensitization, however, mechanisms of low concentration capsaicin defunctionalization are less understood. Our purpose was to analyze the effects of defunctionalizing capsaicin-sensitive nociceptors, using a prolonged low-concentration (<1%) capsaicin treatment, on peripheral and central pain development in i) young healthy adults and ii) individuals living with neuropathic pain following spinal cord injury (SCI). Methods: Thirteen (13) healthy participants applied 0.1% capsaicin cream three times daily within a 50cm² region on the forearm for a 20-day application period. Following the application period, contact heat evoked potentials (CHEP) and cold evoked potentials (CEP) were collected in the area of application and an adjacent control region. Mechanical pain sensitivity (MPS) was assessed within the capsaicin and control regions prior to, and following, repeated suprathreshold heat stimuli applied between the two regions. The suprathreshold heat stimuli were used to induce a temporary state of sensitization between the capsaicin and control regions. This enable characterization of the development of sensitization following the 20-day intervention. Results: Data collection in the young healthy cohort is complete. Recruitment of individuals living with neuropathic pain following SCI is ongoing. Following our intervention in young healthy adults, pain perceptions during CHEPs and CEPs were significantly lower in the capsaicin region compared to the control region (CHEP perception: $r=0.826$, $p<0.001$, CEP perception: $r=0.161$, $p<0.05$). CHEPs, but not CEPs, amplitudes in the capsaicin treatment region were significantly decreased compared to the control region (CHEPs; N2 amplitude: $r=-1.23$, $p=0.001$, P2 amplitude: $r=1.52$, $p<0.001$, CEPs; N2 amplitude: $r=0.313$, $p=0.3$, P2 amplitude: $r=1.52$, $p=0.52$). Mechanical pain sensitivity, following suprathreshold heat sensitization, increased in the control but not the capsaicin region compared to pain sensitivity prior to the heat sensitization protocol (Control region: 32mN: $r=0.963$, $p<0.05$; Capsaicin region: 32mN: $r=0.067$, $p=0.82$). Conclusion: Prolonged, low-concentration capsaicin successfully defunctionalized TRPV1 receptors and diminished secondary hyperalgesia development, via mechanical pinprick testing following suprathreshold heat stimuli. These findings suggest that the use of low concentration capsaicin may be beneficial in preventing central sensitization development, a known contributor to chronic pain. Next steps include continuing our intervention in a targeted SCI cohort, to confirm the efficacy of (<1%) capsaicin to manage neuropathic pain.
Support: Craig H. Neilson Foundation #733994

Learning Objective 1

Discuss the usefulness of topical capsaicin to aid in neuropathic pain management following SCI.

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Poster 80

Intrathecal baclofen drug delivery interference by iPhone magnet

Abstract 4

Michelle Trbovich

Intrathecal Baclofen (ITB) therapy is used for the treatment of spasticity of spinal and supraspinal origin. ITB pump complications are most commonly related to the surgical implantation procedure or catheter dysfunction. Non-catheter pump failure has a very low failure rate ranging from 1.8-7%. Battery failure is a primary cause, however less common complications include a catheter access port dysfunction; motor failure from excessive wear and tear on the motor gear shafts; or a complete stall of the motor/roller, such as caused by the influence of a magnetic field (greater than 20 Gauss). We present previously unreported case of abrupt ITB withdrawal symptoms caused by magnet interference of an iPhone with the ITB motor. Case: 37-year-old male with T9 motor complete paraplegia managed with ITB successfully for 6 years presented to an unscheduled clinic visit with symptoms consistent with ITB withdrawal. Pump interrogation revealed no motor stall in the logs and no alarms had been triggered. Catheter aspiration revealed catheter was patent and intact with the CSF space. Rotor study showed motor was not turning. Pump was replaced within 24 hours and symptoms fully resolved. Because of the possible interference of electromagnetic fields on the pump's operation, further questioning of the patient's relevant history revealed that he had not undergone any MRI studies within the past six months, but that 2-3 weeks prior, he had purchased a new iPhone 12 and carried it in a fanny pack around his waist with the iPhone ~2-3 inches away from the ITB pump for up to twelve hours a day. Post operatively, patient was instructed to keep is iPhone >6 inches away from his pump and he has had no problems since. Discussion: We present a case of motor pump failure from long term ~12 hours/day exposure to a magnetic field stronger than the pump (>20 Gauss) from a new model of iPhone. Wheelchair users (e.g.; TBI and SCI) often carry personal items (such as phones) in a pack around their waits (near common sites of ITB pump implant). The ability of iPhones to overpower the magnet in an ITB pump is not widely known. In 2021, the U.S. Food and Drug Administration (FDA) published a report regarding the effects of magnets in consumer electronics on implanted medical devices, recommending that such electronics should be kept 6 inches or more from the medical device as a safety. It is imperative that patients with ITB therapy and providers managing ITB therapy are aware of this potential interference with the ITB motor/drug delivery. Conclusion: It is important for providers managing patients with ITB therapy to be aware of the ability of newer models of commonly used electronic devices (e.g.; phones, tablets) to stall the ITB motor (if in close proximity) so as to avoid life-threatening complications of ITB withdrawal.

