

# Abstracts



## CSM 2015 Neurology Section POSTER Presentations

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**TITLE:** Retrospective review and telephone follow-up to evaluate a physical therapy protocol for treating Chronic Subjective Dizziness, a pilot study

**AUTHORS/INSTITUTIONS:** K.J. Thompson, J. Goetting, Physical Medicine and Rehabilitation, Mayo Clinic, Rochester, Minnesota, UNITED STATES|J.P. Staab, Department of Psychiatry and Psychology, Mayo Clinic, Rochester, Minnesota, UNITED STATES|N. Shepard, Department of Otorhinolaryngology, Mayo Clinic, Rochester, Minnesota, UNITED STATES|

### **ABSTRACT BODY:**

**Purpose/Hypothesis :** Chronic subjective dizziness (CSD) is a condition of persistent, non vertiginous dizziness or unsteadiness and hypersensitivity to one's own motion, objects moving in the environment, and complex visual stimuli. Since 2007 physical and occupational therapists at Mayo Clinic have used habituation exercises to treat patients with CSD. The purpose of this pilot study was to gather the first scientific data on the efficacy of the habituation form of vestibular and balance rehabilitation therapy (VBRT) for patients with two types of CSD: CSD alone (no vestibular deficit or active neurologic disorder) and CSD with comorbidities (vestibular migraine and compensated vestibular deficit).

**Number of Subjects :** 26

**Materials/Methods :** Patients from the two diagnostic groups who met strict criteria for the study were surveyed by telephone: An oral script was used to query subjects about frequency of exercise, effectiveness of therapy, degree of visual or motion sensitivity remaining, disability level, other vestibular rehabilitation, and use of medication.

**Results :** Fifty four patients met the criteria for the study. Thirty three answered the survey questions, and 26 returned written authorization. Fourteen of 26 found exercise beneficial. Twenty-two of 26 found the PT consultation beneficial. In the CSD alone group 8 of 12 found VBRT helpful whereas in the CSD with co-morbidities group 6 of 14 found VBRT helpful (n.s.) Demographics and baseline characteristics did not differ between those who found VBRT helpful and those who did not, except that the group helped was more depressed ( $p < 0.05$ ). Post treatment symptom rating (0-10 scale) for visual symptoms was  $2.9 \pm 2.7$  for the VBRT helpful group and  $5.1 \pm 3.3$  for the VBRT not helpful group ( $p < 0.10$ ). Post treatment head/body motion ratings were  $1.9 \pm 2.3$  for VBRT helpful group and  $4.5 \pm 3.6$  for VBRT not helpful group ( $p < 0.05$ ). Symptom relief for visual motion was present in 5 of 9 in the VBRT helpful group and 3 of 9 in the VBRT not helpful group (n.s.). Head body motion symptom relief was present in 7 of 7 in the VBRT helpful group and 1 of 11 in the VBRT not helpful group ( $p < 0.05$ ). Complete symptom relief was present in 4 of 10 in the VBRT helpful group and 0 of 12 in the VBRT not helpful group ( $p < 0.05$ ).

**Conclusions :** This was a complicated group of patients with over half of the group having medical and/or psychiatric comorbidities. Despite this, most patients found that the PT consult was helpful and the majority found the exercise program helpful. Greater improvements were achieved with sensitivity to head/body movement than visual stimuli.

**Clinical Relevance :** This pilot study offers the first scientific data on the efficacy of the habituation form of vestibular rehabilitation for treatment of CSD and shows that there is evidence that this strategy may be effective.

**TITLE:** Implementing Weighted Training in a Patient with Cerebellar Ataxia Secondary to Paraneoplastic Syndrome.

**AUTHORS/INSTITUTIONS:** M. Eikenberry, C. Kinney, Physical Medicine & Rehabilitation , Mayo Clinic Hospital in Arizona, Phoenix, Arizona, UNITED STATES|K. Sims, Bellarmine University Physical Therapy , Louisville, Kentucky, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Paraneoplastic Syndrome is a rare neurological disorder that affects patients with cancer. Cancerous tumors, can cause an immune-mediated response via onconeural antibodies that attack the tumor, as well as the central nervous system, peripheral nervous system, neuromuscular junction and muscle. This syndrome can have many different neurologic presentations,, including trunk and limb ataxia as a result of cerebellar degeneration. Limited evidence is available on effective physical therapy interventions for patients with Paraneoplastic Syndrome. However, there is some evidence describing the effectiveness of weighted therapy for patients with cerebellar ataxia secondary to traumatic brain injury and multiple sclerosis. This case study demonstrates the application of best available evidence through the use of various weighted therapy interventions to improve function and independence in a patient with Paraneoplastic Syndrome.

**Case Description :** A 58 year old female with paraneoplastic syndrome was admitted to inpatient acute rehabilitation secondary to functional decline as a result of profound cerebellar ataxia. Six months prior to admission the patient underwent diagnostic laparoscopy and a bilateral laparoscopic salpingo-oophorectomy to remove diffuse fallopian tube carcinoma, followed by six cycles of chemotherapy. Despite aggressive cancer treatment, profound and progressive trunk and limb ataxia remained. The patient required maximal assistance to ambulate household distances with a front wheeled walker. Physical therapy treatment utilized a variety of weighted therapy including: weighted treadmill and over ground gait training, proprioceptive neuromuscular facilitation techniques, and weighted vest activities in quadruped, tall kneeling and standing. Weighted therapy interventions were executed for 8 consecutive days with a total of 625 minutes of physical therapy.

**Outcomes :** Functional Independence Measure (FIM), BERG Balance Scale (BBS) and Scale for the Assessment and Rating of Ataxia (SARA) were assessed the day before treatment commenced and the day after treatment had completed. The patients FIM motor score increased from a 28/91 to a 52/91, with a total increase of 24 points, demonstrating reduced burden of care. BBS improved from 12/56 to 23/56, for a total increase of 11 points. SARA ataxia scale decreased 2 points on the ataxia scale from a 24/40 to a 22/40 during the 8 day treatment session, demonstrating improved ataxia.

**Discussion :** These findings suggest a benefit for using these treatment techniques in this patient. Although treatment was limited to 8 consecutive days with no follow up assessment, the patient had a positive improvement in balance, gait ataxia and reduction in burden of care. Functional improvement in a neurodegenerative disease process should be considered a positive response to physical therapy interventions. Clinicians treating patients with cerebellar ataxia and paraneoplastic syndromes may find these treatment approaches helpful in maximizing patient outcomes.

**TITLE:** Effects of Functional Electrical Stimulation with and without a Wrist-hand Orthosis on Hand Opening in Individuals with Chronic Hemiparetic Stroke: a Pilot Study

**AUTHORS/INSTITUTIONS:** J.E. Sullivan, J.P. Dewald, J. Yao, Physical Therapy & Human Movement Sciences, Northwestern University, Chicago, Illinois, UNITED STATES|N. van Klink, Biomedical Engineering Department, University of Twente, Twente, NETHERLANDS|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** This study investigated how using either functional electrical stimulation (FES) or a wrist hand orthosis (WHO) to maintain the wrist in a close-to-neutral position impacts FES-assisted hand opening.

**Number of Subjects :** twelve individuals with moderate to severe stroke

**Materials/Methods :** Subjects performed maximal hand opening with or without assistance from FES/WHO. Hand opening distance and wrist flexion angles were measured.

**Results :** Our results demonstrated that FES applied to the finger extensors resulted in a trend of larger opening distance ( $p < 0.1$ ), but was associated with a significant reduction in wrist extension angle. Additional FES to wrist extensor didn't create any significant effect as compared to FES to finger/thumb extensors. Using a WHO significantly reduced wrist flexion angle ( $p < 0.01$ ), and has a trend in reducing the finger opening distance ( $p < 0.1$ ) although only by a 2 mm distance. When comparing the effect of 'FES to finger extensors with WHO' and 'FES to wrist and fingers extensors without WHO,' we found no difference in hand opening distance ( $p > 0.2$ ); however, a trend of reduced wrist flexion angle ( $p = 0.057$ ) when using WHO combined with FES.

**Conclusions :** These results suggest that combined FES and WHO should be considered when designing interventions or devices to enhance hand opening in individuals with stroke.

**Clinical Relevance :** FES and an WHO may increase functional hand use following stroke.

**TITLE:** The Feasibility of Pedometer Use Following Acute Rehabilitation Discharge Post-Stroke

**AUTHORS/INSTITUTIONS:** K. Denlinger, C.M. Lopez, E. Jagielo, O.M. Lynch, C. Ward, J.E. Sullivan, Physical Therapy & Human Movement Sciences, Northwestern University, Chicago, Illinois, UNITED STATES|H.A. Scholten, R.M. Pelo, Rehabilitation Institute of Chicago, Chicago, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** A telephone-monitored, community-based pedometer intervention has been shown to be feasible in chronic stroke. It has been hypothesized that earlier implementation of a pedometer intervention may lessen the development of habitual sedentary behavior seen commonly after stroke. The purpose of this study was to determine the feasibility of a telephone-monitored, community-based pedometer intervention in acute stroke following discharge from an acute inpatient rehabilitation facility (IRF).

**Case Description :** Subjects were individuals with acute stroke, who were able to ambulate and were discharged to the community following an inpatient rehabilitation stay. The study utilized a pedometer protocol previously shown to be feasible in chronic stroke. Subjects wore a pedometer on the unaffected hip 7 days/week for 6 weeks following discharge from IRF. Subjects recorded daily step counts, adverse symptoms, exertion levels, losses of balance, and falls with and without injury in an exercise log. Weekly telephone calls focused on exercise log data and patient-driven step count goals for the following week. At the end of the 6-week intervention period and at 3-month follow up, subjects engaged in a structured telephone interview focused on pedometer use and satisfaction.

**Outcomes :** During the 3-month recruitment period, 79 patients with the diagnosis of acute stroke were discharged from the IRF; 61 patients did not meet inclusion criteria and 3 patients declined to participate. Reasons for exclusion included aphasia (n=12), non-English speaking (n=5), cognition (n=21), non-ambulatory at discharge (n=1), and non-community discharge (n=22). 15 patients were screened for eligibility using the Montreal Cognitive Assessment (MoCA); 7 patients did not meet MoCA inclusion criteria score of >26, 2 patients refused to participate at time of screening. Six patients were enrolled in the study. All subjects were able to don pedometers and read step counts. Three subjects did not complete the study, 2 due to incomplete data and 1 secondary to subsequent stroke. The three subjects who completed the 6-week intervention reported that the pedometers were easy to use and 2 said that they would recommend pedometer use to other individuals post-stroke. Challenges for subjects included: walking in inclement weather, frustration with pedometers that fell off or reset unexpectedly, and the burden of data recording. Researcher challenges included: reaching subjects by telephone and engaging subjects in goal setting.

**Discussion :** Less than 10% of potential subjects with diagnosis of acute stroke met inclusion criteria. The feasibility of a telephone-monitored, community-based pedometer intervention following IRF discharge post-stroke is limited by patient characteristics, patient burden, and logistical issues. This study represents a preliminary step in determining the feasibility and highlights the challenges of a pedometer-based intervention in the acute stroke population.

**TITLE:** Perceptions of Attitudes When in a Restaurant Setting Among Individuals with Spinal Cord Injury and Quality of Life

**AUTHORS/INSTITUTIONS:** C. Sartor-Glittenberg, A.T. Still University, Mesa, Arizona, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** There is research documenting negative attitudes toward individuals with disabilities, but few studies from the perspective of the wheelchair user. Research on perceived attitudes and discrimination has been conducted in the workplace and store environment, but not the restaurant setting. The purpose of this mixed methods study was to develop and initiate validation of a novel instrument for measuring the perception of attitudes of restaurant personnel toward individuals with spinal cord injury (SCI) who are wheelchair users; investigate the perception of attitudes of restaurant personnel toward individuals with a SCI who are wheelchair users; and investigate the relationship between perception of attitudes and age, gender, race, level of injury, time since onset, and quality of life (QOL).

**Number of Subjects :** Eighty six participants who had a SCI, 18 years old or older, at least 1 year post-SCI, and used a wheelchair when in a restaurant. Participants were recruited from the state SCI association and from websites and newsletters related to SCI.

**Materials/Methods :** Data regarding perception of attitudes were obtained with a novel questionnaire consisting of 18 closed-ended and 5 open-ended questions. The Life Satisfaction Questionnaire (LiSat-9) was used to measure QOL. Correlation and multiple regression analyses were conducted. Content analysis was used to develop themes and categories from responses to the open-ended questions of the attitudes survey.

**Results :** 86 participants: 41 male (47.7%); mean (SD) age 46.5 (13.0) years. Internal consistency of the attitudes measure, Cronbach's  $\alpha = .87$ . The mean item response score of the attitudes measure was 2.78 (0.55) on a scale of 1 to 5, 5 indicating high perception of negative attitudes. Correlation and multiple regression analyses found no relationship between age, gender, race, level of injury, time since onset, and mean item response score of the attitudes measure. The mean item response score of the attitudes measure was correlated with QOL ( $r = -.26$ ,  $p < .05$ ). Multiple regression analyses were conducted, controlling for age, gender, and race to identify variables associated with the LiSat-9. Entering the variables of level of injury, time since onset, and the mean item response score of the attitudes measure resulted in a multiple  $R^2 = .23$ ;  $F = 3.38$ ,  $P = .01$ . Content analysis revealed problems of physical access of restaurants and negative attitudes of restaurant employees.

**Conclusions :** Individuals with SCI who are wheelchair users perceive physical and attitudinal barriers when in a restaurant. Individuals with higher mean-item response scores on the attitudes measure reported lower scores on the LiSat-9.

**Clinical Relevance :** Healthcare professionals can use the findings of this study when assessing environmental factors influencing participation and QOL of persons with SCI and for developing interventions aimed at improving participation and QOL of these individuals. Improvements in physical design and research and training to reduce attitudinal barriers in restaurants are needed.

**TITLE:** Occlusion of the vertebrobasilar artery: Screening and treatment by a physical therapist, case study of a non-surgical candidate

**AUTHORS/INSTITUTIONS:** M.F. Lyon, Outpatient Rehabilitation, TIRR Memorial Hermann, Houston, Texas, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Ischemia in the vertebrobasilar circulation is a rare cause of dizziness, only 0.7% of persons with isolated vertigo are due to stroke<sup>1</sup>. Symptomatic vertebral basilar insufficiency (VBI) can be caused by mechanical or vascular occlusion<sup>2</sup> and can lead to stroke<sup>3</sup>. Tests used in physical therapy to determine the likelihood of VBI have poor diagnostic accuracy<sup>1,4</sup>. Reported treatments include arterial or ligamentous surgery and use of blood thinners; little evidence exists on treatment of symptomatic non-surgical candidates<sup>2,5-6</sup>.

**Case Description :** JK, a 54 year old male, was referred to physical therapy with a diagnosis of stroke. He reported acute onset of headache, dizziness and inability to work. VBI testing, utilizing the extension-rotation test was negative. With rapid cervical rotation, he reported severe upper cervical pain, headache, dizziness, foginess, and slowed verbal response time. He was referred to neurology due to cervical motion onset cognitive symptoms, and found to have VBI. He was deemed not appropriate for surgery. He participated in 7 physical therapy treatments focused on performance of functional and work activities in head positions avoiding mechanical occlusion along with balance training and cervical strengthening.

**Outcomes :** At discharge, the dizziness handicap inventory (DHI) improved from 54 to 12, the six-minute walk test improved 319 ft, single leg stance improved an average of 7 seconds, and he returned to work. At two-month follow-up, the DHI was 22 and JK reported working full-time with unlimited driving.

**Discussion :** This case describes an instance of successful screening and treatment of VBI by a physical therapist. It highlights the use of therapy to improve symptoms and quality of life in a non-surgical candidate. It also demonstrates the importance of relying on a confluence of symptoms in testing for malignant conditions.

**TITLE:** Assessing a robotic measure of loss of independent joint control in chronic stroke

**AUTHORS/INSTITUTIONS:** M.D. Ellis, C. Hagan, G. Murphy, M. Powers, A. Smith, L. Abplanalp, A. McKeown, L. Meyer, R. Napier, T. Woods, S. Traxel, J.P. Dewald, Physical Therapy and Human Movement Sciences, Northwestern University, Chicago, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Measuring reaching range of motion under controlled abduction loads with the ACT3D robot has been utilized to quantify the loss of independent joint control<sup>1-3</sup> and assess the efficacy of robotic strengthening for individuals with stroke.<sup>4,5</sup> The purpose of our study was to find the minimal detectable change (MDC) for maximum reaching distance and velocity for progressively increasing shoulder abduction loads. We hypothesized that the MDC of these robotic metrics would be 10-20% for maximum distance and 20-30% for maximum velocity. Additionally, we hypothesized that maximum reaching velocity and distance would decrease as a function of abduction loading.

**Number of Subjects :** Twelve participants with chronic stroke that scored from 2-4/7 on the Chedoke-McMaster Stroke Assessment for the arm participated in the study.

**Materials/Methods :** Maximum voluntary torque (MVT) for shoulder abduction was measured using a handheld dynamometer. Maximum reaching distance and velocity were measured using the ACT3D robot under 5 abduction loads; on a haptic surface, and at 0, 12.5, 25, 37.5, and 50% of abduction MVT. Participants were instructed to reach as fast as possible towards an outward target while visualizing an arm avatar. They were re-tested 7 to 14 days later. MDC<sub>90%</sub> was calculated using the following equation:<sup>6</sup>  $MDC_{90\%} = 1.645 \times \sqrt{2} \times SEM$ , where  $SEM = SD_{1,2} \times \sqrt{(1-ICC_{2,1})}$ . SEM is the standard error of measure with 1.645 being the z score for the 90% confidence interval. The,  $SD_{1,2}$  is the combined standard deviation of the two sessions. ANOVA's were used to assess the effect of arm, load, and session on reaching distance and velocity.

**Results :** The MDC for maximum distance reached ranged from 9.70 - 14.85% of total target distance. This represents a range of 12 - 22% of the group mean for maximum reaching distance. The MDC for maximum reaching velocity ranged from 0.16 - 0.74 m/s. This represents 21 - 69% of the group mean for maximum reaching velocity. ANOVA's showed a significant effect of load ( $p = 0.00$ ) and arm ( $p = 0.00$ ) but not session ( $p = 0.77$ ) on distance and an effect of load ( $p = 0.04$ ), arm ( $p = 0.00$ ), and session ( $p = 0.04$ ) on velocity.

**Conclusions :** MDCs were within the range of the expected values. The larger MDCs for velocity indicate that maximum reaching velocity inherently has greater variability, especially at lower abduction loads, and may therefore not be as sensitive as maximum reaching distance for detecting real change following an intervention. Importantly, the deleterious effects of abduction loading found here are consistent with prior work investigating the loss of independent joint control.

**Clinical Relevance :** The range of MDC values found here are lower than the improvements observed in our prior robotic intervention work<sup>4</sup> targeting the loss of independent joint control indicating the capacity for real improvements in reaching function. Following the completion of an ongoing clinical trial, the minimal clinically important difference will be established for these robotic metrics to offer insight into the meaningfulness of intervention-related improvements.

**TITLE:** Differential Diagnosis of Lateral Canal Benign Paroxysmal Positional Vertigo: A Systematic Review

**AUTHORS/INSTITUTIONS:** B. Kinne, B. Baker, C.C. Harro, Grand Valley State University, Grand Rapids, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The effective management of lateral canal benign paroxysmal positional vertigo (LC-BPPV) is dependent upon the accurate identification of the affected ear. The Supine Roll test is the gold standard for diagnosing LC-BPPV. However, in some cases, the elicited nystagmus has a similar intensity when the head is rolled to the right or to the left. The purpose of this systematic review was to determine the effectiveness of accessory diagnostic procedures, used in conjunction with the Supine Roll test, at accurately identifying the affected ear in individuals with LC-BPPV.

**Number of Subjects :** N/A

**Materials/Methods :** The following databases were searched: (1) CINAHL Plus with Full Text, (2) ProQuest Medical Library, and (3) MEDLINE. The following search terms were used: (1) "lateral canal" OR "horizontal canal" AND (2) "positional vertigo" OR "positioning vertigo" OR "positional nystagmus" OR "positioning nystagmus". Prior to the literature review for this systematic review, the inclusion criteria were defined as studies with the following characteristics: (1) participants who were diagnosed with LC-BPPV, (2) the use of an accessory diagnostic procedure (specifically designed to identify the affected ear in LC-BPPV) as an index test, (3) the use of the Supine Roll test as the reference standard for diagnosing LC-BPPV, and (4) research studies that were classified as level 2 evidence. Evidence level was examined with the Oxford Centre for Evidence-Based Medicine 2011 levels of evidence method, and methodological rigor was examined with the QUADAS method.

**Results :** A database search originally identified 1348 records. After the duplicates were removed and the records were screened, 33 full-text articles were accessed for eligibility. Nine studies met the inclusion/exclusion criteria and were included in the qualitative synthesis. This systematic review revealed four index tests that, when used in conjunction with the Supine Roll test, were able to accurately identify the affected ear in a majority of individuals with LC-BPPV.

**Conclusions :** The Pseudo-Spontaneous test was found to be slightly superior to the other three index tests in terms of eliciting nystagmus during its administration, identifying the same affected ear as the Supine Roll test, and leading to a successful BPPV treatment outcome.

**Clinical Relevance :** Although LC-BPPV is not as common as posterior canal BPPV, it still affects up to 40% of all individuals who have been diagnosed with the disorder. Three current interventions are very effective at managing the geotropic variant of LC-BPPV, and two other interventions have the potential to effectively manage the apogeotropic variant. In four of the five treatment techniques, the effectiveness of the intervention is dependent upon the accurate identification of the affected ear. Because the administration of an accessory diagnostic test enhances the accurate identification of the affected ear in LC-BPPV, clinicians should employ one of these index tests when the results of the Supine Roll test are inconclusive.

**TITLE:** The Relationship Between Shoulder Pain and Quality of Life in Manual Wheelchair Users with Spinal Cord Injury: A Systematic Review

**AUTHORS/INSTITUTIONS:** K.J. Curbow-Wilcox, L.J. Barnes, M. West, D. Touchstone, School of Health Related Professions, Department of Physical Therapy, University of Mississippi Medical Center, Jackson, Mississippi, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Shoulder pain is a common issue for people living with spinal cord injury (SCI). The shoulder pain is typically due to increased demand placed on the upper extremities during functional activities, including manual wheelchair propulsion. The pain may negatively affect quality of life (QOL) for people with SCI. The purpose of this systematic review was to examine the relationship of shoulder pain and QOL in individuals with SCI who use a manual wheelchair for primary mobility.

**Number of Subjects :** NA/Systematic Review

**Materials/Methods :** The PubMed database was searched through October 2, 2013 using clinical search terms related to neurologic disorders, shoulder pain, wheelchair, and physical therapy. Specific terms and combinations are presented. Electronic limitations included free full text and publications in the last 10 years. A title screen and an abstract screen were conducted to eliminate articles not specifically related to shoulder pain and manual wheelchair use in the target population of people with SCI. Four articles met inclusion criteria for this systematic review. Quality of the articles was evaluated using PEDro scale and 2011 Centre of Evidence Based Medicine (CEBM) levels.

**Results :** The average PEDro score was 4.75/10 with a range of scores from 3/10 to 7/10. Based on the 2011 CEBM levels, two studies were given level II, one study was given level III, and one study was given level IV. The articles reviewed found that higher levels of shoulder pain led to lower QOL scores and, as pain decreased, the QOL scores improved.

**Conclusions :** Based on the evidence from this systematic review, shoulder pain intensity is inversely related to QOL in individuals with SCI who use manual wheelchairs for primary mobility.

**Clinical Relevance :** Physical therapists may have a positive effect on QOL in this population by decreasing shoulder pain through exercise-based interventions. Additional randomized control trials, which include exercises for both the treatment and control groups, may be beneficial in determining interventions recommended to reduce pain.

**TITLE:** The effect of neurostimulants on functional recovery of individuals with traumatic and non-traumatic brain injuries.

**AUTHORS/INSTITUTIONS:** A.J. Belville, A.J. Jodoin, C.P. Rocco, Physical Therapy, Spaulding Rehabilitation Hospital, Charlestown, Massachusetts, UNITED STATES|R. Doherty, A. Guarino, M. Nicholas, MGH Institute of Health Professions, Charlestown, Massachusetts, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this research study was to assess the degree to which neurostimulants affect the functional recovery as measured by the Functional Independence Measure (FIM) in patients with traumatic and non-traumatic brain injuries. Our hypothesis was that patients with non traumatic brain injuries treated with neurostimulants would have a better functional recovery than patients not treated with neurostimulants, particularly on the cognitive FIM categories.

**Number of Subjects :** 3683

**Materials/Methods :** A retrospective data analysis utilized data recorded in the medical record of patients seen at Spaulding Rehabilitation Hospital (SRH) over a 5-year period. Inclusion criteria included adults ages 18-80 who were admitted to SRH with a traumatic or non-traumatic brain injury. Patients with a length of stay less than 10 days were excluded.

**Results :** A preliminary analysis was completed to identify any differences in medication type. Although there were statistically significant differences in effectiveness among medications, the effect-sizes as measured by the  $\eta^2$  were very small for Cognition and Motor Discharge FIM scores respectively. The improvements seen on the Cognitive and Motor FIM scores at discharge were not statistically significant in the group who received neurostimulants in comparison to the group who did not, when co varying for age, FIM status at admission, length of stay, and number of co-morbidities. The type of brain injury also did not interact with these results on the effect of neurostimulants.

**Conclusions :** These results could suggest a limited effect of neurostimulant use on patients' short-term functional recovery as measured by the FIM. With such a large sample size and large variety of diagnoses, the effect of neurostimulants on specific patients may not be appreciated. Thus there is a possibility that the use of neurostimulants does not have a positive effect on Cognitive and Motor FIM scores despite the impression that improvements are seen in clinical practice. Based on these results, we conclude that further research is indicated to determine the short term and long term benefits of neurostimulants on recovery in patients with traumatic and non-traumatic injuries.

**Clinical Relevance :** Our research has highlighted limitations of the FIM. The FIM, which is one of the standard outcome measures used in both inpatient and outpatient rehabilitation settings to capture a patient's cognitive and motor potential at the time of admission, may need to be supplemented with additional, more sensitive measures of cognitive and motor recovery. For example, the Coma Recovery Scale or the Disability Rating Scale may be more appropriate measures to capture the short term benefits of patients in early stages of brain injury recovery.

**TITLE:** Effect of Strengthening the Plantarflexors on Spasticity and Walking Participation in Individuals with Chronic Stroke

**AUTHORS/INSTITUTIONS:** S.A. Ross, M. Kamp, M. Lenger, B. Voyles, K. Yates, T. Coffey, Physical Therapy, Maryville University, St. Louis, Missouri, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Would you strengthen spastic plantarflexors in individuals with chronic stroke? Strengthening spastic muscles, in the past, has been avoided due to fear of increasing spasticity and decreasing range of motion. However, we know plantarflexor strength is critical for push-off during gait. The purpose of this study was to determine if strengthening the plantarflexors and gait training in a chronic stroke population has an effect on plantarflexor spasticity and the number of daily steps taken in the community.

**Number of Subjects :** A convenience sample of five participants, ages ranged from 53 to 70 years, acted as their own control in this multiple single-subject design.

**Materials/Methods :** Three measurements were taken; two at baseline and one following the intervention period. Participants trained onsite 2x/wk and performed a HEP 4x/wk for 6-weeks. Training consisted of plantarflexor strengthening; 3 sets of 5 repetitions at 80% maximum at both 30 and 90°/s on an isokinetic device and 10 minutes of treadmill walking at slow and fast speeds focusing on push-off of the weak ankle. The HEP included heel raises and a walking program. Outcome measures: Maximum strength was measured for the dorsiflexors and plantarflexors during eccentric and concentric contractions, at 30 and 90°/s on a KinCom. Plantarflexor spasticity was measured using the Modified Tardieu Scale (MTS). For step count, ActiGraph accelerometers were distributed to participants during the first baseline week and data was collected each subsequent week. Data analysis: Data was analyzed using standard error of measure (SEM) and minimal detectable change (MDC) for each participant for strength and step count.

**Results :** Prior to intervention, none of the five participants were able to perform a single unilateral heel rise on their involved limb, indicating less than fair plantarflexor strength. Following intervention, plantarflexor strength values improved above MDC for all participants in the involved limb at both 30 and 90°/s, while spasticity did not appear to change in any of the participants. Ankle dorsiflexion range of motion increased by an average of 4°. Step count significantly increased for one participant who consistently followed the HEP, while other participants showed either a minimal detectable decrease or no change in average daily steps per week.

**Conclusions :** Strengthening spastic muscles is possible in individuals with chronic stroke without increasing spasticity or decreasing range of motion. One in five participants made significant gains in walking activity. This participant also consistently followed the HEP and had the greatest step count deficit at baseline. It is unclear whether these strength gains will lead to improved function in individuals with chronic stroke.

**Clinical Relevance :** Spastic plantarflexors can be strengthened in individuals with chronic stroke without increasing spasticity or decreasing range of motion. Stronger plantarflexors and a focus on push-off with gait training may improve walking participation in individuals with chronic stroke.

**TITLE:** Time to wheelchair use in persons with Amyotrophic Lateral Sclerosis: Pre-diagnosis falls and onset-type as influencing factors

**AUTHORS/INSTITUTIONS:** D. Lanzino, M. Broderick, J. Lane, K. Simon, S. Sorensen, E. Sorenson, Mayo Clinic, Rochester, Minnesota, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The hallmark of Amyotrophic Lateral Sclerosis (ALS), whether symptoms begin in the bulbar or limb muscles, is weakness. As a result, some patients experience falls and most will need to utilize a wheelchair for mobility at some point during their illness. The influence of onset-type (bulbar or limb) or falls on the time that will elapse between diagnosis and the need for a wheelchair is unknown. The purpose of this study was to determine if time to wheelchair use is influenced by onset-type or by the incidence of falls having occurred by the time of diagnosis (baseline).

**Number of Subjects :** Patients with EMG-confirmed ALS seen at Mayo Clinic, ALS Clinic, Rochester, Minnesota, between 2009-2013 (n=297)

**Materials/Methods :** A retrospective chart review was completed to collect patient age, gender, ALS onset-type, date of diagnosis, incidence of falls pre- and post-diagnosis, date of wheelchair use and/or dependence, and ALS Functional Rating Scale revised (ALSFRS<sub>r</sub>) score. Data were characterized using descriptive statistics. Chi square analysis examined the significance of pre- or post-diagnosis falls based on onset-type. Time to wheelchair use based on falls or onset-type was analyzed using Kaplan-Meier curves.

**Results :** Onset-type significantly influenced the presence of pre-diagnosis falls [ $\chi^2(2) = 57.45, P < 0.001$ ]. At the time of diagnosis, 65% of persons with lower limb-onset had already fallen, compared to 44% of persons with upper limb-onset and 14% of persons with bulbar-onset. If falling at baseline, mean time to power or manual wheelchair use was 5 months, whereas if not falling at baseline, mean time was 12 months ( $p < 0.0001$ ). Time to wheelchair use was also significantly influenced by onset-type (5 months for persons with lower limb-onset compared to 11 months for those with upper limb or bulbar-onset,  $p = 0.001$ ).

**Conclusions :** Patients who fall prior to being diagnosed with ALS, or who have lower extremity weakness as their initial ALS symptom required a wheelchair significantly sooner (5 months) than persons with upper limb-onset ALS, bulbar-onset ALS, or who had not fallen by the time of diagnosis. Those persons with lower limb-onset are also more likely to have fallen by the time of diagnosis.

**Clinical Relevance :** Therapists should be prepared for an earlier need for wheelchair prescription and use in persons with baseline falls or lower limb-onset ALS. They should appropriately educate their patients to anticipate these mobility needs and expected disease progression.

**TITLE:** Effect of Aerobic Exercise on Brain Activity Following TBI

**AUTHORS/INSTITUTIONS:** J.M. Lojovich, M. Bryant, C. Jude, D. Kline, J. Carey, Program in Physical Therapy, University of Minnesota, Minneapolis, Minnesota, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** It has been determined that cognitive function depends on an integrated, distributed network of brain connectivity. These networks include areas that are activated by tasks requiring working memory (task-positive networks), as well as a set of brain regions that correlate to a reduced level of activation during the most attentionally demanding tasks. Aerobic exercise has been shown to improve cognition through vascular changes, neurotransmitters, neurotrophins and changes in the brain activity in healthy animal and human subjects. However, the cognitive effects of aerobic exercise has yet to be investigated in a brain injured population. The purpose of this study was to evaluate the effects of a 12-week aerobic exercise intervention on brain activity and working memory in moderate-to-severe TBI subjects.

**Number of Subjects :** Seven males with moderate-to-severe TBI (mean age = 44.43 years, SD  $\pm$ 13.0), mean time since TBI (11.29 years, SD  $\pm$  11.12) completed a 12-week aerobic exercise intervention for 3 days per week.

**Materials/Methods :** A two standard deviation bandwidth method was used to analyze the dependent functional magnetic resonance imaging (fMRI) variables of voxel count, intensity and laterality index for individual subjects during the 0 back and 2 back working memory tasks. Regions of interest within the brain included the dorsolateral prefrontal cortex (DLPFC), precuneus, anterior cingulate cortex (ACC), and posterior cingulate cortex (PCC). Secondary measures examined changes in aerobic capacity (VO<sub>2</sub> max) and accuracy and reaction time on the working memory tasks. A nonparametric Wilcoxon Signed-Ranks test was utilized to assess the differences between the subjects' aerobic capacity and cognitive test data prior to and following the exercise intervention. The relationship between reaction time, aerobic intervention, and memory task was modeled with a mixed model with both fixed and random effects.

**Results :** Following 12 weeks of aerobic exercise, VO<sub>2</sub> max significantly improved (P = .016), accuracy (P<.001) and response time (P=.009) also significantly improved on the N-back task of working memory. Subjects also demonstrated a trend toward left side activation of the DLPFC following exercise and a significant increase in precuneus intensity with a decrease in the number of activated voxels in the 2 back task compared with the 0 back task.

**Conclusions :** This study is the first to examine the effects of exercise as an intervention to promote plasticity following TBI. The results of this study indicate that a 12-week aerobic exercise intervention was associated with significant improvements in measures of aerobic capacity and working memory, in subjects with moderate-to-severe chronic TBI. Data also suggest differences in brain activation following a 12-week aerobic exercise intervention in subjects with chronic TBI. Limitations of this study include a small sample size and lack of a control condition.

**Clinical Relevance :** This preliminary clinical study is the first to examine the effect of aerobic exercise on brain activity in a human population with traumatic brain injury.

**TITLE:** Effect of Aerobic Exercise on Cognition Following Traumatic Brain Injury

**AUTHORS/INSTITUTIONS:** J.M. Lojovich, J. Carey, Program in Physical Therapy, University of Minnesota, Minneapolis, Minnesota, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Emerging evidence suggests that exercise may improve cognitive function in animals, older adults, CVA and Alzheimer subjects. The purpose of this preliminary clinical study was to describe changes in the everyday memory, working memory and executive function in individuals with moderate-to-severe chronic traumatic brain injury (TBI) following participation in a 12-week aerobic exercise intervention.

**Number of Subjects :** Seven males with moderate-to-severe TBI (mean age = 44.43 years, SD  $\pm$ 13.0), mean time since TBI (11.29 years, SD  $\pm$  11.12) completed a 12-week aerobic exercise intervention for 3 days per week.

**Materials/Methods :** A single group, pretest-posttest design was used. Primary outcome measures examined changes in everyday memory, working memory, executive function and perception of disability. Secondary measures examined changes in aerobic capacity (VO<sub>2</sub> max). A nonparametric Wilcoxon Signed-Ranks test was utilized to assess the differences between the subjects' aerobic capacity and cognitive test data prior to and following the exercise intervention.

**Results :** Following the aerobic exercise intervention, significant improvements were found in the overall Rivermead Behavioral Memory Test (P = .016), Paced Auditory Serial Addition Test (PASAT) for both slower speed (P= .016) and faster speed (P= .031), and the Ability (P =.016), Adjustment (P =.016) and overall score (P =.013) of the Mayo-Portland Adaptability Inventory – 4. Aerobic capacity (VO<sub>2</sub> max) also significantly improved over the 12-weeks (P = .016). A significant correlation (r = -.75, P=0.05) between the subjects' change in aerobic capacity and improvement in the amount of non-perseverative errors on the Wisconsin Card Sorting Test was also found.

**Conclusions :** The results of this study indicate that a 12-week aerobic exercise intervention was associated with improvements in measures of everyday memory, working memory and perception of disability in subjects with moderate-to-severe chronic TBI. These results indicate the need for future study in the TBI population with a randomized control trial to further explore the benefits of aerobic exercise as an adjunct intervention to improve not only cardiovascular fitness but cognition and functional outcome. Limitations of this study include a small sample size and lack of a control condition.

**Clinical Relevance :** This study is the first to examine the effects of exercise as an intervention to address the cognitive deficits that commonly persist following TBI.

**TITLE:** Physical Therapy Management of Brown-Sequard Syndrome in an Outpatient Setting: A Case Report

**AUTHORS/INSTITUTIONS:** E.M. Davis, R.E. Carter, R. OShea, R. Washington, Governor's State University, University Park, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** The purpose of this case study is to describe a patient with Brown-Sequard Syndrome (BSS) through her outpatient physical therapy plan of care, utilizing standard strengthening exercises, aquatic therapy, and body weight support treadmill training while tracking functional outcomes to demonstrate patient progress with gait, endurance, and lower extremity strength.

**Case Description :** The subject is a 57-year-old African-American female, status post T5/T6 BSS lesion. The patient presented to outpatient physical therapy after two-week hospitalization and a two-week inpatient rehabilitation stay. The patient demonstrated decreased strength and proprioceptive ability in the left lower extremity. She had decreased gait speed and tolerance to exercise. She also had a decreased reported quality of life according to the Short Form-36 (SF-36).

**Outcomes :** The patient attended an evaluation and 13 physical therapy sessions over five weeks. Her strength in all manual muscle testing, with the exception of abdominals, improved by at least a portion of a grade to indicate increased strength. She was able to advance her Spinal Cord Injury-Functional Ambulation Index score a statistically significant amount, including her two-minute walk test distance by 27.4 meters, to indicate improved gait mechanics and gait speed. Her 10-meter walk test time improved beyond the minimal detectable change of 0.06 m/s for both fast and comfortable paced walking. The SF-36 measures showed no significant improvement for perceived physical health, however, did for mental health components, indicating improved overall quality of life.

**Discussion :** Strengthening exercises, body weight support treadmill training, and aquatic therapy during physical therapy may lead to improved gait, endurance, lower extremity strength, and quality of life when utilized with a self-motivated BSS patient.

**TITLE:** The Use of Outcome Measures for Persons with Acute Stroke: A Survey of Physical Therapists Practicing in Acute Care and Acute Rehabilitation Settings

**AUTHORS/INSTITUTIONS:** H.D. Anderson, Physical Therapy, Neumann University, Aston, Pennsylvania, UNITED STATES|J.E. Sullivan, Department of Physical Therapy & Human Movement Sciences, Northwestern University, Chicago, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to examine which outcome measures (OMs) physical therapists use for persons with acute stroke, therapist perceptions about OM use, and the agreement between OM use and StrokEDGE recommendations.

**Number of Subjects :** 135 physical therapists; majority are subscribers to the listserv of the American Physical Therapy Association's (APTA) Neurology and/or Acute Care Sections.

**Materials/Methods :** The online survey consisted of 14 questions related to participant characteristics, OMs used, perceptions about influences on OM use, and case-based use questions.

**Results :** 54% of respondents practice in acute care settings (AC), 32.6% in acute rehabilitation (AR). 81% of AC + AR respondents were APTA members and averaged 13 years in practice; 58% received a DPT as their highest degree; 20% were American Board of Physical Therapy Specialty (ABPTS) certified. Respondents from AR and AC were not significantly different in years of practice or APTA membership; however therapists from AR were significantly more likely to have a higher terminal degree (.017) and be ABPTS certified (.019). Over half of respondents reported that comfort, evidence, resources, and time influence OM use and that they use OMs to diagnose, develop care plans, select interventions, and make discharge recommendations. Respondents use OMs that capture balance and gait most frequently. OMs that examine muscle tone, although not highly recommended by StrokEDGE, were frequently used (AC 41%, AR 61%). Therapists used OMs that examine motor recovery infrequently (AC 1%, AR 11%), despite the high recommendation from StrokEDGE. Respondents in AR spend significantly more time delivering care to individuals with acute stroke and are more likely to use the OMs highly recommended by StrokEDGE ( $p < 0.01$ ). The percent of StrokEDGE highly recommended OMs used was not significantly correlated with years of practice, having earned a more advanced degree, being an APTA member, or being ABPTS certified. Respondents from AR were more likely to use OMS to diagnose patients, for education, and to contribute to research. More recent graduates were more likely to use OMs to help develop a plan of care but identified time and resources as barriers to OM use.

**Conclusions :** Comfort, evidence, resources, and time influence OM use by physical therapists for persons with acute stroke. Therapists use OMs to diagnose, develop care plans, select interventions, and make discharge recommendations. Use of StrokEDGE highly recommended OMs is associated with practice setting, but not with years of practice, having earned a more advanced degree, being an APTA member, or being ABPTS certified.

**Clinical Relevance :** Appropriate use of recommended OMs is congruent with the APTA Vision 2020 Statement endorsing "evidence-based practice ... enhancing patient/client management and reducing unwarranted variation in the provision of physical therapy services." Understanding current OM use and the factors that influence use is an important step in achieving this goal.

**TITLE:** The Effects of Strengthening Plantarflexors along with Gait Training on Individuals with Chronic Stroke—A Pilot Study.

**AUTHORS/INSTITUTIONS:** J.G. Barry, L. Ewersmann, M. Rolwes, K. Schwarm, T. Arndt, A. Parrish, Maryville University, St Louis, Missouri, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Stroke is a leading cause of disability in adults with weakness and other impairments, such as poor balance, found in more than 90% of survivors which may decrease quality of life (QOL). Gait and balance abilities may be negatively affected by weakness of the plantarflexors. While research has been done in children with spastic cerebral palsy that focused on strengthening of plantarflexors, no research with this intervention focus has been done with chronic stroke. The purpose of this study was to determine, for individuals with chronic stroke, the effect plantarflexor strengthening along with gait training on walking performance, dynamic standing balance, and QOL. It was hypothesized that individuals with chronic stroke would improve gait performance, balance, and QOL after six weeks of plantarflexor strengthening combined with gait training.

**Number of Subjects :** Five individuals with chronic stroke participated.

**Materials/Methods :** This was a multiple single subject study design consisting of two baseline measurement days, six weeks of training, and then one post-training measurement day. A modified version of the Stroke Impact Scale (mSIS) assessed domains related to QOL, the Limits of Stability (LOS) test on the NeuroCom Balance Master assessed dynamic standing balance, and the GAITRite was used to objectively measure walking velocity, step length, and cadence at a comfortable and fast pace. The intervention included 10 minutes of interval treadmill training (alternating a minute of fast and slow walking) and isokinetic eccentric plantarflexor strengthening (3 successful sets of 5 reps at 2 speeds) two days a week. A home exercise program was also given, consisting of strengthening the plantarflexors and walking ten minutes at a fast pace, to be performed four times a week. Statistical significance for each outcome measure was defined as a change of greater than or equal to two standard deviation from the baseline mean.

**Results :** Five mSIS domains of strength, activities of daily living, mobility, participation in meaningful activities, and percent recovery were analyzed for the 5 participants. From these 25 mSIS measures, there were 9 that showed statistical significance. Three out of five participants showed significant improvements with maximal excursion in at least one direction during the LOS test. Two of the slower walkers improved gait velocity at their comfortable pace and two faster walkers showed trends toward improvement. Gait velocities improved when walking at a fast pace in four out of five participants.

**Conclusions :** This study's main finding was improved gait velocity after the intervention period. An improved ability to weight shift was also demonstrated despite no specific balance intervention. These results supported two out of three components of the hypothesis. Larger studies with a control or comparison group are needed.

**Clinical Relevance :** Individuals with chronic stroke may benefit from training at both comfortable and fast walking speeds along with plantarflexion strengthening to improve ambulation and balance.

**TITLE:** A case study illustrating the use of the mini-Balance Evaluation Systems Test for exercise prescription  
**AUTHORS/INSTITUTIONS:** M.A. Stelmach, E. Gallo, Outpatient PT, NYU Langone Medical Center- Rusk Institute for Rehabilitation Medicine, New York, New York, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** There is strong evidence that exercise can reduce fall rates in the elderly. The development of an effective home exercise program (HEP) is a key component. The program should be structured, individualized, progressive and challenging. Standardized outcome measures are commonly used in physical therapy (PT) to screen for balance deficits however most of them are not specific enough to identify the contributing factors. The mini-Balance Evaluation Systems Test (BEST) was developed to allow clinicians to examine the subsystems of balance. The results can assist therapists in constructing individualized balance exercises targeting the specific balance constrains. The following case report illustrates its application.

**Case Description :** A 68 year-old man with the diagnosis of cervical myelopathy was referred to outpatient PT to address progressive decline in balance. Over the past 3 years, he had observed a decline in his functional status, including difficulty walking outside with a cane and standing in the shower. He fell 3 times in the past 12 months. Patient was prescribed a HEP while in PT designed to address specific constrains in balance control identified by the mini-best test. In addition, a chart was designed to organize the exercises into different modes: static, dynamic, gait, dual task, strength training and walking. To improve postural reaction, exercises that provoke stepping strategy individualized to the patient were prescribed, instead of external perturbation training which is not feasible at home. Exercises to strengthen anticipatory postural control were given as a means to diminish the need for postural reaction. The patient was seen for 9 visits over 2 months and was instructed to perform the exercises done in the clinic 3 days a week for 25 minutes at home.

**Outcomes :** During the examination, the following outcome measures were performed: the Activities Specific Balance Confidence scale (ABC) 62.5%, the Timed Up and Go test (TUG) 10 seconds, the Five Times Sit to Stand (FTSTS) 8 seconds, the Berg 51/56, and the mini-BEST 14/28, with the sub scores: anticipatory 5/6, reactive postural control 0/6, sensory orientation 4/6 and dynamic gait 5/10. At discharge, the outcomes were as follows: the ABC 83.75%, TUG 7 seconds, FTSTS 7 seconds, Berg 54/56, and his mini-BEST score was 25/28 with the sub scores: anticipatory 6/6, reactive postural control 6/6, sensory orientation 5/6, and dynamic gait 8/10. Patient was able to ambulate without the use of a cane and had 0 falls.

**Discussion :** This case study highlights the benefits of using the mini-BEST in identifying the specific impairments affecting balance, which were not captured by other outcome measures. It illustrates the design of an exercise regimen that targets all subsystems of balance control while considering the mode of activity. It also shows improvements in postural reaction without using perturbation training or a motion platform that can be safely done as part of a HEP.

**TITLE:** A Multi-Modal Intervention Approach for a Young Adult with Friedreich's Ataxia: A Case Report

**AUTHORS/INSTITUTIONS:** M. Siler, A.W. Andrews, Physical Therapy Education, Elon University, Elon, North Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Friedreich's Ataxia (FRDA) is a progressive and degenerative autosomal recessive disorder affecting the neuromuscular, endocrine, cardiovascular and musculoskeletal systems. The literature is limited regarding physical therapy intervention strategies specifically for patients with FRDA. This case report on a female with FRDA examines the effectiveness of a multi-modal treatment approach over the course of 22 outpatient visits in eight weeks.

**Case Description :** The participant in this case report was a 19-year-old female who had been diagnosed with FRDA two and a half years earlier. At the initial examination, the participant presented with muscle weakness, difficulty with walking, decreased balance, and increased ataxia. Subsequently the patient's difficulties with ambulation required her to use a rollator, when she was not holding onto walls or using others for support. The patient continued to demonstrate an ataxic and steppage gait pattern while using the rollator. Interventions focused on coordinative, balance, and strength training activities as well as aquatic therapy.

**Outcomes :** The patient demonstrated a six-point increase on the Berg Balance Scale, a 0.14m/s increase in gait speed with a rollator, and a 15 second decrease in time for the Five Time Sit-to-Stand test upon completion of the eight week period. The participant reported that she felt stronger and steadier with activities of daily living performance and had decreased the use of her rollator inside her apartment.

**Discussion :** A multi-modal treatment approach comprised of coordinative, balance, and strength training interventions along with aquatic therapy demonstrated positive gains for this patient with FRDA. Further research involving larger sample sizes is needed in order to verify the effectiveness of these interventions for other patients with FRDA.

**TITLE:** The B-FIT Model for Huntington's Disease Rehabilitation: A case series

**AUTHORS/INSTITUTIONS:** E. Ulanowski, Cressman Rehabilitation Center, Norton Healthcare, Louisville, Kentucky, UNITED STATES|M. Danzl, Physical Therapy Department, Bellarmine University, Louisville, Kentucky, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Historically, the dominant yet unfounded paradigm for Huntington's Disease (HD) treatment is that rehabilitation does not attenuate disease progression or improve quality of life. HD rehabilitation research is needed, including development of a theoretical approach and investigation of optimal dose and intensity. The purpose of this case series is to describe the B-FIT model for physical therapy (PT) for people with HD and examine B-FIT within PT rounds over a 16-month period.

**Case Description :** Three subjects with middle-stage HD participated in 2-3 rounds of PT with the same physical therapist, a board certified neurological specialist (1st round: 1-2 visits/week (3-4 months), 2nd round 6 months later (2 visits/week, 2 months), 3rd round 4 months later (2 visits/week, 1 month). The B-FIT approach emphasized: Balance, Functional mobility, Intensity, and Trunk stability. Balance training included static stances, alternate surfaces, multi-directional movements, dual tasking, and vestibular with visual training. Individualized functional mobility training targeted participant specific needs. The intensity of training involved increasing participation past self-perceived maximal intensity levels and adding layers of manual and/or cognitive challenges to tasks. Trunk stability training included both postural awareness and core strengthening. Outcome measures assessed included the Tinetti Performance Oriented Mobility Assessment, Berg Balance Scale, 5 Times Sit to Stand, 6 or 2 Minute Walk Test, 10 Meter Walk Test, falls (number/frequency), single limb stance time, Four Square Step Test, and the Timed Up and Go (normal, cognitive, manual).

**Outcomes :** The 3 subjects improved in each measure assessed when comparing baseline scores to the last PT round discharge scores. Of note, all 3 demonstrated large, immediate, and sustained improvements with the Five Times Sit to Stand test. The subjects rarely demonstrated a return to baseline scores of the previous round, indicating maintenance of some abilities between rounds. Improvements in balance measures were sustained more readily whereas the 10 Meter Walk Test results yielded the greatest decline between rounds. The participants tolerated increased exercise intensity over time enabling subsequent rounds of greater intensity and shorter duration to improve adherence with PT participation.

**Discussion :** This case series lends support for the B-FIT approach to HD rehabilitation emphasizing balance, function, intensity, and trunk stability. HD exercise prescription at increased intensity levels advocated for by B-FIT compared to what is commonly prescribed for this population may be warranted. Individuals with HD may benefit from consistent follow-up by a physical therapist to prevent functional decline and improve quality of life. There are limitations to generalizing these findings and further research is recommended to investigate the effects of B-FIT. Chorea may have impacted performance and formal assessment is recommended for future studies.

**TITLE:** Impairments in laterality recognition in patients with chronic low back pain

**AUTHORS/INSTITUTIONS:** D.L. Allen, Physical Therapy, University of Mary, Bismarck, North Dakota, UNITED STATES|E. Ver Burg, Physical Therapy, Hands On Physical Therapy, Cheyenne, Wyoming, UNITED STATES|A. Wahl, Physical Therapy, St.Alexius Medical Center, Bismarck, North Dakota, UNITED STATES|S. Newman, Physical Therapy, Essentia Health, Fargo, North Dakota, UNITED STATES|A. Gimbel, Physical Therapy, ProStep Rehab, Shelton, Washington, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Chronic pain has been associated with changes in reorganization in somatosensory cortex. Reorganization is associated with impairments in laterality recognition, the ability to identify a body region of movement as left or right. Interventions which change cortical organization, primarily in patients with complex regional pain syndrome, have been shown to relieve pain. More recently, the role of cortical reorganization has been studied in patients with back pain. Bray and Mosely (2011) reported decreases in the accuracy of identifying left/right rotation of the back, likely due to changes in the working body schema. They reported no changes in response time, which is thought to correspond to information processing. The purpose of this study was to examine impairments in laterality recognition accuracy and response time in patients with chronic low back pain.