Learning Objective 1

Recognize the risk of ITB motor stall from external magnetic pull from smartphone device.

Learning Objective 2

Understand how to prevent ITB motor stall from a smartphone device.

Learning Objective 3

Equip learners to educate patients on the risk of smartphone magnetic interference with ITB therapy

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Poster 81

Development of a Standardized Weaning Protocol for Intrathecal Baclofen Pump Removal due to Pump Infection

Abstract 18

Maria Petriello, DO, Stanford University

Case Presentation: A patient with chronic tetraplegia and an intrathecal baclofen pump presents with symptoms of sepsis. It was determined that the intrathecal baclofen pump was the source of the infection and the pump would require removal. The patient's initial intrathecal baclofen dose at presentation was 161.1 mcg/day. He was additionally on Diazepam 5mg q12hr orally. His intrathecal baclofen dosing was initially decreased by 20% for the first 2 days in preparation for pump replacement. After 2 days, he developed withdrawal symptoms of increased spasticity and hallucinations. He was given 20mcg intrathecal baclofen bolus and his oral baclofen was increased to 15mg QID. After 2 days on this dose, he continued to experience increased spasticity, so the intrathecal baclofen dose was increased to 120mcg/day. His pump was replaced on day 5 of hospitalization. His new pump was programmed at 120.2 mcg/day and he was continued on oral baclofen 10mg QID. He continued to experience withdrawal and his intrathecal baclofen dosing was increased approximately 10% per day for the next 5 days until he reached a dose of 167.7 mcg/day. He remained stable on this dose until discharge from rehabilitation. Due to the complications associated with the above case, the need for a weaning protocol for intrathecal baclofen pump removal in the setting of pump infection was identified. Discussion: The hospital protocol development process can differ between institutions and specialties. Although a strict protocol may not be appropriate for all medical processes, it may help expedite safe, equitable care in some cases. In the above case, it was noted by the team that there does not exist in the literature a clinically accepted protocol for baclofen pump weaning in the setting of pump infection, and therefore the team took action to create a protocol that would suit the institution. The protocol was created via input from a multidisciplinary team with the leadership of the spinal cord injury physician team. A literature review was conducted to examine current practices in intrathecal baclofen weaning for all causes. Timing and dosing of oral medications, weaning rate of intrathecal baclofen, timing of surgical intervention and antibiotic administration were all determined. Evaluation and examination protocols were instituted to monitor patient progress. Additionally, the decision of location for patient care was considered. Parameters were identified to determine ICU, medical floor, or SCI unit admission and when transition of care would be appropriate. In addition to the decisions on medical interventions, it was also important to decide on which personnel should be involved in each case. Due to their medical expertise, experience with multidisciplinary modes of care, and often long-term relationships with the involved patients, spinal cord injury physicians may be uniquely positioned to develop and implement hospital protocols related to people living with SCI, when appropriate. Additionally, the inclusion of the hospitalist, neurosurgery, infectious diseases and therapy team were noted to be important for medical decision making. The implementation and evaluation of this protocol is ongoing, and we hope to have additional data to present within the upcoming months.

Learning Objective 1 Describe the steps involved in the development of hospital protocol for intrathecal baclofen pump removal due to pump infection**.**

Learning Objective 2 Discuss the importance of hospital protocols as it relates to people living with spinal cord injury

Learning Objective 3 Describe the role of spinal cord injury physicians in the development and implementation of hospital protocols as it relates to people living with spinal cord injury