**Number of Subjects :** Forty subjects ranged in age from 21 to 62. The experimental group consisted of 20 subjects with back pain ranging in duration from 6 to 276 months ( $105 \pm 104$  mo). The control group consisted of 20 subjects without back pain. Approval from the University of Mary IRB was obtained.

**Materials/Methods :** Subjects with back pain indicated the location and level of their pain. All subjects were assessed for laterality recognition using the Recognise computer program. The program presents 15 pictures showing back rotation, and the subjects indicate the direction of the rotation. The ability to identify left vs. right rotation was assessed, and both the accuracy and response time for each direction of rotation were recorded. Data were analyzed by repeated measures ANOVA.

**Results :** Patients with chronic back pain showed impairments in both the accuracy and response time during laterality recognition assessment. The mean response time (mean  $\pm$  SD, 95% CI) for the control subjects was  $1.410 \pm 0.361$  seconds (1.168 to 1.652), and for the back pain subjects it was  $1.815 \pm 0.715$  seconds (1.573 to 2.057) ( $P = 0.021$ ). Accuracy decreased from  $96.6 \pm 0.1$  (91.5 to 101.6) to  $88.7 \pm 0.1$  (83.6 to 93.7) percent in the chronic back pain group ( $P = 0.031$ ). There was no difference in either speed or accuracy between detecting rotation to the left compared to rotation to the right. There was also no interaction between rotation side and treatment group.

**Conclusions :** Subjects with low back pain showed decreases in laterality recognition as indicated by decreases in accuracy and increases in response time when identifying left or right trunk rotation using the Recognize software program. These impairments suggest that low back pain can affect both the working body schema of the trunk, as well as information processing.

**Clinical Relevance :** Impairments in laterality recognition in patients with chronic back pain provides further evidence that cortical reorganization may be occurring. This is the first report of impairments in both the accuracy and the response time during an assessment of laterality recognition.

**TITLE:** Comparing the LSVT BIG protocol to a modified protocol and traditional physical therapy in the management of individuals with Parkinson's disease: a case series

**AUTHORS/INSTITUTIONS:** C.M. Durrrough, L. Haack, Pi Beta Phi Rehabilitation Institute, Vanderbilt University Medical Center, Nashville, Tennessee, UNITED STATES|R. Brown, School of Physical Therapy, Belmont University, Nashville, Tennessee, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Current evidence supports physical therapy (PT) interventions in promoting positive functional outcomes among individuals with Parkinson's disease (PD). LSVT® BIG is a treatment approach specifically designed for individuals with PD, characterized by standardized large-amplitude movements and patient-selected activities. This approach has been shown to be effective in improving function. There are no studies directly comparing various treatment approaches to determine the most effective intervention. The purpose of this study was to compare the differences in functional outcomes of the LSVT® BIG protocol, a modified version of the protocol, and traditional PT interventions.

**Number of Subjects :** 6

**Materials/Methods :** Six individuals with PD participated in the study. Subjects participated in 16 PT sessions according to a schedule determined by group assignment. A physical therapist blinded to group assignment administered all outcome measures at initial evaluation, discharge, and approximately 1 month follow-up. Outcome measures included gait speed, 5x Sit-to-Stand, Mini-BESTest, Parkinson's Disease Questionnaire-39, 6-Minute Walk Test, and the motor portion of the Unified Parkinson's Disease Rating Scale (UPDRS).

**Results :** Participants in the LSVT® BIG protocol group achieved the greatest improvements in gait speed and 6-Minute Walk Test distance, by 24-28% and 57-60%, respectively. Participants in the traditional PT group achieved the greatest improvements on the Mini-BESTest, by 28-32%. Participants in the modified LSVT® BIG group demonstrated the greatest improvements on the 5x Sit-to-Stand Test and the most consistent improvement across all functional measures. All participants in the LSVT® BIG protocol and modified protocol groups improved on the mobility category of the PDQ-39, while both participants in the traditional PT group declined. All participants across groups reported improvements in emotional well-being on the PDQ-39. At follow-up, trends showed minor declines in functional performance from discharge but maintained improvements compared to their initial evaluation.

**Conclusions :** Overall, all participants showed improvements in functioning as a result of the interventions. Improvements were seen in different assessments depending on the intervention group. Some of the difference could be attributed to a difference in tasks emphasized in each of the interventions. Since the modified LSVT® BIG group did demonstrate functional improvements, this protocol could be a viable option for patients that are unable to commit to the standard protocol of 4 days a week for 4 weeks. Increases in community involvement, social support, and physical fitness could contribute to all participants' increased perception of emotional well-being.

**Clinical Relevance :** Most participants improved across all outcome measures, which lends support for various PT treatment approaches for individuals with PD, including a modified version of the LSVT® BIG protocol. Further research is warranted.

**TITLE:** Rasch Analysis of the Functional Gait Assessment

**AUTHORS/INSTITUTIONS:** M. Beninato, Physical Therapy, MGH Institute of Health Professions, Boston, Massachusetts, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The Functional Gait Assessment (FGA) is a standardized outcome measure used to assess walking balance. It has not yet, however, been subjected to Rasch analysis. The purpose of this study was to use Rasch measurement theory and analysis to determine: (1) if the FGA presents floor or ceiling effects, (2) the hierarchy of FGA items, (3) if the FGA meets appropriate psychometric guidelines for clinical use, and (4) if the FGA represents a unidimensional construct.

**Number of Subjects :** 182 older adults referred to physical therapy for balance retraining (mean age 78.7 years +/- 7.3; 64% female)

**Materials/Methods :** Data from initial physical therapy exams were retrieved from 182 medical records. The Rasch analysis of the FGA was conducted using the WINSTEPS software program.

**Results :** FGA Item scores on the Logit scale ranged from 2.89 for the most difficult item, FGA Item 7 "Gait with Narrow Base of Support", to -1.42 Logits for the easiest to perform item, FGA Item 2 "Walking with Change in Gait Speed". Items were spread across the Logit scale with six of 10 FGA items below the item mean, and cluster of three easy items at the lowermost end of the item scale. Person ability ranged on the Logit scale from 5.18 to -2.64 Logits. Person ability spread, therefore, exceeded that of FGA item difficulty, with eight subjects (4%) who were not matched at the high end with a comparably difficult item, and 9 subjects (5%) who did not have an easy item that corresponded to their ability at the lower end of the scale. There were only two FGA items (FGA Item 7 and FGA Item 8 "Walk with Eyes Closed") above the person ability mean (0.60 Logits) so there were groups of subjects at the higher end of the scale who did not have items that corresponded with their ability level. FGA items, except FGA Item 7, had acceptable Infit and Outfit statistics with Mean Squares (MnSq) ranging from 0.62 to 1.35, indicating appropriate variability in person and item scoring properties. FGA Item 7, the most difficult item, was misfitting with Infit MnSq value of 1.97 and an Outfit MnSq of 1.57. Unidimensionality was questionable when examined by the Principal Components Analysis with 17.5% variance of the construct unexplained from the first principal component with an Eigen value of 1.8, suggesting there may be more than one construct represented within the FGA.

**Conclusions :** Results indicate that the FGA may not represent a unidimensional construct and may measure more than one aspect of function. Adding more difficult items and deleting some of the redundant, easier items may improve the clinical usefulness of the FGA. Further study on the effect of adding and deleting FGA items to improve its psychometric properties is indicated.

**Clinical Relevance :** The is a lack of well fitting, difficult items in the FGA scale suggests that there may not be FGA items that correspond to higher functioning individuals' abilities. In addition, the FGA could likely be shortened and made more efficient for clinical use with the removal of redundant, lower level items.

**TITLE:** Tests and Measures Most Frequently Selected by Neurologic Certified Specialists When Examining Individuals with Chronic Stroke

**AUTHORS/INSTITUTIONS:** J. Mowder-Tinney, E. Schuettenberg, D. Chamberlain, J. Conklin, R. Phipps, A. Bodary, Nazareth College, Rochester, New York, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Stroke is the leading cause of physical disability and the 4th leading cause of death in the US. People who have had a stroke will likely experience residual impairments and functional limitations. Early assessment and a comprehensive examination are key to optimizing the rehabilitation of patients with stroke. Although a large quantity of both tests and measures and standardized outcome measures exist, few have tried to narrow these measures into the most commonly used. The purpose of this study was twofold: 1) Identify examination measures most consistently used by Neurologic Certified Specialists (NCS) physical therapists when evaluating a patient with chronic stroke and 2) Describe the most commonly used standardized outcome measures.

**Number of Subjects :** A convenience sample of 283 NCS therapists with email addresses available on the American Board of Physical Therapy Specialists website were surveyed.

**Materials/Methods :** Utilizing SurveyMonkey, a survey of 50 closed ended questions was designed consisting of tests and measures found in previous research. Using a vignette of a patient with chronic stroke and the scenario of an hour examination, NCS therapists were asked to indicate measures they would use by selecting a unit of time required to complete each measure.

**Results :** The survey response rate was 26.5% (n=75). Frequency data was utilized for each test and measure to identify the most commonly used. Top twenty measures ranged from 96% to 66.7%, with the top five consisting of Gait Speed: comfortable/normal, blood pressure, qualitative description of movement, ability to follow multistep commands and ankle reflex. Six outcomes measures were included in the top twenty: Gait Speed: comfortable/normal, Berg Balance Exam, Sit to Stand Tests, Modified Ashworth Scale, Timed Up and Go and Gait Speed: maximum/fast.

**Conclusions :** The results of this study identify significant variation within the top twenty most commonly used measures, ranging from very specific (ankle reflex) to general manual muscle tests. Overall, the results do suggest a shift towards the increased use of standardized measures. In this study, the frequency of standardized measures within the top twenty doubled compared to Andrews et al. These measures were consistent with those recently “recommended” or “highly recommended” by the StrokeEdge Task Force. Gait speed, recommended to be the new sixth vital sign, has now replaced blood pressure as the most frequently used measure and suggests that this finding has been adopted by NCS therapists. This shift towards the increased use of standardized measures may demonstrate an improvement in access to these measures and changes in requirements for documenting patient care to comply with insurance coverage. In conclusion, although general test and measures varied greatly, standardized measures use is increasing.

**Clinical Relevance :** The results of this study reinforce the importance of utilizing standardized outcome measures and demonstrates the shift to incorporate them into physical therapy practice.

**TITLE:** Muscle Activation of the Shoulder During a Home Exercise Program Designed to Reduce Shoulder Pain in Individuals with Paraplegia: A Case Study

**AUTHORS/INSTITUTIONS:** L. Riek, A. Claflin, K. Marshall, J. Russo, T. Rutan, C. Swinton, Nazareth College, Rochester, New York, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Shoulder impingement pain is prevalent in individuals with paraplegia due to high functional demands placed on the upper extremities. Exercises should selectively target specific muscles to decrease impingement risk while promoting function. Serratus anterior (SA) and lower trapezius (LT) are considered favorable in treating shoulder impingement through upwardly rotating, externally rotating and/or posteriorly tilting the scapula whereas activation of other muscles such as middle deltoid (MD), upper trapezius (UT), latissimus dorsi (LD) and pectoralis major (PM) may contribute to detrimental motions (scapular anterior tilting, humeral internal rotation and/or superior/anterior translation). The purpose of this case study was to biomechanically analyze the level of shoulder muscle activation in one individual with paraplegia during four exercises (two hypertrophy and two endurance) selected from the literature to reduce shoulder pain and maximize function. Hypotheses: Muscle activation levels will be higher during the hypertrophy versus endurance exercises. SA and LT activation will be adequate for strengthening during at least one exercise.

**Number of Subjects :** 48 year old female with T4-5 paraplegia, ASIA B, 12 years post SCI, without shoulder pain.

**Materials/Methods :** In a manual wheelchair, two hypertrophy exercises (Pull-down and External Rotation) and two endurance exercises (Dumbbell Scaption and Scapular Retraction) were completed at eight and 15-repetition maximum, respectively. Muscle activation was measured using Zero-Wire Multichannel Surface Electromyograph (Aurion) for six muscles (PM, MD, UT, LT, SA and LD), and normalized as a percentage of Maximum Voluntary Isometric Contraction (MVIC). MVIC >45% was considered adequate for strengthening.

**Results :** Muscle activation, represented as %MVIC, is listed from greatest to least. Hypertrophy: Pull-down: PM 56±4% SA 13±1% LD 11±3%, MD 5±.2% LT 5±1% UT 3±.5% External rotation: LT 48±7% LD 20±3% SA 16±2% MD 5±.5% UT 4±1% PM 4±.4% Endurance: Dumbbell scaption: LT 44±3% UT 38±6% MD 33±4% SA 15±1% PM 7±1% LD 4±.3% Scapular retraction: LT 36±7% LD 27±5% SA 23±3% UT 8±2% PM 5±1% MD 4±1%

**Conclusions :** Muscles were targeted as per exercise design for primary hypertrophy or endurance effect to meet functional demands. Specifically, only hypertrophy exercises (Pull-down and External Rotation) reached levels adequate for strengthening. However, favorable musculature may not be targeted with sufficient dosage to reduce impingement while detrimental musculature may be overemphasized. LT muscle activation was adequate for strengthening exclusively during shoulder external rotation. Although considered a key muscle to reduce impingement, SA muscle activation was <45% MVIC in all exercises.

**Clinical Relevance :** Biomechanical analysis of muscle activation during an established HEP is an essential first step in gaining knowledge to selectively target key musculature with the appropriate intensity to reduce symptoms of impingement and maximize function in persons with paraplegia.

**TITLE:** Effect of short-term, intensive rehabilitation in the chronic phase of stroke recovery on functional outcomes in rural Jamaica

**AUTHORS/INSTITUTIONS:** B.L. Boehnke, J.D. Chelette, L.E. Good, S.M. Lehman, C. Sheets, J.A. Feld, Department of Community and Family Medicine, Duke University School of Medicine, Durham, North Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The absolute number of strokes every year, number of stroke survivors and the overall global burden of stroke are significant and increasing over the last 2 decades. Little is known about short-term, intensive rehabilitation post stroke in underserved populations. This retrospective case series examines the impact of a 1-week, task-specific stroke rehabilitation program on functional outcomes in rural Jamaica.

**Number of Subjects :** Fourteen adults post-stroke (mean age= 64.2 years, M:F ratio 7:7, mean time post-stroke= 17.5 months) participated in a short-term, intensive, task-specific rehabilitation program in rural Jamaica in December of 2012 and 2013.

**Materials/Methods :** The rehabilitation program implemented over 5-days included outcome testing and intensive task-specific interventions. Functional outcomes included the 6-minute walk test (6MWT), Timed Up and Go (TUG), 10-meter walk (10mW), Berg Balance Scale (BBS) and Function Gait Assessment (FGA). The participants were provided 24-hours of intensive rehabilitation services via 45 minute stations focusing on upper extremity rehabilitation, gait and balance training, and targeted individual-specific intervention. A mat routine was performed daily incorporating position changes, stretching, motor control, and proprioceptive neuromuscular facilitation. Each day ended with a team building functional challenge. Pre- and post-measures were analyzed using paired Wilcoxin rank sum statistics.

Because patient specific balance measures were utilized, the scores were rescaled as a percentage and combined to assess the overall effect. Effect sizes were analyzed using the standardized effect size (SES) measure. Odds ratios for attaining the minimal detectable change (MDC) were performed using the 10mWT as the reference standard.

**Results :** All outcome measures displayed a statistically significant difference at follow-up ( $p < .05$ ). The SES for all measures ( $d = .32-.45$ ) suggests a small to moderate practical significance. Relative to the 10mWT, the odds of achieving the MDC were: BBS/FGA=.13, TUG=.84, 6MWT=.06.

**Conclusions :** Individuals in the chronic phase of stroke recovery are responsive to a short intensive task-specific rehabilitation program. They are more likely, with a week of intensive rehabilitation, to meet the MDC on the 10mWT and TUG than on balance or endurance measures. Lack of improvement on the 6MWT could be attributed to absence of specific endurance training throughout the camp. Limited improvements in the balance measures may have been due to the lack of endurance training as well as the need for a longer period of rehabilitation to improve balance. Short functional walking measures such as 10mWT and TUG seem to be more sensitive in detecting improvement in this population during short-term rehabilitation.

**Clinical Relevance :** A short, intensive, task-specific physical therapy rehabilitation program for individuals in the chronic phase of stroke recovery can have a significant impact on functional outcomes with clinically meaningful changes in gait speed and functional mobility.

**TITLE:** Walking Speed Reserve: Ability of the measure to identify fall risk in community-dwelling individuals with chronic stroke

**AUTHORS/INSTITUTIONS:** A. Middleton, S.L. Fritz, Exercise Science, University of South Carolina, Columbia, South Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to provide preliminary evidence on the relationship between walking speed reserve (WSR, difference between self-selected and maximal walking speeds) and fall-risk in individuals with chronic stroke. It is hypothesized that WSR will provide insight into fall risk in this population.

**Number of Subjects :** Sixty-eight individuals with chronic stroke

**Materials/Methods :** Participants were assessed at one time point. Berg Balance Scale scores (cut point < 45) were used to categorize participants as Fall Risk (FR) or No Fall Risk (NFR). Other measures administered were the 3 Meter Walk Test (3MWT) at self-selected and maximal WSs, Dynamic Gait Index (DGI), and Activities-specific Balance Confidence Scale (ABC). Mann-Whitney U tests were conducted for between group comparisons, and logistic regression (univariate and multivariate) was performed to examine the relationship between WSR and fall risk.

**Results :** Eighteen (26%) participants were classified as FR and 50 (74%) NFR based on BBS scores. Individuals in the FR group were significantly older ( $70.9 \pm 9.4$  compared to  $64.1 \pm 12.4$  years) and more chronic ( $7.3 \pm 5.8$  compared to  $5.1 \pm 3.0$  years) than the NFR group. WSR was significantly lower in the FR group compared to the NFR group ( $0.13 \pm 0.10$  versus  $0.28 \pm 0.13$ ). Logistic regression revealed an inverse relationship between WSR and fall risk ( $p < 0.001$ ). Even after adjusting for assistive device use and age (both of which differed significantly between groups), WSR remained a significant predictor of fall risk. WSR demonstrated a moderate to high correlation with the DGI (spearman's rho = 0.70) and a negligible correlation with the ABC (spearman's rho = 0.25).

**Conclusions :** WSR demonstrates predictive capabilities as a fall risk assessment tool for individuals with chronic stroke. Further research is needed to determine the measure's abilities to assess other domains and other populations.

**Clinical Relevance :** WSR may provide clinicians and researchers with a new tool for assessing fall risk in an at-risk population, community-dwelling individuals with chronic stroke.

**TITLE:** Beta Corticomuscular Coherence in Standing Balance for Young and Older Adults

**AUTHORS/INSTITUTIONS:** K.M. Kelly, J.V. Jacobs, G. Wu, Rehabilitation and Movement Sciences, University of Vermont, Burlington, Vermont, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Understanding mechanisms of balance impairments is essential for optimizing intervention in order to mitigate age-related falls and their consequences. Corticomuscular coherence (CMC) in the beta (13-30 Hz) frequency range represents the synchronization of afferent and efferent communication between the sensorimotor cortex and muscles during sustained muscle contractions and, thus, could provide insight into age-related changes in central neural communication during standing balance. Therefore, the aim of this study is to evaluate the differences in beta CMC between healthy young and healthy older adults during prolonged stance with eyes open (EO) and eyes closed (EC).

**Number of Subjects :** 10 subjects aged 20-29 yr; 11 subjects aged 65-93 yr; no reported neurological disorders or fall history.

**Materials/Methods :** Data were collected bilaterally from the tibialis anterior (TA) and lateral gastrocnemius muscles using surface electromyography (EMG) and from the cortex with focus on the sensorimotor cortex using electroencephalography (EEG). In narrow stance, subjects completed three 60-second trials each with EO and EC in a random order. CMC was computed between each muscle EMG and 41 EEG electrode sites. CMC peak magnitude (PM) and total area (A) above the significance threshold were analyzed. Two-way mixed-model ANOVA were performed to evaluate the effects of group and visual condition.

**Results :** No significant group or condition effects on CMC were found between muscles on the dominant leg and EEG sites ( $p > 0.05$ ). For CMC involving muscles of the non-dominant leg, younger adults exhibited greater PM and/or A than older adults between the TA and 1 fronto-central EEG site as well as between the gastrocnemius and 4 centro-parietal or fronto-central EEG sites. Both groups exhibited greater PM or A in EO than EC between the TA and 2 fronto-central EEG sites and between the gastrocnemius and 1 fronto-central EEG site. CMC between the non-dominant TA and the vertex EEG site decreased in PM from EO to EC for the younger adults, whereas it increased between conditions for the older adults.

**Conclusions :** Less efficient corticomuscular communication appears evident with older age despite no reported neurological disorders or difficulties with balance. Decreased CMC appears more evident in the non-dominant limb and with the gastrocnemius muscle. CMC also appears to be modulated by visual input, although its exact role is unclear.

**Clinical Relevance :** Beta CMC in prolonged stance may provide a novel, sensitive marker for identifying age-related changes in postural control prior to the onset of clinical impairments or falls. Further research should determine whether CMC parameters relate to other balance and fall risk measures and are reversible in response to balance training. Results suggest that proactive balance training may need to pay special attention to the non-dominant side and the plantarflexors.

**TITLE:** A kinematic analysis of gait in lower extremity dystonia: A single subject study design

**AUTHORS/INSTITUTIONS:** J. Callahan, J. Kneiss, Physical Therapy, MGH Institute of Health Professions, Boston, Massachusetts, UNITED STATES|H. Kirwan, C.L. Hancock, D.M. Scarborough, Orthopaedics, Mass General Orthopaedics Sports Performance Center, Foxboro, Massachusetts, UNITED STATES|N. Sharma, Neurology, Massachusetts General Hospital, Boston, Massachusetts, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose(s) of the present study were: 1) To describe the kinematics of gait in an individual with lower extremity dystonia. 2) To determine if a posterior leaf spring (PLS) orthotic improves the gait pattern in an individual with task specific lower extremity dystonia. 3) To gain insight into the association between sensory inputs and altered motor outputs in dystonic gait.

**Number of Subjects :** Single subject study design

**Materials/Methods :** A 69 year old female diagnosed with left lower extremity task specific dystonia ambulated through a motion capture area at her natural speed during two shod conditions: with (Free) and without a left PLS (PLS). Left lower extremity sagittal and frontal plane kinematics of the hip, knee and ankle were averaged across three trials for both conditions. Instrumentation: 3D motion analysis data was collected with 22 MX T-series cameras (Vicon, Corp) at 100 Hz synchronized with five Bertec force plates collecting at 1,000 Hz. The camera system tracked 51 reflective markers attached to the subject. Visual 3D (C-Motion) software was used for kinematic calculations utilizing the International Society of Biomechanic's joint coordinate system.

**Results :** Kinematic data indicate that gait with and without the PLS differs at toe-off and during swing phase yet are similar throughout stance phase. In the sagittal plane, hip extension normalizes at pre-swing and ankle plantarflexion normalizes at initial swing toward expected normal values in the PLS condition. In the frontal plane, the ankle, hip and knee all achieve expected normal values during mid-swing. The PLS condition thus demonstrates greater symmetry and normalization of the left ankle, knee and hip movements in the sagittal and frontal planes.

**Conclusions :** This case illustrates how the use of a PLS improved gait kinematics in an individual with lower extremity dystonia. It is possible that the PLS, by altering tibial progression during stance phase effectively changes the sensory cues used by the central nervous system to initiate swing phase resulting in a different motor output. The increase in ankle plantarflexion and improved symmetry and other joint kinematics in the PLS condition supports the notion that the PLS is facilitating the gait pattern and is not restricting movement at the ankle.

**Clinical Relevance :** This biomechanical analysis of gait in an individual with lower extremity dystonia provides a more comprehensive understanding of the relationship between sensory inputs and motor outputs as they relate to walking in individuals with dystonia. Delineating the way in which manipulation of sensory inputs contributes to a more normalized motor output could contribute to novel management strategies for individuals with LE task specific dystonia.

**TITLE:** Incidence of Polypharmacy in the Spinal Cord Injury Population

**AUTHORS/INSTITUTIONS:** P. Kitzman, J. Hatton-Kolpek, University of Kentucky, Lexington, Kentucky, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to examine the overall prevalence of polypharmacy (5 or more concomitant medications) within the spinal cord injury (SCI) population, the level of polypharmacy with respect to seven classes of high risk drugs commonly used to treat secondary conditions in the SCI population, and the overall risks for drug-related problems (DRP) related to polypharmacy.

**Number of Subjects :** Individuals with tetraplegia, paraplegia, and those with SCI but not specified as either tetraplegia or paraplegia as There were 13,160 individuals with SCI in this dataset of which 7399 (56%) met the criteria for polypharmacy. Of the 7399 individuals in the SCI study group, 2533 were classified as having tetraplegia, 3095 as having paraplegia, and 1771 as unspecified SCI. In addition to the SCI cohort, a control population of randomly selected, gender matched, individuals without a diagnosis of SCI was examined. There were 13,148 individuals in the control group of which 3537 (27%) met the criteria for polypharmacy.

**Materials/Methods :** This was a retrospective analysis of a commercially available claims dataset that included patient cases from 4,800 hospitals in the United State between 2007 and 2009. Outcome measures included the overall prevalence of polypharmacy, the prevalence of commonly prescribed high risk medications, and the prevalence of reported DRPs. Drug related problems were defined using the Supplementary Classification of External Causes of Injury and Poisoning Codes (E Codes) found in the ICD-9-CM. The seven classes of medications that the present study focused on as “high risk” combinations, based on their potential for overlapping effects that could lead to drug-related problems, included: 1) sedative-hypnotic, non-barbiturates, 2) anti-anxiety, 3) serotonergic system agents, 4) analgesics-narcotic, 5) anticonvulsants, 6) skeletal muscle relaxants, and 7) tricyclic antidepressants.