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Poster 82

Leg Stretching using a Robotic Leg Exoskeleton in People with Spasticity

Abstract 131

Steven Brose, DO, Syracuse VA Medical Center

Objective: Spasticity is a debilitating condition in people with chronic spinal cord injury (SCI) that can lead to falls, pressure injury of the skin, and pain. Spasticity interferes with the ability to functionally use voluntary muscle contraction and limits range of motion. Despite the effectiveness of existing medications and therapies for people with spasticity, there is a critical need for advancing non-invasive, non-pharmacological methods for managing spasticity after a SCI. This project develops a wearable controllable leg exoskeleton to enable automatic leg stretching in people with spasticity. Manual stretching is a primary treatment that can provide relief from muscle spasms and preserve (or improve) range of motion in joints; however, providing reliable and on demand stretching imposes a heavy burden on caregivers. The objective in this project is to develop a wearable device that applies safe, customized forces to assist with leg stretching, as an alternative to manual stretching provided by caregivers. Design/Methods: this feasibility study is conducted in a research laboratory to develop the wearable device and integrate its computer-control system and sensors. The stretching approach is implemented in a small sample size of 5 able-bodied individuals and 1 participant with chronic SCI. The wearable device is controlled to perform stretching moving the legs and toes similarly to the forces applied by caregivers when providing manual stretching. Stretching is conducted while participants lie on a bed and sit down in a wheelchair. The device is implemented to apply safe, customize forces to adjust the rotation of the hip, knee, and ankle joints bilaterally at low to moderate stretching rates (e.g., 10-50 cycles/minute). The movements are attempted 3-4 times and rest breaks are provided in between repetitions. Results: Participants completed the following leg stretching movements assisted by the exoskeleton: ankle plantarflexion and dorsiflexion, knee extension, hip flexion with the knee flexed, and toe flexion and extension. Joint kinematics, leg postures, applied forces, and surface muscle activity were collected to characterize the preliminary performance of the device. The results show that the wearable device has the potential to customize the stretching forces and yield safe range of motion for each participant. Safety was also quantified by logging blood flow and heart rate data, the frequency/magnitude of muscle spasms, discomfort, and other observable responses. No adverse effects were reported during testing. Conclusion: the preliminary results aid to establish the feasibility of the wearable exoskeleton as a tool to provide leg stretching. This project can lead to a fully customizable and safer on-demand stretching approach compared to manual physical stretching at the clinic and home. Data collected are analyzed and post-processed to inform the next phase of testing and refine features of the wearable exoskeleton. Future work includes testing in a larger sample of people with spasticity to establish safety, acceptability, ease of use, and patient satisfaction; further, outcome measures of spasticity will be collected during testing of the stretching device.

Learning Objective 1 To establish the feasibility of a wearable robotic exoskeleton as a tool to provide leg stretching in people with spasticity**.**

Learning Objective 2 To establish the feasibility of a wearable robotic exoskeleton as a tool to provide leg stretching in people with spasticity.

Learning Objective 3 To establish the feasibility of a wearable robotic exoskeleton as a tool to provide leg stretching in people with spasticity.

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Poster 83

A Rare Case of Horner Syndrome after Post Operatory Anterior Cervical Laminectomy in a Non-Traumatic Spinal Cord Injury

Abstract 124

Robbie Veriker, MD, University of Louisville

Objective: Horner's Syndrome (HS) is a rare condition that presents with the classic triad of partial ptosis (drooping of the upper eyelid), miosis (constricted pupil), and facial anhidrosis (absence of sweating). HS is due to injury to the cervical sympathetic trunk (CST). HS is a very rare complication of anterior cervical spine surgery approaches. We present a rare case of HS secondary to resection of metastatic epidural tumor after C4-T8 laminectomy. Design/Methods: 63-year-old male with an extensive history of cutaneous melanomas presented to ER with a short history of less than a day of severe weakness in the legs and difficulty walking. During the exam, he was found significantly weak in his legs and hands. He had a sensory level of approximately C6 or at C5 spinal cord level and normal cranial nerves. Neuroimaging demonstrated spinal cord compression, most severe in the upper thoracic low cervical region but extending up to the C4 region and down to the T8 region. Results: The patient underwent emergently operative decompression of the spinal canal and C4-T8 laminectomy. Immediately after surgery, the patient was found to have left miosis and left ptosis in the setting of central cord syndrome. The patient did not have nystagmus, facial weakness, dysphagia, or vertigo. The patient was transferred to a spinal cord injury inpatient rehabilitation facility, where he improved his upper and lower extremity function but did not show HS improvement. Conclusion: Horner syndrome results from an interruption of sympathetic innervation to the eye (oculosympathetic paresis). The classic triad in Horner syndrome is unilateral ptosis, miosis, and anhidrosis, but ptosis and miosis are far more commonly recognized than anhidrosis. The incidence of Horner's syndrome after cervical spine surgery is low (0.06%); the majority of cases were reported after ACDF and from surgery at the C5–6 level. Most patients had at least partial recovery without additional management. In the set of a spinal cord injury, it is important to recognize HS as it may cause severe distress and confusion as the treatment options for HS are centered around the underlying cause, including neurosurgery for tumor resection, aneurysm repair, or vascular surgery for carotid artery dissection. In this case, reassurance of improvement that generally occurs after three to six months was provided to the patient.