**Results :** Overall the patients in the SCI population were prescribed significantly more medications than their control counterparts. In addition, the SCI group had a higher prevalence of individuals prescribed medications from multiple “high risk” classes (e.g. analgesic-narcotics, anticonvulsant, anti-depressant, and skeletal muscle relaxers), as well as multiple medications within each class (e.g. multiple analgesic-narcotics). The SCI group had a higher incidence of DRPs compared to the control group.

**Conclusions :** The results of the current study are some of the first to demonstrate the extent of polypharmacy in the SCI population, as well as the prevalence of several commonly prescribed classes of medications, and rates of DPRs in this population.

**Clinical Relevance :** The high rate of polypharmacy and DPRs in the SCI population can impact rehabilitation goals and long-term health and healthcare in this population. Therefore, polypharmacy needs to be recognized and discussed by both the healthcare providers as well as the patients they serve.

**TITLE:** Non-Surgical and Non-Pharmacologic Interventions for Cervical Dystonia: A Systematic Review

**AUTHORS/INSTITUTIONS:** J. Callahan, S.S. Shrotri, S.N. Raje, M. Beninato, Physical Therapy, MGH Institute of Health Professions, Boston, Massachusetts, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To conduct a systematic review of the literature 1) To evaluate the quality of evidence for non-surgical and non-pharmacological treatment approaches for cervical dystonia and 2) To assess the effectiveness of these interventions in enhancing patient care.

**Number of Subjects :** 10 Studies were included in the final analysis

**Materials/Methods :** MEDLINE, CINAHL, PsycINFO and PEDro databases were searched from January 1996 through July 2013 using the following keywords: “Dystonia”, “Dystonic Disorders”, “Cervical Dystonia”, “Torticollis”, “Primary Dystonia”, “Secondary Dystonia”, Focal Dystonia, “thera\*”, “Rehabilitation. Studies were included at all Sackett’s levels of evidence if the study population consisted of patients diagnosed with focal cervical dystonia of either primary or secondary etiology, with childhood or adult onset and if they employed non-surgical and/or non-pharmacological techniques alone or in combination with surgical and pharmacological techniques for the treatment of cervical dystonia. Studies were excluded if the study population consisted of patients with generalized dystonia, torticollis of muscular origin or if interventions were solely psychologically or behaviorally based. The quality of the selected papers was assessed using the Sackett’s levels of evidence and the Structured Effectiveness Quality Evaluation Scale (SEQES) by two reviewers after establishing inter-rater reliability.

**Results :** 1458 unduplicated studies were identified, of which 17 studies appeared to meet inclusion criteria based on their titles and abstracts. After full text analysis ten studies that met inclusion and exclusion criteria were included in the final review. Of these ten studies, one was a randomized control trial and five were single case studies. Sackett’s levels of evidence ranges from 2b to 5 and SEQES scores ranged from 7 to 38.

**Conclusions :** The best available evidence suggests that Physical Therapy in adjunct to Botox may reduce pain, disability and improve quality of life compared with Botox alone. Physical Therapy may also increase the duration of effectiveness of Botox, and reduce the dose required for a therapeutic effect. A need for methodologically rigorous lower level studies exists given the rare nature of cervical dystonia. Ideally, future studies should include multisite randomized control trials to determine the effective of non-pharmacological and non-surgical treatments of cervical dystonia

**Clinical Relevance :** Currently, the first line treatment for cervical dystonia involves pharmacological or surgical interventions. Although effective, these interventions possess risks and side effects that limit their utility in certain individuals. Thus, adjunctive physical therapy may enhance the effects of these first line medical treatments, particularly botox in the treatment of people with cervical dystonia.

**TITLE:** Retraining Anticipatory Postural Adjustments in People with Moderate Traumatic Brain Injury: A Case Series  
**AUTHORS/INSTITUTIONS:** S. Ryerson, D. Nichols, Research, Medstar National Rehabilitation Hospital, Washington, District of Columbia, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** The ability to recruit postural responses that allow us to maintain balance during the performance of daily activities is essential to avoid falls and potential injury. These postural responses, anticipatory postural adjustments (APAs), occur in response to both internal (limb movement) and external (receiving or delivering impetus) perturbations. Their purpose is to maintain upright posture by counteracting the destabilizing effects of extremity movements. While mechanisms that modify APAs are well documented, there are few descriptions of intervention protocols to retrain this postural response. This case series describes a clinical intervention protocol used to improve the anticipatory postural responses in people with traumatic brain injury (TBI). The aims of this case series were to: 1. determine the effectiveness of an APA intervention protocol , 2. measure changes in APA responses with force plate and clinical measures, and 3. assess the feasibility and safety of this intervention protocol.

**Case Description :** Four individuals, between 1 and 3 years post-TBI participated in 12 intervention sessions of physical therapy. The intervention protocol stressed five features that are known to modify APAs: speed and direction of extremity movement, catching/dropping loads, initial body geometry, and absence of touch support. Outcomes were measured at baseline, immediately post-intervention, and at a 6-week follow up. Ground reaction forces during step initiation were recorded to assess anticipatory postural adjustments (APA), step characteristics for voluntary stepping conditions, and settling time. The displacement of the net center of pressure (Cop) was calculated to determine the APA characteristics. The MiniBEST test was used as a clinical measure of balance

**Outcomes :** The four individuals completed all phases of the case series. Three of the four subjects with no APA present pre-treatment, showed the emergence of an APA post -treatment. Improvements in step time and settling time occurred in two of the four subjects. MiniBEST test scores remained unchanged.

**Discussion :** This case series was an initial effort to create and determine the feasibility of implementing a protocol for retraining APA's. It is limited by the lack of a control group. Specific retraining of APAs has the potential to change balance training not only for individuals with traumatic brain injury, but also for people with other central nervous system health conditions and for the general elderly population.

**TITLE:** Use of an Activity Monitor to Promote Increased Stepping Activity in People with Stroke: A Case Series  
**AUTHORS/INSTITUTIONS:** G.D. Fulk, Physical Therapy, Clarkson University, Potsdam, New York, UNITED STATES|S.A. Combs-Miller, Krannert School of Physical Therapy, University of Indianapolis, Indianapolis, Indiana, UNITED STATES|K.A. Danks, D. Reisman, Physical Therapy, University of Delaware, Newark, Delaware, UNITED STATES|C.D. Nirider, Physical Therapy, Touchstone Neurorecovery Center, Conroe, Texas, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** People with chronic stroke report low levels of physical activity. Novel methods are needed to support and promote increased physical activity to improve overall health. The purpose of this case series was to explore if people with chronic stroke could consistently wear an activity monitor that provides feedback on stepping activity to increase daily stepping activity over a 4-week period.

**Case Description :** 5 people with chronic stroke (mean time post stroke: 46.6 months, mean gait speed: 0.87 m/s) participated. Using the Readiness to Change Questionnaire 3 participants were classified in the Maintenance stage, 1 in the Preparation stage, and 1 in the Contemplation stage. Participants wore a Fitbit activity monitor for one week to determine baseline stepping activity. After the baseline week researchers reviewed the stepping activity with the participants and developed 2-week (increase by an average of 250 steps/day) and 4-week goals (increase by an average of 500 steps/day). Researchers strategized with participants on individualized methods to overcome barriers to increase stepping activity. Participants could receive immediate feedback on stepping activity by viewing the Fitbit. They could also receive feedback on daily and weekly stepping activity, progress towards goals, and digital communication from the researchers using the Fitbit website.

**Outcomes :** All participants wore the activity monitor on a daily basis for 4 weeks. 2 of the participants classified in the Maintenance stage met their 2-week goals but did not meet their 4-week goals. For one of these participants, daily stepping activity changed from 2,404 steps/day during the baseline week to 2,778 steps/day at 2 weeks to 2,143 steps/day at 4 weeks. For the other participant, daily stepping activity changed from 1,727 steps/day during the baseline week to 2,181 steps/day at 2 weeks to 2,185 steps/day at 4 weeks. The other participant in the Maintenance stage did not meet the 2-week or 4-week goals. Daily stepping activity for this participant was 2,119 steps/day during the baseline week compared to 2,093 steps/day at 2 weeks and 2,046 steps/day at 4 weeks. The participant classified in the Preparation stage met the 2-week and 4-week goals. Average daily stepping activity for this participant increased from 6,918 steps/day during the baseline week to 7,416 steps/day at 2 weeks to 7,666 steps/day at 4 weeks. The participant classified in the Contemplation stage met the 2-week and 4-week goals. Average daily stepping activity for this participant increased from 1,027 steps/day during the baseline week to 1,760 steps/day at 2 weeks to 1,665 steps/day at 4 weeks.

**Discussion :** Participants were able to consistently wear and use an activity monitor on a daily basis over a 4-week period. Participants were inconsistent in their ability to increase daily stepping activity. Further development is needed to tailor the use of the activity monitor to support the individual needs of people with stroke to promote increased walking activity.

**TITLE:** Rural Baseline Concussion Screening Implementation

**AUTHORS/INSTITUTIONS:** S. Bobula, Physical Therapy Dept, Pinon Health Center, Indian Health Service, PO Box 10, Pinon, Arizona, UNITED STATES|

**ABSTRACT BODY:**

**Purpose :** Popularity of concussion education and evidence-based management has grown nationwide while in remote settings there remains a void in this aspect of healthcare. There is currently one Vestibular Physical Therapist and few primary care providers comfortable with treating concussions in the Chinle Service Unit and Hopi Nation serving approximately 50,000 residents. Historically, youth concussions have not been reported and about 3 referrals would be placed to Physical Therapy (PT) annually, primarily concerning headaches and neck pain.

**Description :** School and provider education was heavily promoted at the local high school and health care facility during the 2013-2014 academic year. A baseline concussion screening protocol was established by PT and conducted at the school. Screening included the SCAT3 or ChildSCAT3, Dynamic Visual Acuity, Convergence, and the full BESS Tests, which in total took 15 to 20 minutes per student. One PT blocked 4 hours a week over 15 weeks, removing her from clinic. In this time, baseline screens were performed on 112 student athletes (66 males and 46 females) through coordination with the Athletic Director. Each screen was entered into the student's electronic health record for future reference as needed using a fillable template to minimize documentation time. There were several barriers to overcome, including the timing of pulling students from class to minimize turn-around time as well as time away from class. A second barrier was that rosters were not generated long before the season and some baselines were performed after the season had started so true preseason baselines were not feasible in this pilot. This was addressed by coordinating between the clinic and school so baseline screens are performed over the summer when students have their annual physicals performed by a provider. A third barrier of repeatedly pulling the same students when baselines were already performed was overcome by providing the school with a weekly updated alphabetical list of students who completed testing.

**Summary of Use :** Eleven students reported a history of head injuries and 7 were referred and treated for sport-related concussions during the school year. Our baseline concussion screening protocol, in collaboration with providers and the school, has resulted in more than doubled referrals to PT for concussion management although our reported number of head injuries remains skeptically low. Our population also reported more baseline symptoms than published norms, an average of 5.63 +/-5.45 symptoms of a 21 item list per student at a severity of 9.35 +/- 11.03 when a severity of 7 is commonly used as a return to sport cut-off. This data helped providers and PT adjust expectations when known pre-existing complaints existed.

**Importance to Members:** Low cost and informative baseline concussion screens can be implemented in the rural setting, especially in coordination with the school. Baseline screening may be a catalyst in education for community members and providers to maximize evidence-based practice in any setting.

**TITLE:** Effect of Varying the Administration of Tandem and Single Limb Stance Items of the Berg Balance Scale in Community-Dwelling Persons with Stroke

**AUTHORS/INSTITUTIONS:** J.H. Kahn, M. Bach, B. Hermes, R. Lum, R. Nelson, L. Rudenburg, L. Hedman, Northwestern University, Chicago, Illinois, UNITED STATES|D.D. Straube, American Physical Therapy Association, Fennville, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Instructions for the Berg Balance Scale (BBS) administration allow patients to choose how they wish to position their lower limbs for item 13, tandem stance, and which leg they wish to stand on for item 14, single limb stance (SLS). Given the nature of hemiparesis, these choices could change the overall BBS score. The purpose of this study is to determine if modifying the administration of items 13 and 14 of the BBS will alter the total BBS score in subjects with chronic stroke.

**Number of Subjects :** 20 community-dwelling individuals with chronic hemiparetic stroke; 13 male; 7 female; 42-84 (59.6) years old; 9-52 (24.05) months post-stroke.

**Materials/Methods :** Subjects were contacted through a non-public research registry. During BBS administration, subjects were asked to perform items 13 and 14 twice. Initially, subjects performed tandem stance with a self-selected position of their limbs and SLS with their self-selected limb. For the second trial, they were asked to switch their feet position in tandem stance and stand on the opposite limb for SLS. Statistical comparison of BBS scores was performed using a Wilcoxon Signed Rank test.

**Results :** 14 subjects self-selected to place the uninvolved limb in the posterior position for item 13 (UNPos) and 19 subjects self-selected to stand on the uninvolved limb for item 14 (UNSLs). The remaining subjects self selected to place the involved limb in the posterior position (INPos) and stand on the involved limb (INSLs). There was a statistically significant difference in the mean total BBS scores when subjects performed items 13 and 14 using INPos and INSLs (44.10) versus UNPos and UNSLS (46.30) ( $p = .000$ ). There was no significant difference for item 13 mean scores between the INPos (2.40) and UNPos (2.80) ( $p = .163$ ). There was a statistically significant difference in the means for item 14 for INSLs (1.10) and UNSLS (2.80) ( $p = .001$ ).

**Conclusions :** The difference in total BBS scores between the 2 conditions suggests that varying the administration of items 13 and 14 may have an effect on the interpretation of BBS score and fall risk in persons with chronic stroke. The difference approximated the minimum detectable change for chronic stroke on the BBS. Additionally, the mean total BBS score was below the cutoff score for fall risk when testing items 13 and 14 using INPos and INSLs and above the same cutoff point using UNPos and UNSLS. The difference in BBS score between the conditions may be more related to INSLs versus INPos.

**Clinical Relevance :** The study results suggest that the total BBS will provide a more accurate assessment of balance deficits and fall risk if patients perform the BBS using INPos and INSLs for tandem and single limb stance. Testing patients under both conditions may be helpful to a therapist's understanding of how the hemiparetic side contributes to overall balance impairments.

**TITLE:** The Effectiveness of Weight Shift Training on Balance in a Patient with a Chronic Stroke

**AUTHORS/INSTITUTIONS:** M. Taylor, C. Deiter, E. Judkins, M. Naumann, K. Schulz, University of Mary, Bismarck, North Dakota, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** The NeuroCom Balance Master® is a force platform system with visual feedback. This equipment has been proven to be an effective assessment and treatment tool for patients following a stroke. However, many physical therapy facilities are unable to afford such equipment. The purpose of this case report was to evaluate the effectiveness of various weight shift activities without the use of visual feedback that replicated the movements of NeuroCom® tests on functional balance and mobility, weight bearing distribution, and postural control measures in a patient with a chronic stroke.

**Case Description :** The patient was a 59 year old male who had a right sided hemorrhagic stroke approximately 12 months prior and documented balance and mobility impairments. He ambulated short distances with a quad cane and assist of one person and had a history of falls. The patient participated in a 6 week balance training program (3 times per week for 30 min) with interventions that closely replicated the movements of the NeuroCom® tests and encouraged the patient to shift weight onto his left side during functional activities that included sit to stands, weight shift training, step ups, and gait training. The patient's weight bearing distribution and postural control were evaluated using three NeuroCom® measures (sit to stand, rhythmic weight shift, limits of stability), as well as functional balance and mobility were assessed with the Timed Up and Go Test (TUG) and self-selected gait speed (10 Meter Walk Test) pre and post-intervention.

**Outcomes :** The following measures improved (pre to post-intervention): ability to complete a sit to stand, change the direction and speed at which he shifted his weight (rhythmic weight shift), ability to shift weight out of his base of support (limits of stability), and TUG. The greatest changes were noted in directional control during the limits of stability test (28%), on-axis velocity during the rhythmic weight shift test (59%), and TUG (115 sec to 73 sec; 36%). The patient was not able to complete the sit to stand independently pre-intervention. However, he was able to complete the sit to stand independently post-intervention with 14% more weight on his right side, which is close to the normal range. A small improvement was noted in the patient's self-selected gait speed (0.18 m/sec to 0.19 m/sec), but it did not show a clinically meaningful change. The 36% change in the TUG is a significant improvement for the stroke population.

**Discussion :** The results show an overall improvement in functional balance and mobility, weight bearing distribution, and postural control as well as a decreased risk for falls for the patient in a relatively short period of time. The results of this case study illustrate that a weight shift training program without the use of visual feedback and a force platform may have the potential to show improvements in overall balance and mobility in patients with chronic stroke. Additional research is needed to better validate our findings for this population.

**TITLE:** Novice versus Experienced Rater Reliability of the Mini Balance Evaluation Systems Test (Mini-BESTest) in Patients with Acquired Brain Injury (ABI)

**AUTHORS/INSTITUTIONS:** R.M. Patel, D. Linzer, C.E. Maqueda, M. Williams, School of Physical Therapy, Texas Woman's University, Houston, Texas, UNITED STATES|L. Cox, Physical Therapy, Mentis Neuro Rehabilitation, Houston, Texas, UNITED STATES|M. Dent, University of Texas MD Anderson Cancer Center, Houston, Texas, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Individuals who sustain an acquired brain injury (ABI) often have many functional deficits including impaired balance. Currently there is no gold standard for assessing balance in individuals with ABI. Many balance measures have been shown to have a ceiling effect and inconsistent reliability results when completed by a novice physical therapist versus an experienced physical therapist. Thus, the purpose of this study was to examine novice versus experienced rater's inter-rater and test-retest reliability when scoring the Mini-BESTest in patients with ABI. The hypothesis were as follows: 1) There will be a significant ( $p < .05$ ) Pearson's correlation ( $r > .8$ ) to demonstrate test-retest reliability, 2) There will be a significant ( $p < .05$ ) intraclass correlation coefficient ( $ICC > .8$ ) to demonstrate inter-rater reliability.

**Number of Subjects :** 25

**Materials/Methods :** A prospective, single group observational measurement study was completed using a convenience sample of participants who met specific inclusion and exclusion criteria. While completing the Mini-BESTest, participants were video recorded by one test-administrator who was not a rater. 1) Inter-rater reliability was tested using 4 raters (2 novice, 2 experienced) who simultaneously and independently rated performance from the same angle. All raters were blinded to others' scores. 2) Test-retest reliability was tested using 3 raters (2 novice, 1 experienced) who independently viewed video recordings ~ 4 weeks later in random order. All raters were blinded to their own scores and others' scores.

**Results :** There was an excellent degree of correspondence and agreement of ratings between and among novice and experienced raters when scoring the Mini-BESTest. There was a significant intraclass correlation coefficient ( $p < .001$ ) demonstrating excellent inter-rater reliability, and a significant Pearson's correlation ( $p < .001$ ) demonstrating high test-retest reliability among all raters. In addition, novice raters demonstrated slightly higher test-retest reliability ( $r=.953$ ) than the experienced raters ( $r=.933$ ).

**Conclusions :** Both novice and experienced raters demonstrated excellent inter-rater and test-retest reliability when rating individuals with an ABI using the Mini-BESTest.

**Clinical Relevance :** The Mini-BESTest is a reliable tool to assess balance deficits in 4 specific constructs. It can be used by both novice and experienced physical therapists to examine various systems contributing to postural control and to guide interventions for the impaired systems.

**TITLE:** The development of clinical decision making algorithms for management of Lateral Canal Benign Paroxysmal Positional Vertigo (LC BPPV)

**AUTHORS/INSTITUTIONS:** A.K. Galgon, Physical Therapy, Temple University, Philadelphia, Pennsylvania, UNITED STATES|A.R. Tate, M. Fitzpatrick, Physical Therapy, Willow Grove Physical Therapy, Willow Grove, Pennsylvania, UNITED STATES|W.W. Schoenewald, Physical Therapy, WWS Physical Therapy & Associates, Doylestown, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose :** To review the evidence for interventions for lateral canal LC BPPV and present two therapeutic management approaches.

**Description :** The recent development of new maneuvers for LC BPPV may be explained by less than optimal outcomes from any one maneuver. Of the multiple procedures described two types of maneuvers show higher efficacy. Studies show that sidelying head rotation maneuvers resolves 62-90% of geotropic and 40-78% of apogeotropic cases and body roll maneuvers resolve 38-88% of geotropic and 50-70% of apogeotropic cases. Difficulty in determining side of involvement and different pathophysiology underlying the variants may hinder diagnostic accuracy and therapeutic efficacy. The literature suggests that unlike posterior canal BPPV, a single maneuver will not resolve all variants of LC BPPV. As a result two therapeutic approaches were designed, which consider the location and movement of otoconia during maneuvers. The first approach uses a body roll approach to treat all forms of LC BPPV (log roll for the geotropic form and a modified log roll with vibration for the apogeotropic form). The second approach uses sidelying and head rotation maneuvers for all forms. The direction of sidelying and head rotation movements are determined from diagnosis and presumed location of the otoconia. Both algorithms use patient response and careful observation of nystagmus during maneuvers and in post maneuver positional testing to determine subsequent maneuvers, if resolution does not occur.

**Summary of Use :** Clinicians from two private practices that specialize in vestibular rehabilitation provided input on current treatment practices and were advised on development of additional approaches. The clinicians then received further training on pathophysiology and diagnosis of LC BPPV and the two therapeutic approaches as part of an ongoing study of the management of LC BPPV. Utilization of the approaches was adopted in November 2013 in one practice and February 2014 in the second. Each approach has advantages and limitations related to patient characteristics and the level of experience of the clinician. For example, the first approach requires fewer clinical decision choices and may be easier for less experienced clinicians to follow, and the second approach may be physically easier to perform on patients with poor mobility.

**Importance to Members:** High variability in the management of LC BPPV in both diagnostic and intervention methods has been reported in the literature and at our clinical sites. Physical Therapists appear to be less efficient in resolving LC BPPV. Clinical decision making algorithms provide standardization of practice and better care by reducing uncertainty. Algorithms also help educate novice clinicians. Additionally, algorithms become the framework for testing hypotheses and developing better evidence for practice. The long term outcome of this work will be to develop a single algorithm from our clinicians' experiences and results of our current study examining these approaches.

**TITLE:** Utilization of the Coma Recovery Scale-Revised in Clinical Decision Making in the Intensive Care Unit  
**AUTHORS/INSTITUTIONS:** R. Cole, C.L. Szot, A.L. De Joya, TIRR Memorial Hermann, Houston, Texas, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** The Coma Recovery Scale-Revised (CRS-R) is a behavioral assessment tool that can be used for diagnostic classification and treatment planning in patients who are experiencing a disorder of consciousness (DOC). Its reliability and validity have been studied in inpatient rehabilitation settings, however little evidence exists regarding its psychometric properties and application in acute care settings. The purpose of this case report is to describe how the CRS-R was used in clinical decision making to assist in diagnostic classification and discharge planning for an individual with a traumatic brain injury (TBI) in the intensive care unit (ICU).

**Case Description :** The subject of this case report is a 28 year old woman who sustained a TBI after an auto-pedestrian accident with a Glasgow Coma Scale score of 10 at the scene and 9 in the emergency department. The patient was assessed using the CRS-R at initial physical therapy evaluation and 24 hours later in a neuro-trauma ICU.

**Outcomes :** At initial assessment, the patient scored 9/23 with the following subscale scores: auditory function: 3/4, visual function: 2/5, motor function: 2/6, oromotor/verbal function: 1/3, communication: 0/2, arousal: 1/3 scale. Upon assessment 24 hours later, the patient scored 13/23 with the following subscale scores: auditory function: 4/4, visual function: 4/5, motor function: 2/6, oromotor /verbal function: 1/3, communication: 0/2, arousal: 2/3. Based on the patient's demonstration of minimally conscious state on the auditory and visual function subscales on both assessments, the physical therapist recommended in-patient rehabilitation as the patient's next level of care upon discharge from the hospital.

**Discussion :** Research has shown that up to 43% of patients who are experiencing a DOC are misdiagnosed as being in a vegetative state when a clinical consensus diagnosis is made based on non-standardized patient assessments. This has important implications for accurate diagnosis and appropriate discharge planning for those who are experiencing a DOC in an ICU. The results of this case report indicate that the CRS-R can provide useful information to rehabilitation professionals in clinical decisions regarding discharge location. Future studies should be conducted to examine the reliability, validity, and feasibility of the CRS-R in the acute care setting, including the ICU.

**TITLE:** Outcomes of BTX-A for equinovarus deformity in patients with CVA: A case series

**AUTHORS/INSTITUTIONS:** P. Karakkattil, Baylor Institute for Rehabilitation, Frisco, Texas, UNITED STATES|E. Trudelle-Jackson, H. Brown, P. Hammontree, M. Okolo, Texas Woman's University, Dallas, Texas, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** There is evidence that Botulinum Toxin- A (BTX-A) reduces focal spasticity associated with equinovarus deformity to improve gait in patients post stroke. However there is little research examining whether gait improvements are maintained after the effectiveness period of BTX-A injections. The purpose of our study was to determine whether there is a difference in gait parameters before BTX-A injection versus four and ten weeks after.

**Case Description :** Participants A, B, C, (three women, ages: 63, 60, and 42) post ischemic stroke with hemiparesis and equinovarus who received BTX-A injections for management of spasticity participated in this study. Participants underwent measurements for: plantar flexor spasticity using Modified Ashworth Scale (MAS), ankle dorsiflexion passive range of motion (PROM), temporospatial gait parameters using GAITRite (gait velocity, cadence, base of support(BOS),and step symmetry), and gait endurance using 6 minutes walk test(6MWT) before receiving BTX-A injections, 4 weeks after and 10 weeks after. Participants A and B received physical therapy while Participant C did not.

**Outcomes :** Spasticity: All participants had reduced spasticity at week 4, but spasticity returned in participants A and C by 10 weeks, while participant B maintained the MAS score at week 10. All participants improved in ankle PROM, by 4 weeks, but similar to spasticity measurements the improvements in PROM were returned close to baseline at 10 weeks for participants A and C. Only participants A and B, who received physical therapy during the study showed modest gains in gait velocity, cadence, and gait endurance, while Participant C did not improve at all. BOS and step length symmetry ratios did not improve following injections for all three participants.

**Discussion :** Although BTX-A injections improved spasticity, this improvement did not translate to gait outcomes. Addition of physical therapy interventions appeared to improve gait outcomes in this case series. We suggest future randomized control studies to compare effects of BTX-A to BTX-A combined with physical therapy on gait outcomes.

**TITLE:** The Effects of Dry Needling on Spasticity and Range of Motion in Two Children

**AUTHORS/INSTITUTIONS:** R.M. Maher, Physical Therapy, Shenandoah University, Winchester, Virginia, UNITED STATES|D.M. Hayes, Oncology Quality & Accreditation, Northside Hospital Cancer Institute, Atlanta, Georgia, UNITED STATES|T.L. Millard, Physical Therapy, University of North Georgia, Dahlonega, Georgia, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Spasticity can impose severe limitations on movement and on rehabilitative outcomes. Conventional methods used to assess muscle tone are based on manual subjective tests which assess the quality of motion. Ultrasound shear wave imaging (SWE) utilizes Young's modulus (kPa) to quantify the stiffness of tissue. The shear wave propagation through the tissue is captured in real time with an ultrafast ultrasound scanner acquiring up to 20,000 images per second which results in a color coded map depicting the stiffness. This case study used shear wave imaging (SWE) technology to visualize the hypertonicity/stiffness associated with spasticity and to determine if dry needling had an effect on associated range of motion deficits in the upper and lower extremities of two pediatric patients.

**Case Description :** Two male children ages 4 (acquired brain injury) and 10 (cerebral palsy) were recruited for this study. Both children were taking oral Baclofen. Baseline and post dry needling data were acquired for the following: Tardieu scale, shear wave elastography (SWE) and range of motion at the knee, elbow and wrist. Regions of interest (ROI) were selected within the semimembranosus, biceps brachii and flexor carpi radialis muscles based on palpable tone. The ROI were marked on the skin and the ultrasound transducer was placed in a sagittal plane over each ROI as images were acquired with the subjects in supine with the elbow flexed to 90° and the hip and knee flexed to 90°. All ROM was assessed with a goniometer. Dry needling interventions used solid filament needles with guide tubes (0.20mm x 25mm).

**Outcomes :** SWE showed muscle stiffness decreased and the effect was evident upon palpation. Significance was noted for R1 ( $p=0.002$ ;  $p=0.04$ ) for Case 1 and 2 and R2 ( $p=0.03$ ;  $p=0.07$ ) for Case 1 respectively. Both cases demonstrated sustained positive effects up to six days.

**Discussion :** Spasticity and abnormal muscle tone contribute to both the impairment of function and reduced longitudinal muscle growth in children with brain injury. Successful rehabilitative outcomes for children with spasticity are highly correlated with available range of motion. Dry needling is an inexpensive intervention when compared to other interventions and the effects are immediate. This study showed that dry needling had an effect on the range of motion associated with the "catch" in the Tardieu test suggesting that the threshold to elicit the stretch reflex or "catch" was modulated by the intervention. Both subjects presented with reductions in muscle stiffness and improvements in resting muscle length and exhibited increased volitional motion at each joint post treatment which persisted for several days. Further studies are warranted on a larger population in addition to follow up studies to determine the longevity of the effects of dry needling and the mechanism of action in individuals with spasticity. We believe this is the first study to look at dry needling as an intervention for spasticity while using SWE technology to assess its stiffness.

**TITLE:** Measuring effect of an alternative manual therapy on standing balance as measured by computerized posturography

**AUTHORS/INSTITUTIONS:** M.L. Behrens, Outpatient Therapy Services, Memorial Hospital, South Bend, Indiana, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Patients with vestibular migraine are often referred to physical therapy clinics specializing in vestibular rehabilitation. Common therapeutic approaches to vestibular rehabilitation therapy (VRT) include: educating patients to identify possible triggers (dietary, visual, hormonal) for the headache/spells of vertigo, improving body awareness, decreasing dependence on vision for postural control, improving eye/head coordination, tolerance of complex visual environments, as well as improving postural control. An alternative approach that can be a useful tool in VRT and balance training is Zero Balancing, a type of manual therapy used by some practitioners to treat a variety of conditions, as well as promote wellness. Zero Balancing uses manual pressure at points along the bones, and therefore may improve body awareness. In this case study, Zero Balancing was used with the expectation that the intervention would have a positive effect on postural control as measured with computerized posturography, with a secondary positive effect on head pressure.

**Case Description :** A 67 year old male with a history of vestibular hypofunction secondary to vestibular migraine came to PT with complaints of balance impairment and fear of falling. He had been through a course of VRT of 10 visits over 19 weeks at another facility with little progress in his balance, although his dizziness and severity of migraine headache improved. Therapy notes at discharge from the first clinic indicated a 6 point improved Sensory Organization Test (SOT) score, under the 7 point minimal clinically significant score mark. For this round of therapy, the initial SOT score, was in the 47th percentile, well below age matched norm of 70, with significant impairment using vestibular input for postural control. Treatment consisted of manual therapy using a Zero Balancing approach in 7 sessions over 9 weeks.

**Outcomes :** After 9 weeks, the SOT score improved by 20 points, to the aged norm. Patient reported feeling confident with walking, and head pressure that was experienced for several years was resolved.

**Discussion :** These findings suggest that Zero Balancing, may be a helpful part of a physical therapy program to treat vestibular migraine. A number of plausible explanations exist to explain the rationale for using Zero Balancing with VRT using traditional physiologic mechanisms. One explanation is that the manual therapy increases parasympathetic nervous system activity which allows for improved vascularization to the labyrinth. The tactile pressure to the bones of the limbs and spine may improve body awareness, and overall stability. Alternately, the manual therapy intervention may reduce anxiety which has high co-morbidity with migraine symptoms and thereby reduce vestibular symptoms.

**TITLE:** Considerations for treatment planning with upper-extremity robotic training in chronic stroke.

**AUTHORS/INSTITUTIONS:** C. Massie, Occupational Therapy, Indiana University, Indianapolis, Indiana, UNITED STATES|Y. Du, University of Maryland, College Park, Maryland, UNITED STATES|S. Conroy, Veterans Affairs, Baltimore, Maryland, UNITED STATES|G.F. Wittenberg, C. Bever, Neurology, University of Maryland, Baltimore, Maryland, UNITED STATES|J. Whittall, Physical Therapy and Rehabilitation Science, University of Maryland, Baltimore, Maryland, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Robotic interventions have been studied as a treatment for chronic upper-extremity deficits from stroke, yet clinical results are often limited [1, 2]. Kinematic movement analyses can provide an alternative to clinical outcomes by measuring motor performance [3-5]. The purpose of this study, therefore, was to determine if and how the amount of robotic treatment and/or combination with task-oriented training influences kinematic motor performance and learning during the course of treatment.

**Number of Subjects :** Convenience sample of 22 subjects with chronic stroke participating in a larger randomized control trial. The mean age was  $57 \pm 12$  years, and mean Fugl-Meyer score was  $25 \pm 7$ .

**Materials/Methods :** Subjects were randomized into two groups with both groups receiving 3 treatments per week for 4 weeks. One group ( $n=11$ ) completed 60 minutes of robotic training, and the other group ( $n=11$ ) 45 minutes of robotic training followed by 15 minutes of translation-to-task (TTT) practice. All robotic training was completed on a planar IMT robot with assistance provided as needed. The TTT was task-oriented training of functional tasks. Kinematic assessments were conducted on the robot with an unassisted, center-out reaching task to 8 targets at the start of each visit and after each block of robotic training. Kinematic variables included movement time, peak velocity, and smoothness (zero acceleration crossings), and were calculated as the mean of 8 reaching movements. Each assessment was numbered consecutively as an indication of the amount of robotic training independent of the TTT. Individual graphs plotted by block were inspected to explore differences in motor performance gains across the two groups. Online gains (within a treatment session) and offline gains (between treatment sessions) were calculated as the rate of change and absolute change, respectively. Data were analyzed with ANOVAs to determine pre-post changes, and online/offline gains.

**Results :** Movement times and smoothness significantly improved over the course of the intervention similarly for both groups ( $p < 0.001$ ). There was a significant interaction for peak velocity ( $p = 0.024$ ) suggesting the groups did not respond the same over time; the robot only group had a significant improvement in PV whereas there was no change following the robot+TTT training. Generally, the robot+TTT group demonstrated larger online gains compared to the robot only group and the opposite was true for offline gains.

**Conclusions :** The parameters of treatment such as time spent on robot may impact motor performance gains during an intervention. Shorter robotic sessions (45 minutes vs 60 minutes) promoted greater on-line gains (within the session), yet the robot only group had greater off-line consolidation. Additional research is needed to systematically test how to maximize gains over the course of an intervention.

**Clinical Relevance :** Intervention parameters such as time on robot and task-oriented practice influence the extent of on-line and off-line motor performance gains and should be taken into account when planning interventions.

**TITLE:** Modulation of gait performance with progressive increases in exercise intensity and after repeated exposure to high-intensity locomotor exercise in individuals with incomplete spinal cord injury

**AUTHORS/INSTITUTIONS:** K.A. Leech, Interdepartmental Neuroscience Program , Northwestern University, Chicago , Illinois, UNITED STATES|C. Holleran, C.R. Kinnaird, J.H. Kahn, SMPP, Rehabilitation Institute of Chicago, Chicago, Illinois, UNITED STATES|T. Hornby, Physical Therapy, University of Illinois at Chicago , Chicago, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Recent evidence suggests that the intensity of stepping practice may be a critical training parameter to improve locomotor function following neurologic injury. To date, high-intensity locomotion has largely been avoided in rehabilitation following neurologic injury[1], possibly due to the traditional theory that such activities will lead to aberrant movement patterns and spastic motor behaviors[2,3]. However, immediate effects of locomotor intensity on gait performance have not been rigorously evaluated and no studies show a negative impact following high-intensity training. The purpose of this study was to: 1) evaluate locomotor performance during a single session of graded-intensity exercise and 2) determine the impact of high-intensity locomotor training on these measures in subjects with incomplete SCI.

**Number of Subjects :** Single session effects of intensity were evaluated in 19 individuals with chronic motor incomplete SCI. The impact of high-intensity locomotor training was assessed in a subset of 9 subjects.

**Materials/Methods :** All subjects performed a graded-intensity locomotor exercise task with simultaneous collection of sagittal plane joint kinematics and selected EMG of the lower extremities. Following initial testing, a subset of 9 subjects participated in 12 weeks of high intensity locomotor training, with reassessment of locomotor performance post-training. Data analysis focused on consistency of movement patterns between step cycles (joint angle coefficient of variation and hip-knee average correlation coefficient) and muscle timing. Comparisons of selected measures during single testing sessions were made across levels of intensity (33%, 66%, and 100% of peak speed) with repeated measures ANOVAs. Training effects were assessed by comparing measures of locomotor performance at the highest speed common to pre- and post-training with paired t-tests.

**Results :** Single session data indicate no change in muscle timing or gait variability across levels of intensity. Intralimb coordination was more consistent at moderate vs low intensity ( $p < 0.01$ ), with a trend for maintained consistency at high intensity ( $p = 0.06$ ). High-intensity locomotor training led to a significant improvement in overall locomotor performance (increased peak speed from 0.64 to 0.80m/s;  $p = 0.001$ ) with a trend for decreased variability in ankle range of motion ( $p = 0.07$ ) and no change in intralimb coordination at matched speeds in pre- and post-training conditions.

**Conclusions :** In contrast to the theoretical framework of traditional rehabilitation, our data demonstrate high-intensity locomotor exercise within a single session does not elicit more variable movement patterns or aberrant muscle activity. Furthermore, high-intensity locomotor training may improve overall performance and consistency of gait kinematics.

**Clinical Relevance :** These findings expand our understanding of how the intensity of locomotion impacts gait performance in individuals with incomplete SCI.

**TITLE:** Do Measures of Balance, Motor Severity, or Executive Function Accurately Identify Fall History in Parkinson Disease?

**AUTHORS/INSTITUTIONS:** R. Duncan, K.A. Pickett, G. Earhart, Program in Physical Therapy, Washington University, St. Louis, Missouri, UNITED STATES|R. Weiss, M.C. Campbell, Neurology, Washington University, St. Louis, Missouri, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study is to comparatively assess the accuracy of retrospective identification of fall history between measures of balance, motor severity, and executive function in people with Parkinson disease (PD). We hypothesize that balance, motor severity, and executive function will be accurate in retrospectively identifying falls in individuals with PD with balance being a more accurate predictor of previous falls.

**Number of Subjects :** 66 non-demented PD participants (36.8% female; mean age: 66.9(9.8); median MDS-UPDRS III: 35.0(11.2); median Hoehn & Yahr: 2.5, range 2-4).

**Materials/Methods :** Participants underwent testing of balance using the Mini-Balance Evaluation Systems Test (Mini-BEST) and executive function using the Trail Making Test (TMT), Stroop, Verbal Fluency –Switching condition, and Go/No-Go Response Inhibition test. All participants completed testing off anti-PD medication. Retrospective fall history was collected and those participants reporting 2 or more falls in the past 6 months were classified as fallers. ANOVA or its non-parametric equivalent was used to characterize differences in balance and executive function between fallers and non-fallers. Those variables that were significantly different between fallers and non-fallers were entered into a forced entry logistic regression model to determine collective contributions to the variance in fall history. A stepwise regression model was also used to determine unique contributions to the variance in fall history. Sensitivity, specificity, and Area Under Receiver Operating Characteristic curves (AUC) were calculated for significant predictor variables ( $\alpha \leq 0.05$ ).

**Results :** Fallers (n=17) were significantly different from non-fallers in Mini-BEST ( $p < 0.001$ ), MDS-UPDRS III ( $p < 0.001$ ), and Go/No-Go inhibition accuracy ( $p = 0.03$ ). Collectively, the Mini-BEST, MDS-UPDRS III, and Go/No-Go inhibition accuracy explained between 24.2% of the variance in fall history ( $p < 0.001$ ). Only the Mini-BEST was entered into the stepwise regression model and explained 20.1% of the variance in fall history ( $p < 0.001$ ). The AUC for the Mini-BEST was 0.77 (cutoff score=17/28; sensitivity=0.77; specificity=0.80).

**Conclusions :** People with PD with a past history of falls had worse balance, motor severity, and Go-/No-Go inhibition accuracy than those without a history of falls. Balance, as measured by the Mini-BEST, was the only variable to explain a unique portion of the variance in fall history.

**Clinical Relevance :** Balance may be more accurate in identifying fall risk than motor severity or executive function in individuals with PD. However, the Mini-BEST was only moderately accurate in identifying those with a past history of falls. As such, clinicians should not solely rely on the Mini-BEST when attempting to determine fall risk for patients with PD.

**TITLE:** Using Daily Walking Activity to Assist with Clinical Decision Making in People Post Stroke

**AUTHORS/INSTITUTIONS:** G.D. Fulk, Physical Therapy, Clarkson University, Potsdam, New York, UNITED STATES|T. Rosenbaum-Chou, Modus Health, Washington, District of Columbia, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** The recovery of walking ability is a primary goal for people post stroke. Physical therapists (PT) use performance and self-report outcome measures to develop an appropriate plan of care to enhance walking ability and assess improvement. The purpose of this case study was to explore the impact of the direct measurement of home and community walking activity on PTs clinical decision making related to walking goals in people post stroke.

**Case Description :** Upon admission to out patient physical therapy 4 people with stroke underwent an initial examination that included tests and measures selected by the PT as well as gait speed (GS) and the Berg Balance Scale (BBS) or Functional Gait Assessment (FGA). Two PTs evaluated the data from the initial exam and assigned participants a Medicare Functional Limitation G-Code and Severity Modifier (SM) for Mobility. Participants then wore a StepWatch Activity Monitor (SAM) for 2-3 days in their home and community prior to their next physical therapy session. The SAM collected patients' daily step activity in their home and community. PTs reviewed the SAM data and re-evaluated the G-Code severity modifier.

**Outcomes :** For patient 1, based on an initial gait speed of 0.21 m/s and BBS of 26 a SM of 80-99% impaired was assigned. With the addition of the SAM data (average daily steps of 1537) the PT modified the SM to 100% impaired. For patient 2, based on an initial gait speed of 0.78 m/s and BBS of 55 a SM of 40-59% impaired was assigned. With the addition of the SAM data (average daily steps of 8109) the PT modified the SM to 20-39% impaired. For patient 3, based on an initial gait speed of 0.43 m/s and BBS of 27 a SM of 100% impaired was assigned. With the addition of the SAM data (average daily steps of 3224) the PT did not change the SM. For patient 4, based on an initial gait speed of 1.22 m/s and a FGA of 27 a SM of 1-20% impaired was assigned. With the addition of the SAM data (average daily steps of 6,841) the PT did not change the SM.

**Discussion :** In this small sample, the addition of home and community walking activity provided unique insight into participants' level of walking disability that may not be captured solely by standard clinical outcome measures. The addition of the SAM data at admission resulted in a modification in the G-Code Severity modifier (one to a greater degree of walking restriction and one to a lesser degree of walking restriction) for 2 patients and no change in the initial G-Code Severity modifier for the other 2 patients. The development of an algorithm to assist with the determination of Functional Limitation Mobility G-Code SM may be helpful. Further investigation is needed to explore how PTs use data from the initial examination to develop the plan of care.

**TITLE:** A community-based exercise program for gait, balance, and fatigue in people with Huntington's Disease: a case series

**AUTHORS/INSTITUTIONS:** D.C. Clark, E. Ulanowski, Physical Therapy, Norton Healthcare, Louisville, Kentucky, UNITED STATES|M. Danzl, Physical Therapy, Bellarmine University, Louisville, Kentucky, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** A growing body of evidence supports physical therapy and exercise to improve gait, balance, endurance, and quality of life for persons with Huntington's Disease (HD). There remains a paucity of research investigating community-based programs for individuals with HD and interventions for those "at risk" for HD. The purpose of this case series is to describe the design, implementation, and outcomes of a community-based group program with individualized exercises aimed at improving gait, balance, and fatigue in participants who are diagnosed with HD or considered "at risk" due to a family history.

**Case Description :** Three individuals with HD participated in this case series. Two participants had a medical diagnosis and paternal history of HD, including a 30-year-old female and a 27-year-old male. The third participant, a 28-year-old female, had no significant past medical history and was considered "at risk" for HD due to an extensive family history. The group met once per week for 8 weeks to participate in a program designed as a circuit-training model with exercises to improve balance, strength, and cardiovascular fitness. A board certified neurological physical therapist and a physical therapy neuroresident led the program. Exercises were modified based on the participant's ability. Participants' family members were encouraged to attend and participate in each session to offer encouragement and social support. Pre- and post-outcome measures included the 10 meter walk test (10MWT), Berg Balance Scale (BBS), Fatigue Impact Scale (FIS), and the Timed Up and Go (TUG).

**Outcomes :** Each participant completed the 8-week intervention, demonstrating improvement or maintenance of abilities in all measures with no adverse events. The 10MWT, TUG, and BBS scores for both participants with HD exceeded the minimal detectable change (MDC) and improvements were noted with the FIS. The participant at risk for HD exceeded the MDC for the 10MWT, improved the TUG time, and maintained baseline BBS and FIS scores.

**Discussion :** The novelty of this case series is twofold: 1) both individuals diagnosed with HD and those identified as "at risk" for HD were recruited and 2) an individualized approach to exercise prescription was included within the community-based group format. The findings lend support for an individualized, community-based exercise group aimed to improve balance and gait speed and reduce fatigue for persons with HD. Anecdotally, the inclusion of family and caregivers had a positive impact on participation. Additional research is warranted to investigate causal relationships, the optimal dose and design, and the long-term effects of community-based exercise programs.

**TITLE:** Intense In-home Physical Therapy 17 Years Post-Traumatic Brain Injury - A Case Report

**AUTHORS/INSTITUTIONS:** L.M. Frank, Physical Therapy, St. Ambrose University, Davenport, Iowa, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** An estimated 1.7 million Americans suffer a Traumatic Brain Injury (TBI) each year and 275,000 of these are hospitalized. A typical course of therapy after severe TBI includes intense multidisciplinary services in an inpatient/day rehab setting, then decreased intensity of services on an in-home or outpatient basis.

There is a lack of research on appropriate intensity of therapy for patients with chronic TBI, and on the most appropriate location for these services. The purpose of this case report is to illustrate the benefits of intense in-home physical therapy for a community-dwelling individual 17 years following a severe TBI.

**Case Description :** This patient suffered a severe TBI in January 1994 at age 36. He was in a deep coma for 6 weeks, then received therapy in both inpatient and outpatient settings for the next 22 months. He was left with residual short term memory deficits and impaired strength, ROM, and motor control of the right arm and leg, limiting balance and functional mobility. The patient showed gradual improvement in motor control and use of the right upper and lower extremities over the years. At 17 years post-injury he was living independently and using a wheelchair for primary convenient mobility, with occasional use of a rolling walker to ambulate from his van into familiar buildings. His goal to walk with a 4-pronged cane required sufficient strength, balance, endurance, and confidence. The patient's modified independence disqualified him for reimbursed in-home therapy, but patient and therapist agreed that overcoming barriers to progress would be maximized by working in his own environment, so pro bono services were arranged. This also allowed a trial of more intense physical therapy services than he could tolerate or fit into his schedule if travelling to an outpatient clinic. Physical therapy consisted of 60-minute in-home sessions 3-5 times a week for 4 weeks, followed by a home program with follow up visits 1 time per week for the next 2 weeks, then occasional contact by telephone. Procedural interventions included ROM/stretching, strengthening, neuromuscular reeducation, balance, and functional training. Sessions also included problem solving to overcome barriers, plus education in a home program to be incorporated into his current daily activities and schedule.

**Outcomes :** The patient's goal of walking with a 4-pronged cane was not met but he improved his balance confidence, increased his time spent in standing throughout the day and incorporated new upright activities into his day that continued even 6 months later.

**Discussion :** Additional research is needed to determine the potential for further functional improvements with physical therapy for individuals with chronic TBI, including the appropriate intensity and location of services. An individual who can access outpatient services independently may still require some in-home services in order to overcome barriers and maximize carryover.

**TITLE:** The Immediate Influence of Carbon Composite Ankle Foot Orthoses on Balance and Gait in Individuals with Peripheral Neuropathy: A Pilot Study

**AUTHORS/INSTITUTIONS:** K. Jackson, K. Edginton-Bigelow, University of Dayton, Dayton, Ohio, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Limited data exists supporting the use of ankle foot orthoses (AFOs) for improving balance and gait in individuals with peripheral neuropathy and no studies have evaluated the effects of carbon composite AFOs in this population. The primary purpose of this study was to determine the immediate effects of carbon composite AFOs on postural control, dynamic balance and gait in individuals with peripheral neuropathy.

**Number of Subjects :** Twelve subjects (mean age = 75.1) with peripheral neuropathy who were ambulatory without an assistive device and had not previously used an AFO were recruited for the study.

**Materials/Methods :** Subjects performed a battery of tests including force plate posturography, the Mini-BESTest, gait speed and the Timed Up and Go both with and without carbon composite AFOs. Testing conditions were counter balanced to eliminate an ordering effect.

**Results :** Subjects exhibited significantly less sway in the A/P and M/L sway directions ( $p < 0.05$ ) with eyes closed while wearing the AFOs, but experienced a reduction in A/P limits of stability ( $p = 0.000$ ). There were no group differences for the Mini-BEST, gait speed and TUG, however individual subjects experienced both positive and negative changes that exceeded minimally important change values for the Mini-BEST and gait speed.

**Conclusions :** Carbon composite AFOs have an immediate effect on balance in individuals with peripheral neuropathy. There were generally improvements in static postural control but the effects on dynamic measures of balance and gait were more variable.

**Clinical Relevance :** Clinicians should evaluate individuals with peripheral neuropathy using standardized measures that include a variety of dynamic balance and gait measures to assess potential benefits and risks of AFO use so they can make appropriate recommendations.

**TITLE:** Agreement between physical therapists in identifying nystagmus in positional tests to diagnosis benign paroxysmal positional vertigo

**AUTHORS/INSTITUTIONS:** A.K. Galgon, Physical therapy, Temple University, Philadelphia, Pennsylvania, UNITED STATES|A.R. Tate, M. Fitzpatrick, Willow Grove Physical Therapy, Willow Grove, Pennsylvania, UNITED STATES|W.W. Schoenewald, WWS Physical Therapy and Associates, Doylestown, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of the study was to examine the agreement between physical therapist to identify nystagmus and diagnose type and side benign paroxysmal positional vertigo using positional testing.

**Number of Subjects :** Nineteen subjects (n=38) with complaints of positional vertigo and 3 physical therapists (n=6) from each of two clinical sites (S1 and S2) who specialize in vestibular rehabilitation participated in this study.

**Materials/Methods :** All therapists were trained on a standardized testing sequence using video goggles and recording systems. Video recordings captured the eyes of subjects during positional testing including supine to sit test, right and left roll tests and right and left Dix Hallpike tests. Therapists independently observed videos and rated each for nystagmus direction, duration and intensity in each testing position. A diagnosis including side and canal of involvement and type (otoconia position) or no BPPV was made for each subject. Percent of agreement and Kappa statistics ( $\kappa$ ) were calculated between therapists within each clinical site for nystagmus identification in each positional test and subsequent diagnosis.

**Results :** Identification of nystagmus: At S1, 16 out of 19 subjects had nystagmus identified during video observations and the clinicians showed substantial to almost perfect agreement for the presence of nystagmus during positional testing for sit to supine ( $\kappa = 1$ ), the roll ( $\kappa = 0.68$  to  $0.89$ ,  $p < 0.005$ ) and the Dix Hallpike ( $\kappa = 0.66$  to  $0.89$ ,  $p < 0.005$ ) tests. At S2, 15 out 19 subjects had nystagmus identified and the clinicians showed moderate to almost perfect agreement for presence of nystagmus during positional testing for sit to supine ( $\kappa = 0.65$  to  $0.88$ ,  $p < 0.005$ ), roll ( $\kappa = 0.57$  to  $0.89$ ,  $p < 0.005$ ), and Dix Hallpike ( $\kappa = 0.75$  to  $1$ ,  $p < 0.005$ ). In both clinical sites when all three clinicians identified nystagmus, they had 100% agreement on at least one component of nystagmus direction. Diagnosis: At S1, 16 out of 19 subjects were diagnosis with having BPPV and the clinicians had almost perfect agreement for side ( $\kappa = 0.91$  to  $1$ ,  $p < 0.005$ ) canal ( $\kappa = 1$ ) and type ( $\kappa = 1$ ) of involvement. At S2, 13 out 19 were diagnosed with BPPV and the clinicians had almost perfect agreement for side ( $\kappa = 0.81$  to  $1$ ,  $p < 0.005$ ), canal, ( $\kappa = 0.90$  to  $1$ ,  $p < 0.005$ ) and type ( $\kappa = 0.90$  to  $1$ ,  $p < 0.005$ ).