Learning Objective 1

Rise awareness and educate providers about HS presentation after anterior cervical spine approach in a spinal cord injury

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Poster 84

Inclusion of Non-Traumatic Spinal Cord Injury in Spinal Cord Injury Model Systems Database: One Center's Experiences

Abstract 142

Yuying Chen, MD, PhD, University of Alabama at Birmingham

Objective: Research from Spinal Cord Injury Model Systems (SCIMS) National Database over the last 5 decades has contributed significantly to the understanding of traumatic spinal cord injury (tSCI) and improved the care of people with tSCI. The extent to which such knowledge and clinical practices applicable to people with non-traumatic spinal cord injury (ntSCI) is unclear. With an ultimate goal of expanding the benefits of SCIMS Database to the broader SCI population, this study was conducted to: 1) build a ntSCI patient registry in parallel to the SCIMS Database, 2) collect pilot data at a local SCIMS Center to inform the design of future ntSCI national database, and 3) report current demographic trends and status of ntSCI. Design/Methods: This study was a retrospective chart review of patients with ntSCI who received inpatient rehabilitation between December 2019 and April 2022. Data obtained mirrored the SCIMS - Form I chart review items for feasibility assessment and comparative analysis, including socio-demographic, neurological, and clinical information. International SCI Data Sets for ntSCI was used to document ntSCI characteristics. Patients with tSCI enrolled in the local SCIMS Center during the study period were included in the analysis. Chi-square test and analysis of variance were performed, as appropriate, to compare characteristics and outcomes among three grouped etiologies: tSCI, vertebral degenerative (VD) ntSCI, and non-vertebral degenerative (NVD) ntSCI. Results: Among 60 patients with ntSCI enrolled, VD was the most common etiology (58.3%), followed by inflammatory (13.3%), neoplastic-malignant (11.7%), neoplastic-benign (5.0%), infection (5.0%), vascular (3.3%), and others (3.3%). During the study period, an identical number of patients with tSCI (n=60) were enrolled in the local SCIMS Database. People of VD etiology were older (61.9y) than those of NVD (48.8y) and tSCI (40.4y, $p<0.001$). Related to age differences, the majority of tSCI cases were single (64.4%) in comparison to VD (31.4%) and NVD (40.0%) groups ($p = 0.008$). VD cases were also heavier (body mass index [BMI]=37.4 kg/m2) than people of NVD (26.5 kg/m2) and tSCI (26.4 kg/m2, $p<0.001$). Most of people with tSCI were male (78.3%) and of minority race (56.7%), while the percentages were 51.4% and 41.2%, respectively, for VD and 40.0% and 24.0%, respectively, for NVD cases. Incomplete tetraplegia (48.2%) was the most frequent category in the tSCI group, while incomplete paraplegia was most common in the VD (67.9%) and NVD (82.4%) groups ($p<0.001$). Average length of rehabilitation stay was longest in the tSCI group (27.6 days), followed by NVD (23.3 days) and VD (13.9 days, $p<0.001$). Conclusion: People with ntSCI of VD etiology were older and overweight, while those with tSCI had a higher level of injury and longer rehabilitation stay. As compared with tSCI, detailed neurological examination was not consistently performed in patients with ntSCI. Date and timeframe of onset of ntSCI symptoms were not always clearly documented. Training and prospectively documenting can resolve these issues. This study provides pilot data to guide the development of data collection protocol to include people with ntSCI in the future SCIMS Database.

Learning Objective 1

Discuss opportunities and challenges in building a national non-traumatic spinal cord injury database

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Poster 85

Rehabilitation Outcomes for Patients with Epidural Lipomatous Myelopathy Compared to Traumatic Spinal Cord Injury

Abstract 186

Ben Johnson, (N/A), Mayo Clinic

Objective There are no published rehabilitation outcomes or long term follow up for patients impacted by epidural lipomatosis related myelopathy (ELM). To provide meaningful evidence-based guidance to patients regarding expectations, we conducted a retrospective review of all cases of myelopathy related to ELM. Methods All myelopathy patients discharged from inpatient rehabilitation at Mayo Clinic-Saint Marys Hospital between January 1, 1995 and December 31, 2021 were potential participants. There were 3021 potential participants. 59 declined to allow retrospect medical record review for research purposes and were excluded. We anticipated the ELM patient population to be older than the overall population of individuals with traumatic SCI. Therefore, we performed a one-to-one matched cohort design. Individuals with ELM were matched to individuals with traumatic SCI (TSCI) for year of discharge, age, sex, and neurological impairment. Data analysis was performed using BlueSky software. Wilcoxon tests were used to compare groups, and Kaplan Meier tests were used to analyze survival. Results 23 individuals with ELM were identified and matched to 23 individuals with traumatic SCI. Average age for the population was 52. The group was 80% men. There was no difference between the groups regarding age, sex, neurological impairment, or year of discharge. When matched for these factors there was no difference in Functional Independence Measure discharge scores (ELM 94, TSCI 88), body mass index (ELM 30.3, TSCI 29.6), or length of stay (ELM 15 days, TSCI 25 days p=0.055). Median survival was not statistically different; 9.8 years for ELM and 10.3 years for TSCI. Conclusion Patients with ELM have rehabilitation outcomes and survival similar to individuals with TSCI. Discussion ELM is a rare condition. Despite the 26-year time interval used to identify cases, the small sample size limited the ability to detect differences. A larger, multicenter study will be needed to detect outcome and survival differences between ELM and TSCI.