**Conclusions :** There was high agreement on the presence and direction of nystagmus within clinical sites that see a high volume of patients with BPPV. The clinicians utilized observations from multiple positional tests to determine diagnosis. This was evident by positive nystagmus in multiple positions in most subjects and occasional disagreement in some subjects' positional tests, but agreement in diagnosis.

**Clinical Relevance :** Experienced physical therapists are consistent in observing for nystagmus during positional tests and demonstrate high interrater reliability in diagnosing BPPV. The result of this study may not be generalizable to less experienced clinicians or for observations made without video recordings.

**TITLE:** Effect of a wearable robotic device in outpatient physical therapy for gait training in individuals with stroke  
**AUTHORS/INSTITUTIONS:** A. Winstanley, H. Roth, C. Mummidisetty, A. Jayaraman, Max Nader Lab for Rehabilitation Technologies and Outcomes Research, Rehabilitation Institute of Chicago, Chicago, Illinois, UNITED STATES|H. Takahashi, Honda R&D Americas, Raymond, Ohio, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The Stride Management Assist (SMA) is wearable robotic gait assist device developed by the Honda Corporation. The device fits around the waist and assists with hip motion (flexion and extension) during gait. Typical gait impairments seen post stroke include: decreased ankle dorsiflexion, knee flexion and hip flexion during swing phase as well as decreased hip extension during late stance. Commonly, physical therapists use technology to target ankle, foot and knee motion using orthoses or functional electrical stimulation devices. Currently, there are limited interventions for specifically addressing deficits in active hip motion during gait.

**Number of Subjects :** By the end of 2014, 50 ambulatory subjects > 30 days post stroke

**Materials/Methods :** After being randomized into either the traditional therapy group or the SMA group, subjects participated in outpatient physical therapy (PT) sessions 3 times per week for 6 weeks. All PT was performed in an outpatient clinical setting by licensed physical therapists. Standardized clinical tests including measures of gait speed, spatiotemporal parameters of gait, static and dynamic standing balance and quality of life measures were taken before, at mid-point, immediately following and 3 months post training.

**Results :** At midterm data analysis (25 subjects), both groups demonstrated significant improvements in gait endurance during the 6 minute walk test (36.81% traditional, 51.14% SMA), self selected gait speed during the 10 meter walk test (29.79% traditional, 38.39% SMA), and balance confidence as measured by the Activities Specific Balance Confidence Scale (37.29% traditional, 25.58% SMA). The only outcomes that had significant differences between groups were overall number of steps taken and calories burned by the SMA group in comparison in the traditional group during the participation period of the study (including home and community walking).

**Conclusions :** With significant improvements in both groups at mid-term analysis, we expect completion of 50 subjects will demonstrate statistical significance between groups, as well as from pre to post testing. We also plan to complete 3 month follow-up data collection which will reveal any differences in maintenance of gains made during training.

**Clinical Relevance :** Stride Management Assist is a robotic device that could be used in outpatient PT clinics to address deficits in hip motion during gait post stroke. With limited interventions available to specifically address deficits in hip motion, this device could improve rehabilitation outcomes for the stroke population. SMA could potentially be used as a home training device in areas with low access to physical therapists or large rehabilitation centers.

**TITLE:** Dual Task Training and the effects on walking function and dual task ability in a young adult with a severe traumatic brain injury

**AUTHORS/INSTITUTIONS:** C.M. Garces, E.J. Fox, P.M. Spigel, Physical Therapy, Brooks Rehabilitation Hospital, Jacksonville, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Attentional and motor deficits commonly follow a severe traumatic brain injury (TBI), resulting in impairments in dual task ability which is required for safe functional mobility. Dual task training (DTT) programs are effective for improving walking function and dual task ability in individuals with neurologic conditions such as stroke, Parkinson's disease and mild TBI due to concussion. Evidence regarding the effectiveness of DTT for individuals with severe TBI is limited, but is critical for ensuring that these individuals achieve their highest potential post injury. The purpose of this case report is to describe the use of DTT and the effects on walking function and dual task ability in a patient with a severe TBI.

**Case Description :** The patient was a 17-year-old male who sustained a severe TBI during a motor vehicle crash 20 days prior to the physical therapy evaluation in an inpatient rehabilitation hospital. His cognitive function was classified as Rancho level IV due to behaviors of agitation and perseveration. His cognitive impairments in executive function, decreased attention and motor impairments in strength and coordination limited his dual task ability which was required to perform safe transfers and walking. Physical therapy sessions were provided for 29 sessions, with 12, 60-minute sessions focused on DTT. DTT initially was performed by having the patient walk on a treadmill using a passive overhead harness and performing cognitive tasks. Progression of motor and cognitive tasks included: dynamic balance, walking on multi-surfaces, sequencing, memory recall, and abstract reasoning. Community re-integration activities were also included to practice dual tasking during real life scenarios. Due to the patient's inability to follow commands, dual task performance-based outcome measures were deferred until he emerged to Rancho level V. Walking function as well as dual task ability were assessed using 2 versions of the Timed Up and Go (Cognitive TUG and Manual TUG) and 2 versions of the Walking While Talking Test (Simple and Complex). Assessments were conducted weekly until discharge.

**Outcomes :** Walking and dual task function improved based on changes in the Timed Up and Go Cognitive and Manual versions: 30.86s to 9s and 36s to 15s, respectively. Improvements also were evident based on the Walking While Talking Test, Simple and Complex versions: 29s to 10s and 38.74 to 11.75s (average score of 4 trials), respectively.

**Discussion :** DTT as part of an inpatient rehabilitation program was effective for improving walking function and dual task ability in an individual with a severe TBI. DTT appeared to benefit the patient's functional performance based on an observed improvement in his ability to perform a motor task with the addition of a cognitive task. The patient's improvements in walking function and dual task ability suggest the potential benefits of DTT in the severe TBI population. Future research is required to further explore the use of DTT in the severe TBI population.

**TITLE:** Effectiveness of exercise programs for management of shoulder pain in manual wheelchair users with spinal cord injury: a systematic review

**AUTHORS/INSTITUTIONS:** K.A. Cratsenberg, C.E. Deitrick, T.K. Harrington, N.R. Kopecky, B.D. Matthews, L.M. Ott, Community and Family Medicine, Duke University, Durham, North Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Shoulder pain is highly prevalent in manual wheelchair users with spinal cord injury (SCI). The incidence and severity of shoulder pain in this population has been shown to increase with time post-injury due to abnormal loading forces. Therapeutic exercise has been demonstrated to be an effective, conservative approach to treating shoulder pain in able-bodied individuals. The purpose of this review is to evaluate current literature on the effectiveness of exercise programs on the reduction of shoulder pain in manual wheelchair users with SCI.

**Number of Subjects :** 142 manual wheelchair users

**Materials/Methods :** We searched the English language literature through Pubmed, CINAHL, Web of Science and EMBASE from 1966 to January 22, 2014, using search terms related to spinal cord injury, manual wheelchairs, and shoulder pain. Eligibility criteria included a prospective study design, an exercise intervention for manual wheelchair users with shoulder pain, and use of the Wheelchair User's Shoulder Pain Index (WUSPI) as an outcome measure. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and assessed study quality using the checklist proposed by Downs and Black.

**Results :** Our search strategy identified 228 articles. Of these, three randomized control trials and three cohort studies met inclusion criteria. Two studies were rated as good quality and four as fair quality. Three different interventions were evaluated in the included studies: arm ergometry, resistive strengthening with or without EMG biofeedback, and stretching that targeted the shoulder girdle. Comparative studies included a control group consisting of either education alone or no intervention. Across the six studies, the exercise intervention was associated with reduction in shoulder pain that exceeded the estimated minimal detectable change of 5.10 points for the WUSPI. We were unable to conduct a meta-analysis to estimate a pooled effect size for exercise relative to a control intervention because of inconsistent reporting of findings across the six studies.

**Conclusions :** Current literature supports the use of a variety of exercise programs to reduce shoulder pain and increase daily function over time. Exercise is a feasible and conservative therapeutic intervention for the treatment of shoulder pain among wheelchair users. Additional high quality studies are needed to evaluate and differentiate techniques for the reduction of shoulder pain, to determine the most effective duration of intervention, and to estimate the magnitude of effect associated with therapeutic exercise for shoulder pain among wheelchair users.

**Clinical Relevance :** Clinicians should consider a variety of techniques including strengthening, stretching and/or endurance training of the shoulder girdle for individualized treatment and management of shoulder pain in manual wheelchair users with SCI.

**TITLE:** Relationship of Depression and Medications on Incidence of Falls among People with Late Effects of Polio  
**AUTHORS/INSTITUTIONS:** C.P. Da Silva, B. Zuckerman, School of Physical Therapy, Texas Woman's University, Houston, Texas, UNITED STATES|R. Olkin, California School of Professional Psychology, San Francisco, California, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose was to determine the relationship between falls in polio survivors (with or without post-polio syndrome [PPS]), and presence of depression (on two measures), use of anti-depressant or psychoactive medications, and number of medications taken. The null hypothesis was that there would be no relationship between the rate of falling, depression (self-reported or Geriatric Depression Scale short form [GDS-15]), the number of medications taken, or use of psychoactive medications in polio survivors with and without PPS.

**Number of Subjects :** 172 people returned a mailed questionnaire (57% response rate)

**Materials/Methods :** The survey, developed with input from the International Polio Clinics Directors' Network, included questions on demographics, general health, medication use, use of mobility devices, home and work environment, falling history, balance confidence, and depression. Depression was measured by self-report and GDS-15. Medications were reviewed and categorized based on the number of total medications, depression medications, and other psychotropic medications taken. Independent samples t-test was performed to analyze a relationship between the number of medications taken and falls. Chi square analysis was performed to assess the associations of psychoactive medications and falls, the number of medications taken and the risk for falls, self-report of depression and GDS-15 score, depression and treatment of depression with medication, and depression and falls.

**Results :** All 172 returned questionnaires included a completed GDS-15, and 146 (84%) surveys were completed with a list of current medications. Sixty-two percent of participants reported falling in the past 12 months. The mean number of medications taken by people who had fallen was 5.01 and by people who had not fallen was 5.11. There was no significant difference between total number of medications taken and a fall history ( $p = 0.879$ ) or anti-depressant and/or psychoactive medications and falling ( $p=0.298$ ). Their reports of depression were significantly corroborated by GDS-15 scores ( $p<0.001$ ), and depression and falls were significantly related in polio survivors ( $p<0.010$ ).

**Conclusions :** Depression was significantly associated with falls in this sample of polio survivors, some with PPS. In addition to traditional interventions for fall prevention, routine screening for and addressing depression by referring for treatment, as indicated, is essential. Polypharmacy and use of psychoactive medications were not related to falls in this population, unlike with other older adults.

**Clinical Relevance :** Prevalence of falls and depression were high in this sample of polio survivors with and without PPS. Clinicians need to routinely screen for both issues through appropriate outcome measures or simply asking questions about fall history and depression.

**TITLE:** Effectiveness of galvanic vestibular stimulation for the treatment of unilateral neglect in patients post-stroke: A systematic review

**AUTHORS/INSTITUTIONS:** H. Carter, J. Godfrey, C. McCormick, K. Schenck, J. Stambaugh, C. Viviano, R. Clendaniel, Community and Family Medicine, Duke University Medical Center, Durham, North Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Unilateral neglect is a common condition in patients after a stroke, resulting in the inability to attend to sensory stimuli in the hemisphere contralateral to the lesion. Neglect most commonly occurs due to damage to the right parietal lobe after an infarction of the right middle cerebral artery, leading to left-sided neglect. Galvanic vestibular stimulation (GVS) is a novel and little-studied, non-invasive treatment that stimulates sections of the cortex and vestibular system which may be involved in neglect. This systematic review investigates the efficacy of GVS for the treatment of unilateral neglect in patients during the sub-acute and chronic phases post-stroke.

**Number of Subjects :** 130 subjects were examined across the 5 included studies.

**Materials/Methods :** This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A computer-assisted literature search of Medline, CINAHL, Web of Science, EMBASE, and Scopus was conducted using keywords related to stroke, GVS, and unilateral neglect. To be included, studies were required to 1) include patients with unilateral neglect who had an average time post-stroke greater than or equal to six weeks, 2) utilize a measurable outcome to quantify neglect, and 3) have a comparison amongst different stimulation conditions. Studies were assessed for quality using the PEDro scale.

**Results :** 511 studies were initially screened, and 11 of these were included in the full text review. 5 studies met the inclusion criteria. 1 randomized controlled trial, 3 randomized controlled trials with crossover design, and 1 non-randomized trial with crossover design were included in the qualitative review. Using PEDro, 1 of these studies was deemed to be of excellent methodological quality, 3 were of good quality, and 1 was considered to be of fair quality. Heterogeneity of the outcome measures in the included trials prevented meta-analysis. All studies concluded a benefit of GVS in treating unilateral neglect as compared to sham treatment or baseline assessment, though differing protocols were utilized throughout the trials. 2 studies favored using right GVS, and 3 indicated a greater effect with left GVS. No detrimental side effects to GVS were reported during any of the trials.

**Conclusions :** The existing research supports the use of GVS to treat unilateral neglect in patients post-stroke. The lack of high quality randomized controlled trials on this topic with adequate sample sizes and uniformity of stimulation protocols demonstrates a need for further research in this population.

**Clinical Relevance :** Patients with unilateral neglect post-stroke frequently lack affect and motivation to improve, and behavioral interventions can be challenging in this population. GVS may provide a promising therapy with few side effects to induce prolonged attentional shifts and ameliorate the negative effects of unilateral neglect.

**TITLE:** The Effect of Cognitive Dual Tasks on Gait in Patients with Sub-Acute and Chronic Stroke: A Systematic Review

**AUTHORS/INSTITUTIONS:** L. Grabbe, Physical Therapy, Sage Graduate School, Troy, New York, UNITED STATES|L.Z. Gras, Physical Therapy, Ithaca College, Ithaca, New York, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Cerebral vascular accident (CVA) is the most common form of acquired brain injury in the world. Patients with a CVA can have a myriad of health problems including impaired gait and increased risk for falls. Dual task is the act of performing 2 tasks simultaneously, and is an exercise performed daily by most adults. Cognitive motor interference (CMI) is a phenomenon that occurs when an individual performs a cognitive and motoric task concurrently. Commonly, one or both of the tasks suffers as a result. The purpose of this systematic review was to investigate the effect of CMI on gait in subjects with sub-acute and chronic stroke.

**Number of Subjects :** n/a

**Materials/Methods :** Articles published between 2000-2013 were search through PEDro, Academic One file, CINAHL, Cochran, Health Source Health Reference Center Academic, Journals Ovid, Medical Evidence Matters Archives, Medline, ProQuest, Google Scholar, and PubMed. Search terms used were: “dual task”, “parallel processing”, “task switching”, “multi-tasking”, “stroke”, “cerebral vascular accident” “cognitive motor interference”, “ambulation”, and “gait”. The inclusion criteria was community dwelling subjects with sub-acute and chronic stroke, a primary motor task of gait, and secondary task purely cognitive in nature. Exclusion criteria was non ambulatory patients, patients with other neurological conditions, patients with memory impairments or those unable to follow simple instructions, patients with aphasia, patients with uncorrected vision or hearing deficiencies, patients with orthopedic problems that would prohibit gait. A Critically Appraised Topic was done on articles that met the inclusion and exclusion criteria and then they were evaluated using the PEDro scale.

**Results :** After a search of 2,337 articles through the databases, 2,189 were excluded based on a lack of those articles meeting the inclusion criteria. Of the remaining 128 articles, 9 were selected which focused on dual-task and stroke rehabilitation. The reviewed articles consisted of 6 quasi-experimental mixed designs and 3 quasi-experimental repeated-measures designs. The average PEDro score of the articles reviewed were 5.67/10 ±.5. It was found that CMI was increased in subjects with sub-acute and chronic CVA as compared to healthy older and younger adults. The amount of CMI, and which task was most severely affected, varied depending on task and walking speed.

**Conclusions :** Cognitive dual task in combination with gait in subjects with sub-acute and chronic CVA increases CMI and can increase the risk of falls.

**Clinical Relevance :** Dual task ambulation causes increased CMI in people who have had a CVA that can decrease their ability to complete either the motor or cognitive task effectively. When working with patients with stroke, a therapist should be aware of CMI and may need to adjust intended therapies accordingly.

**TITLE:** The Effects of Task-Specific Training on Balance and Gait in a Young Adult After a Traumatic Brain Injury with Complications: A Case Report

**AUTHORS/INSTITUTIONS:** J. Banta, J. Freund, Elon University, Elon, North Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Traumatic brain injury (TBI) is a major cause of chronic disability in the United States. Task-specific training may be beneficial in improving functional outcomes in persons with TBI. The purpose of this case report is to describe the effects of task-specific training on gait and balance in a young adult with chronic TBI and complications.

**Case Description :** The patient was a 26 year-old male who sustained a TBI three years prior. The patient's recovery was complicated by meningitis, pontine cerebral vascular accident, hydrocephalus with shunt placement and a percutaneous endoscopic gastrostomy. Rehabilitation included initial inpatient physical, occupational and speech therapy, followed by ongoing outpatient services. His regular physical therapy was suspended as he volunteered as a patient in a university physical therapy course, one hour, twice a week for five weeks. His goals were improved sit to stand and balance. He had right hemiparesis and walked with supervision without an assistive device. Interventions were treadmill walking, stair climbing and obstacle course negotiation including stepping over and around objects, walking backwards and sideways, sit to stands, ball kicking, and step ups.

**Outcomes :** The Berg Balance Scale (BBS), High Level Mobility Assessment Tool (HiMAT), and Five Times Sit to Stand were tested at initial examination and discharge. BBS improved from 41/56 to 49/56, indicating decreased fall risk. The patient also reported his balance was +4 (a great deal better) pre to post-intervention on an 11 point global rate of change scale. HiMAT and Five Times Sit to Stand did not change significantly.

**Discussion :** Task specific balance and gait activities may improve balance in individuals with chronic TBI and multiple complications.

**TITLE:** Safety and Feasibility of Treadmill Training in Ambulatory Individuals with Huntington's Disease

**AUTHORS/INSTITUTIONS:** A.D. Kloos, M. Fiumedora, D.A. Kegelmeyer, Physical Therapy, The Ohio State University, Columbus, Ohio, UNITED STATES|S.K. Kostyk, Neurology, The Ohio State University, Columbus, Ohio, UNITED STATES|N.E. Fritz, Kennedy Krieger Institute, Johns Hopkins University, Baltimore, Maryland, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Individuals with Huntington's disease (HD) experience balance and walking problems. Treadmill training (TT) improves walking function (e.g., gait speed, stride length) in Parkinson's disease suggesting that TT may also be beneficial in HD. The purpose of this study was to investigate the safety, feasibility, and possible effects on gait of a single session of TT in individuals with HD.

**Number of Subjects :** Nine ambulatory individuals with HD [mean (SD); age: 53.4 (9.4) yrs; symptom duration: 9.5 (5.9) yrs; 5 women; TFC: 8.2 (3)] participated in this study.

**Materials/Methods :** Spatiotemporal gait parameters in forward, forward fast, and backward walking were assessed with GAITRite. Mobility was assessed with the Timed Up and Go (TUG) test. Outcome measures were assessed before (pre1), after a 15 minute delay (pre2) and immediately following (post) TT. TT included 20 minutes of continuous walking with treadmill speed set at the participant's overground comfortable walking speed initially and then increased by 10% in each subsequent 5-minute time interval. Vital signs and perceived rate of exertion (RPE) were collected before, during, and after TT.

**Results :** All participants completed the 20-minute training period. Blood pressure and heart rate responses to walking were within normal ranges; no adverse events occurred. RPEs during treadmill walking ranged from 2-3; one individual needed to rest during TT. Gait measures were unchanged across all conditions following TT. TUG scores trended toward significance between pre1 and post testing ( $p=0.067$ ). Treadmill walking required the full attention of many participants to maintain continuous stepping and most participants (60%) did not attain their comfortable overground walking speeds on the TT by session end, suggesting that it was cognitively challenging.

**Conclusions :** Preliminary data from this study suggest that TT of moderate intensity may be safe and feasible in individuals with HD. Analysis of gait variability and motor coordination data is ongoing.

**Clinical Relevance :** Further studies of the effects of TT on mobility in the HD population seem warranted.

**TITLE:** Gait Variability in Persons with Multiple Sclerosis: Underlying Impairments and Mobility Limitations

**AUTHORS/INSTITUTIONS:** E.C. Held Bradford, J.M. Wagner, Program in Physical Therapy, Saint Louis University, St. Louis, Missouri, UNITED STATES|R.T. Naismith, Department of Neurology, Washington University, St. Louis, Missouri, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Gait variability (GV) is elevated in persons with multiple sclerosis (pwMS) compared to healthy controls and has been linked to recurrent falls. Little is known about the impairments contributing to GV in pwMS. The aim of this study was to explore the impairments underlying GV and determine if pwMS with high GV have greater impairment and mobility limitations than pwMS with low GV.

**Number of Subjects :** 30 pwMS (25 female, 5 male; age: Md=42, range 24-60) with minimal to moderate clinical disability (Expanded Disability Severity Scale (EDSS)): Md=3.0, range 0-6.

**Materials/Methods :** Participants completed a Timed 25-foot Walk Test (T25FWT) across an embedded 16 foot GAITrite instrumented walkway. Spearman rank order correlation ( $\rho$ ) coefficients indexed associations between GV (step length and step time coefficient of variance (SL-CV, ST-CV) and 5 underlying impairments: 1) ataxia (Scale for Assessment and Rating of Ataxia), 2) lower limb (LL) weakness (composite ankle and knee maximal voluntary isometric torque from Biodex System IV computerized dynamometer), 3) LL spasticity (Modified Ashworth Scale composite), 4) LL sensory loss (Computer Aided Sensory Evaluator –vibration perception threshold at great toe), and 5) fatigue (Modified Fatigue Impact Scale-physical). PwMS with CV >5% for either SL, ST or both were classified as being in the high GV group (9/30, 30%), whereas pwMS with CV ≤5% were in the low GV group, (21/30, 70%). Mann-Whitney U and Fisher's exact tests were used to assess differences between the high and low GV groups for 1) the 5 underlying impairments, 2) mobility (Dynamic Gait Index (DGI), Four Square Step Test (FSST), Multiple Sclerosis Walking Scale-12 (MSWS-12v2), Activities-specific Balance Confidence Scale (ABC)), 3) clinical disability (EDSS), and 4) fall history.

**Results :** Ataxia ( $\rho=0.50$ ) and spasticity ( $\rho=0.45$ ) were significantly associated with SL-CV ( $p \leq 0.05$ ). Sensory loss ( $\rho=0.39$ ) and weakness ( $\rho=-0.38$ ) were associated with ST-CV ( $p \leq 0.05$ ). PwMS with high GV had significantly greater ataxia, spasticity, sensory loss, self-perceived walking limitations (MSWS-12v2), impaired mobility (DGI) and greater disability (EDSS) than pwMS with low GV ( $p \leq 0.05$ ). Effect sizes ranged from 0.36 to 0.42. PwMS with high GV had a greater percentage of fallers, 6/9 (66.7%) versus 6/21 (28.6%), but this was not statistically significant ( $p=0.10$ ).

**Conclusions :** SL-CV and ST-CV were associated with different impairments, although only ataxia, spasticity, and sensory loss differed significantly between GV groups. PwMS with high GV reported and demonstrated greater limitations in gait-specific tasks and clinical disability than pwMS with low GV.

**Clinical Relevance :** GV may negatively impact gait-specific tasks and is most likely driven by a combination of impairments, illustrating the importance of an individualized clinical assessment for pwMS.

**TITLE:** Locomotor Recovery After Thoracic Spinal Arteriovenous Malformation

**AUTHORS/INSTITUTIONS:** C. van den Broek, P.M. Spigel, E.J. Fox, Brooks Rehabilitation, Jacksonville, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Sudden, non traumatic spinal cord injury (SCI) may be caused by the rupture of an arteriovenous malformation (AVM); leading to severe functional impairments. Walking recovery is a primary focus of rehabilitation and a common patient goal. Locomotor training (LT) is an intense, activity based therapy that activates spinal neural networks below the level of the spinal cord lesion to promote neuroplasticity and recovery. While the effectiveness of LT for promoting walking recovery after SCI has been established, most studies have not focused on persons with SCI due to an AVM. Since an AVM is a vascular insult, responses to LT may differ from outcomes reported in individuals with injuries secondary to trauma. The purpose of this case report is to describe the use of LT and its effects on walking recovery in a patient with a spinal AVM. A secondary purpose is to discuss how this rare mechanism of SCI may impact the prognosis of functional recovery.

**Case Description :** The patient was a 47 year old male who experienced a sudden onset of complete lower extremity paralysis due to an undiagnosed spinal AVM. The rupture of the AVM resulted in a SCI classified as T2 AIS D. The patient participated in a progressive 4-week inpatient rehabilitation program, including 15 sessions of intense LT using a treadmill and partial body-weight support (BWS). Initial BWS was 60% and progressed down to 15%; treadmill speeds were initially set at 0.8 mph and progressed to 2.5 mph. Skills emphasized on the treadmill were then practiced over-ground to facilitate carryover to functional ambulation. Once the patient no longer required BWS, daily over-ground LT became the focus of therapy sessions. Walking function was assessed prior to LT and weekly until discharge.

**Outcomes :** Initially, the patient was unable to stand or walk without BWS. Following inpatient rehabilitation and intense LT, walking function significantly improved. He was able to walk 241 meters on the 6 Minute Walk test, achieve a gait speed of 1.23 m/s on the 10 Meter walk test, and a 17/20 on the Walking Index for SCI. Upon completion of his inpatient rehabilitation program, he was able to walk without a device or any physical assistance. He even walked out of the hospital on day of discharge, unassisted.