Learning Objective 1

Present the rehabilitation outcomes for patients with myelopathy related to epidural lipomatosis in comparison to a matched group of individuals with traumatic SCI.

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Demographics and functional outcomes in Non-Traumatic vs Traumatic Spinal Cord Injury

Abstract 187

Ana Valeria Aguirre Guemez, MedStar National Rehabilitation Hospital

Background The incidence of non-traumatic spinal cord injury (NTSCI) is increasing1 and it is likely that the numbers will continue to increase due to an aging population. The rising numbers and the unique features of NTSCI compel us to understand NTSCI so that we may deliver optimal rehabilitation. Objective To describe the population and functional outcomes after acute rehabilitation for those individuals with SCI/D of NTSCI and traumatic spinal cord injury (TSCI). Method A retrospective case control study of the NTSCI vs TSCI population admitted to acute rehabilitation (AR) at MedStar National Rehabilitation Hospital (MNRH) from October 2021 to August 2022. This database includes age at injury, sex, etiology, level of injury, ISNCSCI, Inpatient Rehabilitation Facility Patient Assessment Instrument (IRF-PAI), length of stay (LOS), and discharge location. Results For the past year, at MNRH, in Washington DC, we have screened all new admissions to AR with diagnosis of SCI, regardless of etiology or date of injury. In total 159 persons underwent chart review. Of those individuals 79 had NTSCI, and 80 TSCI, including chronic injuries (13). Demographics of the chronic individuals were used for the analysis, for functional outcomes only acute TSCI data was used. Percentage of men with a NTSCI is 56.9% vs 77.5% men in the TSCI. For NTSCI mean age was 59.8 (SD+/-13.4), and the majority (78.4%) were 56 or older. This was compared with 52.4 (SD+/-19.8) and 51.2%, respectively for TSCI. The most prevalent cause of NTSCI was degenerative causes at cervical level (stenosis and myelopathy; 31.6%) while falls were the most prevalent cause of TSCI (45%) followed by GSW (26.2%). Most injuries were at the cervical level for both (51.7% NTSCI vs 57.5% TSCI). The most common impairment group was AIS D for both NTSCI and TSCI. Of the NTSCI 3.9% were AIS A, 5.2% AIS B, 7.9% AIS C, and 53.9% AIS D, and 22.7% were only reported as incomplete. This is compared with 27.5% AIS A, 5% AIS B, 17.5% AIS C and 46.25% AIS D for TSCI. The mean LOS for NTSCI was 18.9 days (+/-14.2 days, range 2-105 days), compared with 29.9 (+/-19.1, range 1-118 days) for individuals with an acute TSCI. 77.1% of the individuals with a NTSCI were discharged home, compared with 59.6% in TSCI. The ADLs assessed with IRF-PAI in NTSCI at admission showed a mean of 20.3 (SD +/-5.9) and a mean at discharge of 33.9 (SD +/-7.3) compared with a mean of 16.3(SD+/-6.7) and 30.4(SD+/-10) respectively for TSCI, and for the mobility items NTSCI had a mean at admission of 28.3 (+/-14.8) and 66.3 (+/22.1) at discharge compared with a mean of 21.1 (SD+/-13.2) and 53.7(SD+/-25.4) respectively. Conclusion For our population in metropolitan Washington, DC, the NTSCI and TSCI looks quite similar demographically, which defers from previous reports2. Causes found for NTSCI were degenerative, tumoral, vascular, infectious, and autoimmune disorders. Outcomes for people with NTSCI seem to reflect adequately functional improvement. A broader representation sample is needed to better understand demographic and functional dynamics.

Improve understanding on demographics and functional dynamics of non-traumatic spinal cord injury (NTSCI).