**Discussion :** LT is an effective rehabilitation approach to promote recovery of walking after incomplete SCI. In this individual with a SCI due to a ruptured AVM, independent walking function was achieved following a rehabilitation program that included intense LT. LT may have been particularly effective for this individual since his SCI was vascular in origin, and non-traumatic. Limited literature is available on the prognosis of functional recovery after spinal AVM. Neurologic function at the time of surgical intervention is thought to be the best predictor of prognosis. Despite this patient's initial lower extremity paralysis and unfavorable prognosis at the time of surgical intervention, intense LT appeared to be effective for promoting walking recovery in this individual with this rare mechanism of SCI.

**TITLE:** Functional Electrical Stimulation to Assist Equinovarus Deformity during Gait for a Patient with a foot Dystonia: A Case Study

**AUTHORS/INSTITUTIONS:** H.A. Hayes, B.J. Fechter, Department of Physical Therapy, University of Utah, Salt Lake City, Utah, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Functional Electrical Stimulation (FES) to address a walking difficulty associated with equinovarus deformity and foot drop has been shown to improve gait pattern and quality of life in populations with central nervous system disorders presenting with spasticity (i.e. Stroke, Spinal Cord Injury, and Multiple Sclerosis). Dystonia is a neurological movement disorder presenting with muscles that contract involuntarily, often presenting as a twisting movement of the affected body part making it difficult for voluntary muscle contraction to occur. Limited research has been performed on the use of FES with a foot dystonia. The purpose of this single case study was to assess the use of FES on an individual with foot dystonia on gait speed and quality of life (QOL). We hypothesized that FES would demonstrate improved gait speed and QOL in a patient with foot dystonia.

**Case Description :** The subject was a 32 year old female diagnosed with West Nile Virus and meningoencephalitis (WNVE) from a mosquito bite. She presented with flaccid paralysis and bulbar muscle weakness requiring a feeding tube. The patient had resolution of the bulbar and muscle weakness after 2 weeks of rehabilitation and reported 100% resolution of symptoms related to bulbar weakness. At 6 months she presented to neurology with pain, dysesthesias, hyperesthesia, swelling and skin changes in her left foot. She was diagnosed with complex regional pain syndrome (CRPS) that resolved after 8 months with limited intervention, but developed focal foot dystonia. The patient presented to therapy more than 5 years after initial injury with equinovarus in her left foot causing an inability to walk longer distances. The patient was assessed with and received an FES system to be used during ambulation and returned for follow up 20 months later.

**Outcomes :** After 20 months of daily use of the FES system, clinically significant improvements were noted in 10m Walk Self Selected pace (10SS) and 10m Walk Fast Pace (10FP) both with and without the FES device (10SS with FES +0.18 m/s (+23%), 10FP with FES +0.27 m/s (+28%), 10SS without FES +0.22 m/s (+18%), and 10FP without FES +0.27 m/s (+24%). In addition, improvements were seen in patient subjective report of QOL, which increased by 20%, and Fear of Falling, which decreased by 20%.

**Discussion :** The results of this case study demonstrate improvement in the gait speed and subjective QOL measures for an individual with an equinovarus deformity secondary to a focal dystonia. Improvements were observed both with and without FES, which may suggest an improvement in voluntary muscle control. Although other options exist for treatment of a foot dystonia, e.g. orthotics and deep brain stimulation; FES may be more feasible option as it is less invasive and may be a more functional option. More research is needed to find the effectiveness over a greater number of subjects. FES may be a feasible option for patients with foot drop due to dystonia to improve gait velocity and quality of life.

**TITLE:** Anterior versus posterior walker and walking function after chronic cerebellar stroke: A case report

**AUTHORS/INSTITUTIONS:** K. Mattern-Baxter, C.M. Swanson, D.R. Curtis, C. Estrem, N. Tri, M. McKeough, California State University, Sacramento, Sacramento, California, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Cerebellar stroke causes difficulty with upright mobility due to ataxia and impairments of postural control. Front wheel walkers are the most commonly prescribed walking devices for patients with cerebellar stroke. This case study examined whether a reverse walker (RW) could improve walking speed, walking distance and self-reported safety compared to a customary front wheel walker (FW) in a subject with chronic cerebellar stroke.

**Case Description :** The subject was a 69 year-old male former attorney who suffered a cerebellar stroke four years prior to study onset, resulting in moderate/severe ataxia indicated by a Scale for the Assessment and Rating of Ataxia score of 24.5/40. Since the stroke, the subject regularly engaged in walking activities with a FW with contact guard support. During the study, the subject was evaluated under three walking conditions: customary FW weighing 4.54 kilograms (kg), a RW weighing 12.25 kg, and a control condition of a FW weighted to 12.25 kg. The subject was evaluated on three different days in each walker condition. Outcome measures included the timed 10-meter walk test (10MWT), the 6-minute walk test (6MWT), and a self-reported measure of confidence during activities such as standing, walking on incline, decline, even ground, uneven ground and turning. After initial testing, the subject used the RW for six weeks at home with a caregiver during daily walking, followed by post-assessment.

**Outcomes :** The subject demonstrated superior performance on the outcome measures during the RW condition compared to the other walker conditions. The subject showed fastest walking speed in the 10MWT (0.635 m/s) while using the RW, which was 70% and 44% faster than the FW and weighted FW, respectively; both improvements exceeded the minimal clinically important difference (0.16m/s) for the 10MWT. The subject walked the greatest distance in the 6MWT (157.6 m), or 13% and 24% further than the FW and weighted FW, respectively. The subject scored highest (8/10) on the self-report measure using the RW, compared to the FW (6/10) and weighted FW (7.16/10). After an additional six weeks of using the RW, the subject maintained a faster walking speed (0.5 m/s) on the 10MWT, walked a comparable distance (157 m) during the 6MWT, and reported an improved score (9.8/10) on the self-reported confidence measure.

**Discussion :** The results of this case study show that the use of a RW was superior to a customary FW or weighted FW in regard to walking speed, walking distance, and self-reported walking safety even without practice in a subject with chronic cerebellar stroke. Although the subject had used a FW for four years for ambulation post stroke, the RW led to immediate improvements in all measures even without training. An additional six weeks of walking using the RW led to further improvements in self-reported safety.

**TITLE:** Acute Rehabilitation of Stiff Person Syndrome: A Case Study Report

**AUTHORS/INSTITUTIONS:** C. Munteer, L. Perillo, NYU Langone Medical Center, New York, New York, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Stiff Person Syndrome (SPS) is a rare neurologic disease with an incidence of less than one per million. Symptoms include progressive muscle rigidity in the trunk and limbs, muscle spasms, and abnormal postures. Symptoms are severely disabling to the individual, resulting in loss of functional independence. Currently, there is a paucity of literature on physical therapy (PT) management and rehabilitation of persons' with SPS. This case report follows a patient with SPS from admission in an acute care setting to discharge from acute inpatient rehab. The purpose of this case study report is to describe the benefits of early and intensive rehabilitation in an individual with SPS.

**Case Description :** A 28 year old female diagnosed with SPS less than one year ago was admitted to the hospital with a subjective report of weakness and difficulty walking. Upon examination, she presented with decreased strength and increased rigidity noted in bilateral lower extremities, ataxic trunk movement during mobility, and difficulty isolating single limb movement during gait. She required moderate assist for bed mobility and transfers, and assist of two people for ambulation. She was in the acute care setting for three weeks, receiving three to four 30-minute sessions per week. PT sessions focused on gait training with progression from bilateral hand held assist to use of a rolling walker. Following medical management in acute care, she was discharged to inpatient rehabilitation where she participated in three hours of PT intervention, a minimum of five days a week. Interventions included treadmill training using body weight support treadmill training (BWSTT) with the use of auditory and tactile cues aimed at improving foot placement, step length, and foot clearance. Immediately following BWSTT, over ground gait training was used to progress the individual from use of a rolling walker to no assistive device by discharge.

**Outcomes :** At discharge from inpatient rehab, she demonstrated significant improvements in all areas of functional mobility. Gait speed improved from 0.14m/sec at initial evaluation to 0.73m/sec at discharge. Static and dynamic standing balance improved as evidenced by an increase of 20 points on the Berg Balance Scale. She also decreased the time to complete the Timed Up and Go (TUG) from 33.2 seconds using a rolling walker to 10.6 seconds without the use of an assistive device. The greatest improvements in gait speed and the TUG were observed immediately following the use of BWSTT.

**Discussion :** Current evidence of physical therapy management in individuals with SPS is limited. This case study report demonstrates the effectiveness of intensive rehabilitation and early mobilization for one individual with SPS. This case study is unable to separate the effects of medical management versus rehabilitation, as both appear to be vital in the return of function. This case study highlights that PT intervention may improve functional mobility in individuals with SPS and is an area to be further explored.

**TITLE:** Functional Mobility Improved with Task Specific Training in a Person with Acute Stroke and Complex Medical History: A Case Report

**AUTHORS/INSTITUTIONS:** M. Fedorcha, J. Freund, Elon University, Elon, North Carolina, UNITED STATES|L. Holman, Pine Ridge Health and Rehabilitation, Thomasville, North Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** The purpose of this case report is to describe the effects of task-specific training on balance, gait, and functional mobility in a person with acute stroke and complex medical history. Task-specific training has been shown to be an effective physical therapy intervention after stroke. There is limited evidence on task-specific training for individuals with an acute stroke and a complex medical history.

**Case Description :** The patient was a 70-year old female admitted to a skilled nursing facility (SNF) 3 days after a right cerebral vascular accident with left hemiparesis. Her medical history included hypertension, diabetes mellitus, chronic kidney disease, dementia, depression, hyperlipidemia, osteoarthritis, coronary artery disease, and Sydenham's chorea secondary to childhood rheumatic fever with resultant chronic left side weakness. Prior to admission she used a rolling walker and required close supervision outside of her home. The patient participated in physical therapy 5 times a week for 13 weeks for decreased balance, severe muscle weakness, impaired functional mobility and inability to walk. Her primary goal was to return to her prior level of function. Interventions included task-specific training for gait and functional mobility, and lower extremity strengthening.

**Outcomes :** The following measures improved (pre to post-intervention): Postural Assessment Scale for Stroke (4/36 to 30/36), Tinetti Performance Oriented Mobility Assessment (0/28 to 17/28), Berg Balance Scale (0/56 to 35/56), Forward Modified Functional Reach (2 in. to 5 in.), and gait (unable to contact guard with a hemiwalker 80 feet). The patient rated her overall mobility from pre to post –intervention as +4 (a great deal better) on an 11 point Global Rate of Change (GROC) Scale. She had no falls while at the SNF.

**Discussion :** Improvements in the Forward Modified Functional Reach, Postural Assessment Scale for Stroke, Tinetti Performance Oriented Mobility Assessment, and Berg Balance Scale exceeded the minimal detectable change (MDC) for each measure. The patient was able to return home with the assistance of her daughter. Task-specific training may be an effective intervention to improve balance, gait, and functional mobility in persons with acute stroke and complex medical history.

**TITLE:** Evidence-based treatment approaches as applied to a patient with disorders of consciousness (DOC) through the continuum of care: A case study

**AUTHORS/INSTITUTIONS:** K.M. O'Brien, Shepherd Center, Atlanta, Georgia, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Several individuals with traumatic brain injury (TBI) are admitted to inpatient rehabilitation facilities in vegetative or minimally conscious states, which are classified as disorders of consciousness (DOC). Several theories exist regarding assessment and treatment of patients with DOC. However, efficacy of these methods are sparse within the literature and virtually nonexistent within an inpatient, clinical setting. This case report describes the pathophysiology, assessment, plan of care, and progression of a patient admitted with DOC during his inpatient rehabilitation episode of care. In addition, this case study provides an evidence-based review of treatment approaches utilized during the patient's transition from dependent mobility to assisted ambulation.

**Case Description :** A 19-year old male sustained a severe, closed TBI and was ventilator dependent until his admission to an inpatient rehabilitation facility. He presented in a vegetative state (Rancho Los Amigos Scale II) with signs of progressing to a minimally conscious state. DOC plan of care included sensory stimulation in various functional positions along with initiation of mobility tasks. The patient then emerged to Rancho IV and rehabilitation progressed, focusing on motor control during functional mobility tasks and gait training. Several theories presented in the literature were trialed, such as body-weight supported (BWS) gait training, weighted trunk versus weighted assistive device, and functional electrical stimulation (FES).

**Outcomes :** Several outcome measures were utilized, such as FIM, JFK-Coma Recovery Scale-Revised, Observational Gait Analysis, and BWS percentage. The Acute Care Index of Function (ACIF) was also used to assess meaningful improvements in functional status. The ACIF is a sensitive measure to reflect meaningful changes in an acute care setting and was used in this instance to reflect the subtle improvements of this patient. ACIF scores progressed from 0.51 during his rehabilitation phase to 0.75. The patient progressed from dependent mobility (during DOC phase) to ambulating Min assist (Rancho VI) with a wheeled walker by the end of his inpatient rehabilitation stay.

**Discussion :** This case report demonstrates a young patient's progression from DOC and dependent mobility to Rancho VI and Min assist for transfers and ambulation. Current theories and research regarding sensory stimulation, motor control, and several modes of gait training were applied within the inpatient rehabilitation setting. Patient responses to plan of care and improvements in outcome measure assessments guided clinical decision-making. This case report illustrates the use of evidence-based practice when treating a patient with TBI through his brain injury recovery and continuum of rehabilitation care.

**TITLE:** Investigating the effects of texting on reactive balance

**AUTHORS/INSTITUTIONS:** T. Lampe, L. Schlink, Department of Physical Therapy, Bradley University, Peoria, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of the current study was to investigate how dual tasking affects an individual's reactive balance. The researchers investigated to determine if a more complex distracter, such as texting, with visual, cognitive, and fine motor components, would have a greater affect on reactive balance compared to reading a text, looking down, or looking ahead (control). The researchers hypothesized that the texting condition would lead to the greatest balance impairment, as indicated by increased DMA scores, as measured by the PROPRIO 5000TM.

**Number of Subjects :** 32

**Materials/Methods :** Verbal and written informed consent, exclusion criterion to participate, and demographic/texting habits were obtained. Participants were placed on the PROPRIO 5000TM with a harness. Sample trials in both directions were carried out to expose the participant to the platform movements before the recorded trials. Two separate tasks consisting of four different trials were performed, with the platform moving anterior/posteriorly (AP) and then laterally. The conditions included were looking forward (control) , looking down, reading a text, and texting.

**Results :** Significant differences were found between the means of the total body movement in all conditions in AP and lateral perturbations (Fap=9.072, Flat=9.79, Fapap=5.88, Flatlat=8.035,  $p < .00$ ). Post-hoc analysis revealed a difference ( $p < .00$ ) between the mean total body movement in the control and reading conditions and between the control and texting conditions. No significant differences were found between the control and looking conditions or between the reading and texting conditions for any trials.

**Conclusions :** The results of the study suggest that mild perturbations are more likely to cause a loss of balance in both the AP and lateral directions when an individual is distracted on multiple levels, as illustrated by the reading (visual and cognitive distracters) and texting (visual, cognitive, and fine motor distracters) conditions. Increased postural sway was found in the lateral direction compared to the AP direction, possibly explained by the contact surface area of the feet or the musculature used to maintain upright balance. During the texting and reading conditions, the participants had significantly more postural sway in all trials, indicating that the higher degree of distraction impaired the participants' spatial awareness, and created more movement and poorer balance.

**Clinical Relevance :** The results of the study indicated that the dual tasking of cell phone use did have a significant effect on reactive balance. However, the most interesting part of the research done was that there were no significant differences between reading a text message and typing a text message, providing evidence that the cognitive distracter played the biggest role compared to the visual and fine motor components. In the clinic, these research findings provide reason to challenge our fall risk patients not only with vision removal and compliant surfaces, but with cognitive distracters to most effectively simulate real world fall situations and possibly prevent future falls.

**TITLE:** Self-Reported Trunk Fatigue Impairs Postural Control in Persons with Multiple Sclerosis

**AUTHORS/INSTITUTIONS:** J.R. Magill, J. Freund, D. Stetts, S. Vallabhajosula, Elon University, Burlington, North Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Persons with multiple sclerosis (PwMS) commonly have impaired balance with subsequent decreased mobility and increased falls risk. Trunk muscles provide stabilization for posture and mobility and when fatigued impair postural control in healthy persons. It is unknown how trunk fatigue effects postural control in PwMS. The purpose of this study was to determine the effects of self-reported fatigue due to a trunk isometric endurance protocol on postural control in PwMS and to compare postural control in PwMS to healthy persons.

**Number of Subjects :** 13 ambulatory PwMS of varying levels of remission and age and gender-matched healthy controls (for both groups, mean age, 52.5 years, standard deviation of 14.66 years for PwMs and 13.40 years for controls; 12 females).

**Materials/Methods :** Subjects performed flexion and extension trunk endurance tests to self-reported fatigue (measured in s). Their postural sway was assessed during a 3-minute quiet standing trial on a Biodex Balance System both before and after trunk endurance testing using similar foot position. Center of pressure data was collected and analyzed to compute range, path length and sway area for first minute and overall three minutes of each standing trial. Time (Pre1min, PreOverall, Post1min, PostOverall) X Group (PwMS, Controls) mixed ANOVA was performed to estimate both short-term fatigue due to standing (Pre1min vs. PreOverall; Post1min vs. PostOverall) and long-term fatigue due to trunk endurance testing (Preoverall vs. PostOverall). Subjects' self-reported fatigue during endurance tests was analyzed using independent samples T-test.

**Results :** Significant time x group interaction was found for path length ( $P = .005$ ). Both PwMS and controls exhibited similar values for Pre1min (PwMS: 64.11 cm, Controls: 40.14 cm) and Post1min (PwMS: 64.00 cm, Controls: 43.77 cm). Controls had greater path length Post- compared to Pre- trunk endurance (7%). However, PwMS exhibited lesser path length Post- compared to Pre- trunk endurance (4%). All measures showed significant group main effect where PwMS exhibited greater elliptical sway area (67.26%), path length (31.26%), A/P range (32.37%), and M/L range (34.57%) compared to controls ( $P < 0.05$ ). PwMS exhibited fatigue quicker than controls during both trunk flexion (52%;  $P = .026$ ) and extension (45%;  $P = .002$ ) endurance tests.

**Conclusions :** Decreased path length without a different sway area in PwMS after self-reported fatigue may indicate increased trunk muscle activation to stiffen the spine and improve stability. Also, PwMS fatigued quicker during the trunk endurance tests suggesting decreased trunk muscle performance. Continued research is needed to investigate trunk muscle structure and performance in PwMS related to postural control and functional mobility.

**Clinical Relevance :** Due to decreased time to self-reported fatigue and related impaired postural control, trunk flexion and extension endurance testing and training should be considered in PwMS.

**TITLE:** Inpatient and Outpatient Physical Therapy Treatments for Von-Hippel Lindau Disease: A Case Report

**AUTHORS/INSTITUTIONS:** S. Flanzraich, Outpatient Physical Therapy, NYU Medical Center, Rusk Institute for Rehab, New York, New York, UNITED STATES|K. Knotte, Outpatient Physical Therapy, NYU Medical Center, New York, New York, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Von Hippel-Lindau Disease (VHL) is a rare inherited multisystem familial cancer syndrome with visceral and CNS expressions. It is found on chromosome 3q25 with an annual incidence of one per 36,000 live births. The CNS findings of VHL disease include hemangioblastomas (slow-growing highly vascular neoplasms) of the retina, brainstem, cerebellum, spinal cord and endolymphatic sac tumors. In VHL disease cysts commonly grow along with the hemangioblastomas, which may cause swelling and inflammation along the spinal cord and is the common cause of symptoms/impairments. These neoplasms may never grow or they may have growth phases for a period of time such as 12-18 months. The purpose of this case report is to show that patients with Von Hippel-Lindau Disease (VHL) can continue to make gains with both inpatient and outpatient physical therapy throughout their disease.

**Case Description :** Patient is a 21 year old male who was diagnosed with VHL disease in 2008. Patient's history includes extensive inpatient and outpatient physical therapy that was last received 1 year ago. Patient was referred to outpatient physical therapy currently for decline in functional mobility and quadriparesis. Patient presented to outpatient initial evaluation with bilateral lower extremity weakness, decreased endurance and impaired standing balance. Patient reported that he had not stood for 3 weeks, was non-ambulatory and required max assistance for transfers. He received outpatient therapy for 4 treatment sessions and was then admitted from home to inpatient rehabilitation for 4 weeks to maximize functional recovery. Patient returned to outpatient physical therapy after his rehabilitation admission for continued gait, transfer and balance training. Physical therapy interventions in both inpatient and outpatient therapy included gait training in the parallel bars followed by over level ground using weighted rolling walkers and TheraTogs, standing balance, core strengthening, and bilateral lower extremity strengthening exercises in various positions, including tall and half kneeling.

**Outcomes :** At admission to inpatient rehab, patient was able to ambulate 15 feet in parallel bars with contact guard and perform sit to and from stand transfers using rolling walker with contact guard. Post inpatient rehab and re-admittance to outpatient physical therapy, patient was able to ambulate in his apartment with a Rolling Walker with supervision and perform all transfers with supervision. Patient also presented with a 50 foot walk test score of 2 min 33 sec with a rolling walker and a Time Up and Go score of 1 min 41 sec with a rolling walker.

**Discussion :** There has been little research on the benefits of receiving physical therapy in patients with VHL disease. The above case study highlights that both inpatient and outpatient physical therapy after a prolonged period of time without therapeutic services can provide functional improvements in patients with chronic neurological conditions such as VHL disease.

**TITLE:** Physical Therapy management and functional outcomes following neurorestorative surgery for individual with incomplete SCI

**AUTHORS/INSTITUTIONS:** N. Weeks-ONeal, R. Silverman, Physical therapy, Touro University Nevada, Henderson, Nevada, UNITED STATES|J.M. Brown, Assistant Professor of Neurosurgery, Director of Neurosurgery Peripheral Nerve Program and Co-Director of the Center for Neurophysiology and Restorative Neurology, University of California, San Diego, San Diego, California, UNITED STATES|L. Teske, Physical Therapy, Healthsouth Rehabilitation Hospital of Henderson, Henderson, Nevada, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Restoring ambulation ability following incomplete spinal cord injury (SCI) is a primary rehabilitation goal. Incomplete SCI can result in muscle hypertonicity, which can further impair walking function. A relatively new surgical procedure is being performed to decrease the amount of muscle tone through selective peripheral neurotomies. The single case report investigated the impact of walking function on a person with a C5 Incomplete SCI status-post selective peripheral neurotomies to the tibial nerve to reduce spasticity in the plantarflexors and 21 physical therapy sessions for neuro reeducation, gait training

**Case Description :** A 50 year old male who suffered from an Incomplete SCI after MVA resulting in partial paralysis of his right side. Two years post-injury he continued to have non-functional ambulation velocity and was high fall risk due to right lower extremity muscle weakness and plantarflexor hypertonicity. Participant underwent selective neurotomies of the right tibial nerve and subsequent physical therapy, which resulted in substantial improvement in both gait speed, gait quality, and balance.

**Outcomes :** At study completion, improvement was noted in walking speed (from 0.34m/s to 0.46 m/s); Improved balance as indicated both TUG (from 27 s to 18 s) and Berg Balance Scale scores (from 45 to 50). Observational gait analysis revealed improved stride length on the right LE, no longer circumducted R LE during swing. transition from use of Small Based Quad cane during community ambulation to single point cane, with patient report of not using an assistive device while walking at home.

**Discussion :** This case report describes the impact of physical therapy interventions on gait following neurorestorative surgery on an individual with incomplete SCI. The patient demonstrated improvements in gait mechanics, gait velocity, less restrictive AFO brace, balance, however, objective measures still indicated patient was a fall risk at time of discharge from physical therapy. Patient was able to achieve improved ankle ROM dorsiflexion, but, due to continued contracture of right plantar flexors muscles, the physician and physical therapist recommended surgical intervention. Patient was subsequently discharged from physical therapy to preserve insurance plan limitations on visits per calendar year, pending resumption of physical therapy following Achilles tendon lengthening surgery and additional neurorestorative surgical interventions for right upper extremity. This surgical approach is a relatively new technique in the United States, thus much can be learned from following the patients utilizing objective outcome measures for functional mobility and gait. Due to the newness of the surgery, there are limited cases to study and even fewer reporting on physical therapy interventions. This case report was aimed at adding to the body of knowledge on this.

**TITLE:** Treadmill-based training with manual assistance improves dynamic balance more than overground training in persons with motor-incomplete spinal cord injury.

**AUTHORS/INSTITUTIONS:** E.C. Field-Fote, Crawford Research Institute, Shepherd Center, Atlanta, Georgia, UNITED STATES|D. Meadows, S. Garcia, Department of Physical Therapy, University of Miami Miller School of Medicine, Miami, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Current rehabilitative strategies to improve impaired walking ability after motor incomplete spinal cord injury (MISCI) focus on task-specific locomotor training. Beyond walking function, good dynamic standing balance is important for allowing persons with MISCI to walk faster, for longer distances, while decreasing fall risks. There has been little investigation into the effect of locomotor training as an approach to facilitate the recovery of dynamic standing balance. Although over ground locomotor training has been shown to be associated with greater improvements in walking speed and distance compared to treadmill-based training in persons with MISCI, it is unknown which locomotor training approach has the greatest influence on dynamic standing balance. The purpose of this study was to compare the improvement in balance produced by each of four different locomotor training approaches.

**Number of Subjects :** Participants (n=74) with a chronic (> 1 year) American Spinal Injury Association (ASIA) Impairment Scale (AIS) classification C or D SCI at or above T10 were recruited and 64 subjects completed the study.

**Materials/Methods :** This study was a single-blind, randomized clinical trial conducted in a rehabilitation research laboratory. Participants were randomized into one of 4 treatment groups, including: treadmill-based training with manual assistance (TM, n=17), treadmill-based training with functional electrical stimulation (TS, n=18), over ground training with dorsi-flexion assist stimulation (OG, n=15), and treadmill-based training with robotic assistance (LR, n=14). Participants received 12 weeks of locomotor training treatment sessions 5 days per week. Standing balance was evaluated at baseline and at the end of the 12 weeks using the Berg balance scale. ANOVA was used to compare the 4 groups on change in balance score. Effect sizes for the change in balance score were calculated for each group.