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Poster 87

Standardized 3D Printed Devices with Patient Specific Interfaces

Abstract 104

Jared Grier, B.S. ME, Shepherd Center

The use of 3D printing in the rehabilitation hospital environment is not new. As a tool, it excels in the environment in which complex, custom parts are needed on demand. There are many benefits to the utilization of printed devices by patients for completing everyday tasks. But with a wide variety of patients, each with unique body types and circumstances, it can be hard to develop a 'one size fits all' part. An option is to modify each part for a patient based on their body type or a therapist's requests, but this increases part complexity, creates more work for the rehab engineer and therapist, and lengthens the part delivery time. A solution to this problem is to meet in the middle by creating a standardized part with an interface method that allows for customization by the therapist. With this solution, parts can be quickly printed to order without the need for modification. Once in the therapist's hands, they have the freedom to create a custom fit interface for their patient. This method is currently being utilized at the Shepherd Center for a variety of parts used in ADLs. A system has been implemented that allows therapists to digitally order parts from a catalogue that a rehab engineer will then print and deliver. Once received, the therapists use thermoplastic splint material to form a personalized handle that allows the patient to properly use the part. This solution also increases part durability and reusability. With the main component being 3D printed, the files can be shared, and the process adopted by other rehabilitation hospitals across the world.

Learning Objective 1

Learn about the ways 3D printing can be combined with custom splinting to make patient specific devices.

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Integration of Multi-Functional Nanostructured Microelectrodes onto a Mechanically-Adaptive Polymer Nanocomposite for Neural Interfacing Applications

Abstract 130

Allison Hess-Dunning, PhD, Louis Stokes Cleveland VA Medical Center

Local anti-inflammatory drug therapy from implanted interfaces to the nervous system promotes integration and healing after neurological injury or after surgical implantation of a bioelectronic interface. Though a multiphasic process of tissue reorganization and injury stabilization continues for months after device implantation or injury onset, local drug release is either limited in duration with an inconsistent release profile or requires complex and invasive fluidic delivery systems. Our objective is to develop a multifunctional neural implant capable of both sustained drug release for weeks to months-long durations and for electrical sensing or stimulation. Toward this end, we have evaluated titania nanotubes arrays (TNAs) as a multifunctional material for controlled drug release and for electrical sensing. By integrating the TNAs onto a highly mechanically-compliant substrate, we aim to establish a multifunctional neural interface that integrates well with neural tissues. Titania is known as a biocompatible material with antibacterial and anti-inflammatory properties. By generating controlled, vertically-aligned nanoporous structures in the form of nanotube arrays, TNAs can function as tunable nano-reservoirs that allow sustained release of drugs via controlled diffusion. In an in vitro study, our TNA system demonstrated sustained release of dexamethasone for >6 weeks. The efficiency with which TNAs can store drugs combined with the duration of consistent release suggests that this material can help to promote healing and biological integration when implanted as part of a neural interface. In addition to the tunable drug release characteristics of TNAs, the electrical properties of TNAs are dependent upon the fabrication process. Electrochemical impedance spectroscopy (EIS) was used to characterize the effect of electrochemical, thermal, and plasma treatment properties on the TNA interface, demonstrating a sufficiently low impedance for electrical sensing applications. Additionally, we found that loading the TNAs with dexamethasone did not substantially affect the electrochemical impedance, suggesting the multifunctional use of TNAs for both drug delivery and sensing. To take advantage of the unique multiple functions of TNAs, we have integrated TNA microsegments onto a mechanically-softening polymer nanocomposite (NC) substrate. An inverted microfabrication process for integrating TNA microelectrodes into the NC structure was developed using a combination of photolithography and laser micromachining to produce a functional device. The NC substrate softens upon implantation, facilitating mechanical compatibility with tissue. Thin film gold traces interface the TNAs with external electronics. With our demonstrated extension of TNAs to integration within mechanically-compliant, multi-functional biomedical devices, we have established a multifunctional platform for applications in interfaces to the nervous system.

Learning Objective 1

Describe the biomaterials-based approach for multi-functional neural interfaces.

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Poster 89

Goals Categories Identified by Patients after PNT

Abstract 99

Parvin Eftekhar, PhD, University Health Network

The incidence of spinal cord injury (SCI) has been gradually rising over the past decade, affecting eight to 246 persons per million each year worldwide. Nearly half of these cases result in complete or incomplete tetraplegia. Loss of upper extremity function is a devastating consequence of cervical SCI, affecting all activities of daily life. The impairments in arm and hand function are one of the most desired sites of functional restoration by patients living with tetraplegia. Peripheral nerve transplant (PNT) for SCI is becoming a common surgical procedure offering a potential to restore volitional control of elbow, wrist, and hand function of individuals with cervical SCI or C5-T1 tetraplegia.7 This provides a unique opportunity to target specific muscles for a specific hand function that an individual after SCI may desire. The complex procedure is accomplished by borrowing non-essential uninjured motor axons from above the level of injury to innervate target muscles below the level of injury. An important part of comprehensive and effective rehabilitation requires active engagement of the patient and carers/family through the rehabilitation journey. Research indicates that negotiating meaningful goals in collaboration with the patient and their families after SCI is the most effective approach to gain the most recovery. Identifying goals by patients depicts their values, needs and expectations from rehabilitation. Goal setting also advances the patient's awareness and acceptance of disability. Objectives: to examine : 1) the categories of the identified goals by patients after PNT who have ASIA A to B with tetraplegia 2) correlate the goals to their neurological level after SCI. Design: Retrospective chart review of 10 patients who received PNT in the last two years, who had identified at least three goals. Methods: Convenience sampling from the PNT program-KITE Clinics (N=10). Review and mapping of goals (3 goals each) to the International Classification of Functioning, Disability and Health (ICF). It is a model that facilitates the use of common international language to classify the impact of diseases across different health or health-related domains. Outcome Measures: 1) The Canadian Occupational Performance Measurement (COPM) assesses a person's self-perception of functioning and satisfaction in their daily life. The COPM is well validated in the SCI population; however, there is little use in PNT/SCI population to date. 2) International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI) - Measures neurological impairment including Neurological Level of Injury (NLI) and American Spinal Injury Association (AIS) Analysis: We will conduct a descriptive data analysis and examine the types of goals related to Activities of Daily Living and Instrumental Activities of Daily Living. We will explore the correlation between the COPM scores and the level of spinal injury based on the ISNCSCI.

Learning Objective 1

Categorize patient identified functional goals after peripheral nerve transfer surgery among individuals with spinal cord injuries

Learning Objective 2

Map the identified goals to the ICF Model

Learning Objective 3

Correlate the COPM scores (performance & Satisfaction scores) to the level spinal injury based on the ISNCSCI

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Poster 90

Perceived impact of the COVID-19 pandemic among people with spinal cord injury: A descriptive study

Abstract 100

James Krause, PhD, Medical University of South Carolina

Objective: COVID-19 is a public health crisis that has dramatically changed everyday life, presenting challenges to community participation, quality-of-life, and health, and restricting access to daily necessities and services. The pandemic may have particularly adverse effects for those with known chronic conditions, including people with spinal cord injury (SCI). Our purpose is to describe the self-reported effects of COVID-19 on a population-based cohort of people with SCI. Design/methods: The South Carolina SCI Surveillance and Registry (SCISRS) is a population registry that identifies all individuals treated for SCI in nonmilitary facilities. SCISRS conducts follow-ups by contacting individuals and requesting completion of self-report assessments (SRA). Beginning in 2021, a COVID-19 supplement was included. A total of 382 adults with traumatic SCI of at least one-year post-onset completed materials between December 2020 and March 2022. The SRA included impact of the COVID-19 pandemic on quality-of-life, ability to get daily necessities, and access to healthcare, including attendant care. Results: Over half of the participants (58.9%) reported negative impacts of the pandemic in at least one of five life areas, with community participation being the primary area affected (51.4%). A small portion of individuals had trouble obtaining necessities, with approximately 12% reporting difficulties getting enough or quality food and 8.2% reporting difficulty getting prescription medications. However, 25% reported delaying healthcare procedures because of fear of catching COVID-19. Among those who required personal care, 32% reported a decrease in quality of care and fully 51.9% relied more on family to assist with their care. Conclusion(s): The COVID-19 pandemic related to several perceived negative impacts. Of particular importance, there was reduced access to healthcare and declines in quality and stability of attendant care, with greater reliance on family. Fear of obtaining routine procedures must be addressed in future outbreaks.

Learning Objective 1

To identify the perceived impact of the Covid-19 pandemic on the quality-of-life, access to basic services, and access to specialized needs for equipment, medical treatment, and personal care assistance.

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Poster 91

Functional Improvements Caused by the Utilization of Myoelectric Powered Wearable Orthotics in Persons with Chronic SCI

Abstract 113

Ghaith Androwis, PhD., Kessler Foundation

Upper extremity (UE) weakness and/or paralysis following spinal cord injury (SCI) can lead to a limited capacity to perform activities of daily living (ADL). Such disability significantly reduces an individual's level of independence. Further, restoration of UE motor function in people with SCI remains a high priority in rehabilitation and the field of assistive technology. The overall goal of this study was to evaluate the effects of a myoelectric-powered wearable orthosis (MPWO) manufactured by MyoMo, Inc. (Boston, MA) for UE movement assistance on ameliorating UE motor function in order to improve ADL and quality of life in people with SCI. This investigation represents a prospective design in a SCI rehabilitation hospital and research center settings. Two male participants with chronic incomplete SCI (iSCI), a 75- and a 31-year-old with AIS D and B, respectively, underwent 18 sessions (over 6 weeks) of UE movement rehabilitation using the MPWO. Handgrip strength, active range of motion (AROM) of the hand, response time to initiate a movement, and muscles activations were examined before and after the rehabilitation training using the MPWO. The response time to initiate UE movements decreased, and handgrip strength and AROM improved after training with the MPWO. These preliminary data suggest that rehabilitation with the use of the UE-MPWO device could enhance the participants' UE activities that led to improved function. The overall goal of this study was to evaluate the effects of UE-MPWO (MyoPro) in ameliorating UE movement impairments to improve ADL and quality of life in people with iSCI. Further study is ongoing, but these initial findings suggest a promise for neurological change by using such a device. These preliminary results from two individuals with iSCI suggest that training with UE-MPWO assistive devices may improve UE utilization during ADL for individuals with muscle weakness or paralysis but still possessing residual voluntary muscle activation capabilities.

Learning Objective 1

To examine the impact of utilizing a myoelectric powered wearable orthosis in remedying upper extremity strength and function for persons with SCI.

Learning Objective 2

To evaluate the safety and efficacy of the use of a MPWO as a rehabilitation intervention for persons with SCI.

Learning Objective 3

To examine improvements in handgrip forces, active range of motion (AROM), and response time to initiate a movement after rehabilitation training

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Poster 92

Patient-centered strategies to engage and retain participants in clinical trials

Abstract 122

Amanda Rounds, PhD, MedStar National Rehabilitation Hospital

Background: National leaders in medical research, like the SCI model systems are located in metropolitan areas.1 Therefore, providing accessible options to research should be considered. Objective: Describe effective strategies for recruitment, implementation, and retention of participants nationally in urinary self-management interventional trials. Method: Four nationwide studies at varying timepoints (completed or ongoing) have all used a structured framework for recruiting, implementing, and retaining participants in these studies. Patient-centered approach: Consumer experts are involved from development (grant writing), recruiting, training participants on how to do the intervention and adapting the intervention (if needed). Before study start-up Screening: A screening script is created with a consumer expert to ensure recruiters clearly describe the study. A one-page inclusion/exclusion screening form is developed and completed for each participant who is screened. Education and supply kits: A detailed handbook and one-page quick guide is created with a consumer expert. Throughout study Screening: Reasons for inclusion/exclusion is assessed weekly for safety and other considerations that may arise. Education and supply kits: Training materials are accessible in print and digitally to accommodate the participant's preference. A study handbook is sent with intervention supplies to the participants household. A consumer expert provides training by phone or virtually on study logistics including: how to submit online surveys and how to complete the intervention. If needed, the consumer expert and researchers will alter education as needed. Monitoring: Weekly REDCAP e-mails followed by daily reminders are distributed. If a survey hasn't been completed by the end of the week, phone calls are made by the coordinator. Monthly "check-ins" are completed to ensure there are no questions about participation and reminders of aspects of the study that may not be incorporated in their regular weekly/daily surveys. Results: These four studies vary with population and how a urinary symptom self-management strategy is used. Below are the screened, consented, completed and retention numbers ((#dropout - #consented) / (#consented)) for each study. Study status Screened Consented Participants % Female Age (range) Completed % Retention Study 1 2–4 Completed 397 103 SCI=75 MS=2 SB=7 39% 43.7 ± 14 (20-74) 83 81% Study 2 Ongoing 942 136 of 182 SCI=102 MS=30 SB=4 46% 49.7 ± 14 (18-75) 52 88% currently Study 3 Ongoing 737 32 of 182 SCI=27 MS=6 27.3% 54.6 ± 13 (31-77) 6 100% currently Study 4 Ongoing 35 12 of 120 SCI=11 MS=1 25% 51.1 ± 15 0 100% currently SCI: Spinal cord injury, MS: Multiple Sclerosis, SB: Spina Bifida Conclusion: Patient-centered studies are crucial for the translational aspects of research. Consumer-scientist collaboration enable interventions to be created using the consumer experience to tailor to the population of interest, minimize possible side effects and reduce burden on the participant. Once an intervention leaves the research phase, multiple checkpoints, education, and consumer involvement ensure that implementation is possible and take into consideration the translational struggles an intervention may encounter before it reaches market.

Learning Objective 1

Discuss how to recruit, implement, and retain research participants in a nationwide interventional clinical trial.