**Results :** The TM group demonstrated a moderate effect size (ES=0.52). Mean Berg scores improved for all 4 groups but the effect size was small for the TS (ES=0.05), LR (ES=0.14) and OG (ES=0.16). ANOVA analysis identified a statistically difference between the TS and TM groups in Berg score change.

**Conclusions :** In people with chronic motor incomplete SCI, dynamic standing balance improved with each of the four locomotor training approaches; the greatest improvement was observed in the treadmill-based training with manual assistance.

**Clinical Relevance :** Treadmill-based locomotor training with manual facilitation of stepping holds greater promise for improving dynamic standing balance in persons with MISCI. It is possible that treadmill-based training provides an external challenge that requires an appropriate reaction to maintain standing balance during mobility, resulting in improved balance responses. Improved dynamic standing balance decreases the risk for falls, and may have a positive effect on walking speed and distance while decreasing the risk for falls.

**TITLE:** Improving Functional Ability in a Person with Myotonic Dystrophy Following Respiratory Failure: A Case Report

**AUTHORS/INSTITUTIONS:** M. Shaffer, K. Erickson, Carroll University, Waukesha, Wisconsin, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Myotonic dystrophy (DM) is the most common adult muscular dystrophy. The slowly progressive autosomal dominant disorder affects both smooth and cardiac muscle function. Additionally, progressive respiratory muscle weakness can lead to impairment of airway clearance, inadequate ventilation and respiratory failure within this population. Although the literature is generally supportive of strength training in healthy patients with DM, a thorough search of the literature showed a lack of evidence to determine the safest and most efficacious approach to rehabilitation with individuals with progressive neuromuscular conditions who also experience respiratory failure. The purpose of this case report was to describe systematic physical therapy intervention based on exercise principles for a patient with respiratory failure secondary to the progression of myotonic dystrophy.

**Case Description :** The patient was a 69 year old female in an LTAC setting with a history of myotonic dystrophy, poliomyelitis, and pneumonia with respiratory failure. The patient presented with weakness, lethargy, full time use of a ventilator and dependence with all mobility skills. The patient's functional abilities were assessed using the Function in Sitting Test (FIST) and four mobility measures of the Functional Independence Measure (FIM) which were administered at the initial evaluation and after 6 weeks of physical therapy. Interventions included a controlled progression of strengthening and mobility training using the overload principle and specific adaptations to imposed demands (SAID principle) with close monitoring of vital signs and perceived exertion using the BORG scale. The physical therapist utilized a combination of lower extremity strengthening, bed mobility training, unsupported sitting for balance and trunk control, and gait training.

**Outcomes :** At the conclusion of the 6 week intervention, the patient was independent with bed mobility skills and was able to transfer and ambulate using an assistive device with contact guard assist of one. The patient was also weaning from the ventilator with ventilator use only at night and use of 2 liters of oxygen during therapy sessions. The outcome scores improved significantly during the intervention (mobility FIM improved from 4/28 to 18/28, FIST improved from 27/56 to 50/56).

**Discussion :** The patient demonstrated significant functional weakness secondary to myotonic dystrophy with respiratory failure. There is little research on appropriate intervention selection and progression within this specific patient population. The PT intervention utilized allowed the patient to gradually increase her activity tolerance safely and systematically. The patient's outcomes suggest that through the use of overload and SAID principles along with increasing mobility was an effective approach to improve functional independence.

**TITLE:** Mirror therapy for patients with hemiparesis – A systematic review

**AUTHORS/INSTITUTIONS:** H. Master, Y. Salem, C. Holmes, H. Liu, Physical Therapy, University of North Texas Health Science Center, Fort Worth , Texas, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** By using the “imagery” movement of the affected upper or lower extremity, the Mirror therapy (MT) has been lately considered by many rehabilitation professionals as an effective adjunct intervention for recovering patients with stroke. The purpose of this study was to identify patient population who can benefit from MT, MT intervention parameters, outcome assessments for the MT-related studies, and possible neural mechanism of the MT intervention.

**Number of Subjects :** Fifteen articles were qualified for analysis of this review.

**Materials/Methods :** Two researchers performed literature search by using Ovid Medline, Scopus, Medline, Cochrane and PubMed independently. Eligible studies published from 1996 through April 2014 were selected. The keywords for search were stroke, CVA, mirror therapy, Imagery therapy, hemiparesis, and hemi-paralysis.

**Results :** Among all qualified articles, most (14/15) investigated the MT effect on upper extremity (UE), but few (1/15) on the lower extremity (LE). MT could be used alone , or combined with therapeutic exercise, or neuromuscular electrical stimulation (NMES). Patients in subacute or chronic stage of stroke could benefit from the MT intervention either on UE or on LE. The intervention parameters in these studies are: 20-45 minutes/time, 3-5 times/week for 6-12 weeks (subacute stage) or 3-6 weeks in chronic stage. It demonstrated that the MT could improve: 1) functional performance (assessed with Jebsen Hand Function Test, Wolf Motor Function Test, Frenchay Arm Test, Functional Independence Measure, Fugl-Meyer Assessment, time to complete ADL, or UE reaction time), 2) muscle strength and flexibility (measured with grip strength test and range of motion), 3) functional mobility (assessed with Motor Activity Log Scores, Functional Ambulation Categories, and 10-meter walk), and 4) pain (determined with pain scales). However, no improvement was identified in spasticity tested with Modified Ashworth Scale in two studies. It was found that with the “fake” movement of the affected UE in a patient with stroke, the areas for hand and forearm in bilateral premotor cortexes were activated as evidenced by functional MRI. It has been reported that in premotor cortex, there are mirror neurons – that can mirror the movement of one side of body, as though it was motion of other side of body.

**Conclusions :** Mirror therapy alone or combined with regular exercise or NMES is able to improve functional performance, strength and flexibility, mobility, and pain in patients in subacute and chronic stage, but improvement of spasticity seems not to be promising. Patients in subacute stage may take longer duration time than those in chronic stage. Identification of mirror neurons in the cortex areas might attribute to the explanation of MT effectiveness.

**Clinical Relevance :** Mirror therapy is a convenient, easy-to-use, and cost-effective intervention for patients with stroke in rehab hospitals, outpatient clinics, and even at home. Its use alone or combination with other physical therapy interventions may be able to facilitate the functional recovery of upper and lower extremities.

**TITLE:** Vibration as an effective treatment for reducing spasticity in patients with a neurological impairment

**AUTHORS/INSTITUTIONS:** J.C. Layman, N. Gelvezon, R. Sweet, M.Y. Poteat, Physical Therapy, Southwest Baptist University, Bolivar, Missouri, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Due to of the prevalence of spasticity in neurological patients; a more convenient, effective, and less invasive approach to treatment, such as vibration, would be beneficial to a large patient population. Therefore this systematic review investigates if the use of vibration is an effective treatment for reducing spasticity in patients with neurological impairments.

**Number of Subjects :** 152 (total across all articles included in the systematic review)

**Materials/Methods :** A search of Academic Search Elite, Academic Search Premier, CINAHL Complete, Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Cochrane Methodology Register, Database of Abstracts of Reviews of Effects, Historical Abstracts, Information Science & Technology Abstracts, MEDLINE, MLA Directory of Periodicals, SocINDEX, and SPORTDiscus, using the terms “whole body vibration” and “spasticity” was conducted. Inclusion criteria was scholarly, peer reviewed journals, and the Modified Ashworth Scale (MAS) as the outcome measure. Exclusion of duplicates filtered down the results to seven articles. These articles were graded using a level of quality scale from the AACPD’s Methodology to Develop Systematic Reviews of Treatment Interventions (Revision 1.2).

**Results :** The studies ranged from 14 to 36 subjects with spasticity as a result of a neurological condition (CP, MS, SCI, or CVA). Five of the studies were group studies ranging in methodological quality from Level II – M(4/7) to Level II – S(7/7). The remaining two studies were single subject designs with methodological quality of Level II – M(8/14) and Level II – S(11/14). Five of the seven studies showed a statistically significant reduction in spasticity after the use of vibration treatment.

**Conclusions :** The evidence supports the use of vibration therapy to treat spasticity as improvements in spasticity were seen with most patients. Findings also support the potential for effects to be sustained for six to eight days after treatment. There is still a need for larger randomized controlled trials to determine its efficacy, a possible therapeutic threshold of treatment for improvement, and the potential duration of effect on spasticity after treatment.

**Clinical Relevance :** Vibration could be useful in decreasing spasticity and the effects might persist for at least eight days after treatment. There also appeared to be a correlation between level of spasticity and amount of improvement; patients that were more spastic had a larger decrease in spasticity. Patients also improved the same amount regardless of whether or not they were on antispastic medication. Therefore, whole-body vibration could be used in conjunction with (or as a possible alternative to) pharmacotherapy. The lack of adverse events and the significant changes seen in some of the studies supports the use of vibration to treat spasticity.

**TITLE:** How are standardized assessments used to guide clinical recommendations for rehabilitation services post-stroke?

**AUTHORS/INSTITUTIONS:** M.D. Bland, C.E. Lang, Physical Therapy, Washington University, St. Louis, Missouri, UNITED STATES|M.H. Whitson, H.K. Harris, Rehabilitation Services, Barnes Jewish Hospital, St. Louis, Missouri, UNITED STATES|L.T. Connor, Occupational Therapy, Washington University, St. Louis, Missouri, UNITED STATES|R. Fucetola, M. Corbetta, Neurology, Washington University, St. Louis, Missouri, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Examine how standardized assessment scores from initial, acute care physical (PT) and occupational therapy (OT) evaluations, contribute to discharge recommendations for post-stroke rehabilitation services.

**Number of Subjects :** 2738 post-stroke participant records with the same PT and OT recommendation for rehabilitative services, stored in the Brain Recovery Core database from January 2010-March 2013.

**Materials/Methods :** Participants admitted to the acute hospital with diagnosis of stroke received PT and OT evaluation with the following standardized assessments: Motricity Index, somatosensation, Berg Balance Scale, 10-m walk speed, Short Blessed Test, Trail Making Test A and B, Unstructured Mesulam, Boston Naming Test, Functional Independence Measure (gait assist, grooming, dressing, toileting). Additional variables: age, gender, race, and help at home. At initial evaluation, PT and OT make a discharge recommendation of home no services, home with services, inpatient rehabilitation facility (IRF), or skilled nursing facility (SNF). A K-means clustering algorithm was run to determine if participants could be categorized into the four discharge recommendations based on their initial assessment scores. Results from the cluster analysis were compared to the discharge recommendations made by PT and OT to see how assessment scores were being used to guide post-acute care rehabilitation recommendations.

**Results :** The cluster analysis revealed 4 clusters (A, B, C, D) with Cluster A being the least impaired followed by B, C, and D. The mean cluster center for Cluster A was 58 years old with a Motricity Index affected limb upper and lower extremity scores of 84 and 86 respectively, modified independence or supervision on functional activities and a negative screen for dementia or neglect. In comparison, Cluster D had a mean cluster center age of 69, a Motricity Index affected limb upper and lower extremity scores of 38 and 42 respectively, moderate or maximal assist required on functional tasks and positive screens for dementia and neglect. Cluster B and C fit sequentially between A and D. Despite the differences across the four clusters, a similar percentage of participants were recommended to go to each location: home without services (15-23%), home with services (4-12%), IRF (60-65%), or SNF (9-10%).

**Conclusions :** Participants post-stroke can be classified into meaningful groups based on assessment scores from their initial acute care PT and OT evaluations. Clear groups emerged based on levels of severity across the domains of mobility, cognition, and language. Surprisingly, regardless of the group, PT and OT recommendations for post-stroke rehabilitation services were similar.

**Clinical Relevance :** A goal of standardized assessment is to use the objective measures of impairment, activity and participation to assist clinicians in determining services post-discharge. However, these results suggest that standardized assessments are not used to systematically guide post-stroke acute care discharge recommendations for rehabilitation services.

**TITLE:** The benefits of aerobic exercise on fatigue, functional status, sleep, and cardiorespiratory fitness in individuals with multiple sclerosis: a pilot study

**AUTHORS/INSTITUTIONS:** C.F. Siengsukon, M. Aldughmi, P. Dowling, S. Billinger, KU Physical Therapy and Rehabilitation Sciences, The University of Kansas Medical Center, Kansas City, Kansas, UNITED STATES|J. Bruce, Psychology Department, University of Missouri-Kansas City, Kansas City, Missouri, UNITED STATES|S.G. Lynch, Neurology Department, University of Kansas Medical Center, Kansas City, Kansas, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The benefits of aerobic exercise (AE) in healthy adults are well known. However, the impact of aerobic exercise on individuals with MS is less clear and randomized controlled trials assessing the impact of AE on individuals with MS is lacking. This is particularly important as up to 90% of people with MS experience fatigue and 50% experience sleep issues, two of the most common issues other than functional limitations reported by individuals with MS. The purpose of this pilot study was to examine the effect of a 3 month AE program on fatigue and sleep in individuals with MS. The secondary purpose was to assess compliance with the AE program.

**Number of Subjects :** Nine individuals with relapsing-remitting or secondary-progressive MS ( $57.1 \pm 9.48$  years of age) participated in this randomized controlled study.

**Materials/Methods :** Participants underwent baseline assessment by completing questionnaires to assess fatigue (Modified Fatigue Impact Scale), functional status (Functional Status Questionnaire), and sleep quality (Pittsburgh Sleep Quality Index) and underwent a submaximal exercise test to predict cardiorespiratory fitness (measured as predicted peak VO<sub>2</sub>) and to prescribe exercise. Following baseline assessment, participants were randomized into either a supervised moderate-intensity AE group or a home exercise program (HEP) group which consisted of stretching and walking at a low intensity. Following 12-weeks of exercise, participants underwent reassessment of the outcome measures. Individuals in the HEP group kept a daily exercise log to assess compliance with the HEP program, and research personnel kept a daily exercise log for individuals in the AE group. Due to small sample size, percent change scores are reported for the primary outcomes of interest. Percent compliance was also calculated using the daily exercise logs.

**Results :** The AE group demonstrated an improvement in fatigue (3%), sleep quality (10%), functional status (5%), and predicted peak VO<sub>2</sub> (27%) while the HEP group demonstrated either no change or a worsening of these outcomes (fatigue worsened by 5%, sleep quality worsened by 8%, no change in functional status, and a 1% decline in predicted peak VO<sub>2</sub>). The AE group was 93% compliant with the exercise program, and the HEP was 79% compliant.

**Conclusions :** This study suggests that AE may maintain or improve fatigue, sleep quality, functional status and cardiorespiratory fitness in people with MS while an unsupervised low intensity HEP does not. The improvements in primary outcomes may be due to the improvement in cardiorespiratory fitness experienced by the individuals in the AE group rather than compliance with the exercise programs because individuals in both groups were compliant with the program. A larger scale randomized control trial is needed to support these preliminary findings.

**Clinical Relevance :** AE may be a simple, cost effective non-pharmacological method to address symptoms commonly experienced by people with MS. Future studies are needed to verify this contention.

**TITLE:** Reliability of Limits of Stability test in high school adolescents using portable force plate system

**AUTHORS/INSTITUTIONS:** K. Stockdale, J. Haines, A.M. Yorke, B. Alsalaheen, Physical Therapy, University of Michigan-Flint, Flint, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Adolescents present with an array of injuries that warrant postural stability assessment. While static balance is commonly utilized in clinics, assessment of dynamic postural stability may be more clinically meaningful and functionally relevant. The Limits of Stability (LOS) test is a comprehensive dynamic balance assessment protocol administered using force platforms. Despite its wide use, the test-retest reliability for LOS is not well documented in high-school adolescents. The purpose of this study was to determine test-retest reliability of LOS testing outcomes in high-school aged adolescents between the age of 14 and 18 years.

**Number of Subjects :** Twenty Six (17 Male/ 9 Female, Mean age 16 years)

**Materials/Methods :** Participants performed the LOS test during two different sessions, one week apart. During each session, each participant was instructed to move his/her body as quickly and accurately as possible toward eight predetermined targets and maintain the end position for 8 seconds. The sway and movement data were sampled a rate of 100 HZ/second. The data was used to generate five composite scores (reaction time, movement velocity, endpoint excursion, maximum excursion, and directional control). The reliability of the composite scores was analyzed using the Intraclass Correlation Coefficient (ICC: 2, 1).

**Results :** The ICCs for test-retest reliability for comprehensive endpoint excursion and maximum excursion demonstrated excellent reliability with ICCs of 0.81 and 0.86, respectively. Fair reliability was shown for comprehensive movement velocity with an ICC of 0.65. Poor reliability was reported for reaction time and directional control with ICCs of 0.55 and 0.50, respectively.

**Conclusions :** LOS composite scores demonstrated fair to excellent reliability for all parameters except reaction time and directional control in high school aged adolescents. Participants may have focused on the speed of movement or accuracy of movement direction resulting in less than fair reliability scores for reaction time and directional control.

**Clinical Relevance :** Reliability and detectable change estimates for dynamic balance measures are necessary to determine the true change in balance compared to change attributed to error in measurement or normal variance. This information will be useful to clinicians to make clinically sound decision about true improvement or decline in dynamic balance

**TITLE:** Variability of vestibular rehabilitation outcomes based on patient's perceptions of symptoms and functional limitations.

**AUTHORS/INSTITUTIONS:** B. Alsalaheen, Department of Physical Therapy, University of Michigan-Flint, Flint, Michigan, UNITED STATES|W. Carender, Department of Otolaryngology, University of Michigan Health System, Ann Arbor, Michigan, UNITED STATES|P. Sabourin, Department of Rehabilitation Services, Beaumont Health System, Royal Oak, Michigan, UNITED STATES|J. Schreiber, Colleague for Graduate Studies, Chatham University, Pittsburgh, Pennsylvania, UNITED STATES|G. Marchetti, Department of Physical Therapy, Duquesne University, Pittsburgh, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Patients with vestibular disorders present with different perceptions about their symptoms and the functional limitations associated with the diagnosis. However, it is unclear how clinicians identify these perceptions and how these differences may affect the course and the outcomes of vestibular rehabilitation. Therefore, the purpose of this case report was to describe the clinical course and outcomes of two patients with similar clinical presentations but different perceptions of symptoms and activity limitations. In addition, an expert clinician shared reflections on how patient perceptions about diagnosis may affect the course and the outcomes of vestibular rehabilitation.

**Case Description :** Two patients (48 and 57 years old) were referred for vestibular rehabilitation following surgical repair for superior semicircular canal dehiscence syndrome. Upon initial evaluation, both patients demonstrated the same level of functioning on the Dynamic Gait Index and Timed Up & Go (TUG). However, they differed on subjective components of assessment and the Dizziness Handicap Inventory Score suggesting different behavioral traits. A certified vestibular physical therapist (11 years of vestibular experience, 29 years of clinical PT experience) was asked a series of questions related to identification and management of patient perceptions of symptoms and functional limitations over the course of rehabilitation.

**Outcomes :** The patient with lower perceived handicap at evaluation improved on functional performance and self-report measures within two visits over the course of 3 weeks. The other patient with higher perceived handicap exhibited a slower improvement on functional performance (8 visits over the course of 18 months) and the functional improvement was not reflected on self-report assessments. The expert clinician identified three key considerations that may contribute to variability of vestibular rehabilitation outcomes; description of factors that provoke symptoms and the extent of functional limitations, the relationship between changes in self-report and performance measures, and the interpretation of transient increase in symptoms. The two patients presented in this case study were different on the identified key considerations, which may have influenced their clinical outcomes

**Discussion :** Patients with vestibular disorders may present with traits that are determinant to vestibular rehabilitation outcomes. Some of these traits include vague description of symptoms and provoking factors, greater mismatch between functional performance and perceived function, and difficulty in recognizing small incremental improvements. Patients with these traits may require accommodations to facilitate optimal outcomes of vestibular rehabilitation. Accommodations may include different goal setting parameters, higher visits frequency, slower progression of exercise programs, detailed exercise prescription parameters and utilization of multiple self-report and functional measures to assess recovery.

**TITLE:** Reliability of Instrumented Balance Assessment in Adolescents using Portable Force Plate System

**AUTHORS/INSTITUTIONS:** J. Haines, A.M. Yorke, K. Stockdale, B. Alsalaheen, Department of Physical Therapy, University of Michigan-Flint, Flint, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Assessment of balance in adolescents can be challenging for clinicians. Clinical balance measurements currently in use may not be sensitive to detect subtle balance deficits possessed by adolescents. Additionally, clinical measures used in this population are subjective in nature and exhibit high learning effects. The availability of portable force plates systems in recent years has allowed for instrumentation of clinical measures outside laboratory settings; however, the reliability of instrumented balance measures has not been examined. The purpose of this study is to describe the test-retest reliability for the instrumented Balance Error Scoring System (BESS) and the Modified Clinical Test for Sensory interaction on Balance (MCTSIB) in healthy adolescents using commercially available force plate system (Balance Master, NeuroCom, Inc).

**Number of Subjects :** Twenty-Six (17 Male/ 9 Female, Mean age 16 years) were recruited from local high schools.

**Materials/Methods :** Participants performed the instrumented BESS and the MCSTIB test in a random order during two different sessions, approximately one week apart. The data was sampled from the force plate at a rate of 100 Hz/ second. For each individual condition, the sway velocity was calculated (degree/ second). Additionally, the average sway velocity across conditions was calculated to generate one composite score. The reliability of individual condition scores and the composite scores was calculated using the Intraclass Correlation Coefficient (ICC 2, 1). Standard Error of Measurements and the Minimal Detectable Change were calculated for the composite scores.

**Results :** A reliability score of 0.85 and 0.78 was obtained for the composite score of the BESS and the MCTSIB, respectively. The reliability of individual conditions ranged between (0.2 - 0.6) for the BESS, and (0.40 -0.72) for the MCTSIB. Minimal detectable change (MDC) scores at the 95% confidence interval were 0.6 deg/ sec, and 0.2 deg/ sec for the BESS and the MCTSIB, respectively.

**Conclusions :** The composite scores for the instrumented BESS and MCTSIB demonstrated acceptable reliability for clinical use in adolescents. However, the reliability of individual conditions ranged from poor to moderate which may have been attributed to minimal variability in sway velocity in healthy adolescents. A change of 0.6 deg/ sec in the composite score of the BESS or more considered a true change, whereas a change of 0.2 deg/ sec or more is reflective a true change in the MCTSIB.

**Clinical Relevance :** Instrumented balance assessment using force plate system may provide a reliable assessment of balance in adolescents. However, the responsiveness of sway velocity to subtle changes in balance is yet to be examined in clinical populations. Clinicians may use MDC scores established in this report to examine if change in sway velocity is reflective of true change in balance or attributed to normal variability between trials and/or measurement error.

**TITLE:** Treatment Alternatives for a Patient with Vestibular-Exacerbated Ataxia

**AUTHORS/INSTITUTIONS:** A. Ehrhart, L. Wall, Department of Physical Medicine and Rehabilitation, Cedars-Sinai Medical Center, Los Angeles, California, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Standard treatment (tx) for ataxic gait aims to improve proprioception and sensory feedback of muscle contraction and coordination during functional activities. Methods include balance training and proprioceptive feedback using joint weights, assistive devices, and manual facilitation. Ataxia stems from a multitude of genetic, inflammatory, or structural lesions in the spinocerebellum. However, the vestibular system also connects through the cerebellum, which can lead to vestibular-exacerbated ataxia if multiple lesions are present in the vestibulo- and spino-cerebellum. In one patient (pt) this type of ataxia required additional vestibular exercises and whole body, deep pressure positioning to achieve successful outcomes after standard tx showed minimal gains.

**Case Description :** A 56-year-old female was admitted to the Acute Rehabilitation Unit (ARU) after a left suboccipital craniotomy and resections for multiple cerebellar masses due to recurrent hemangioblastomas. The pt completed 18 days of ARU-level therapies before discharging home. The initial ten days focused on decreasing ataxia using ankle weights and a weighted vest during gait. Activities in quadruped and seated vestibular-ocular reflex (VOR) exercises (with fixed object) were also done separately to address the pt's ongoing dizziness. The last eight days of tx focused on using whole body deep pressure techniques throughout a developmental progression with simultaneous VOR exercises. Outcomes were measured via qualitative video gait analysis, the Tinetti Performance Oriented Mobility Assessment (Tinetti POMA: a task-oriented balance test), the Scale for Assessment and Rating of Ataxia (SARA: a clinical impairment scale), and self-reported dizziness during gait.

**Outcomes :** The pt made small gains in the first 10 days with 480 total tx minutes (all gait assessments done with walker). After 8 days of 250 total minutes of whole body deep pressure tx, the pt demonstrated marked improvement in qualitative gait pattern with decreased ataxia and dizziness, and functional gait of 150 feet with contact guard assist. Day #1: Tinetti POMA 6/28, SARA 25/40, Gait Moderate assist 25 feet, Dizziness present Day #10: 10/28, 23/40, Moderate assist 80 feet, Dizziness present Day #18: 15/28, 17/40, Contact guard 150 feet, Dizziness absent \*Tinetti: higher = improved \*SARA: lower = improved

**Discussion :** Combining VOR exercises with a defined progression of whole body, deep pressure positions from prone into standing demonstrated better outcomes than standard tx for a pt with vestibular-exacerbated ataxia. The pt made the most gains with qualitative gait analysis, shown by improvements in functional independence and self-reported dizziness. The pt also made clinically relevant gains on the Tinetti POMA (>4.2) and the SARA. Whole body, deep pressure tx techniques are a potentially beneficial advancement for patients with multi-focal ataxia.

**TITLE:** Electromyographic (EMG) Analysis of Hip Extensor Muscle Activity During Common Exercises and Functional Activities in Subjects After Stroke

**AUTHORS/INSTITUTIONS:** S. Greenspan, MGH Institute of Health Professions, Boston, Massachusetts, UNITED STATES|W.B. Weiss, Rancho Los Amigos National Rehabilitation Center, Downey, California, UNITED STATES|D. Haladay, University of South Florida, Tampa, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to measure hip extensor muscle activity using fine wire EMG during 8 common physical therapy exercises and 4 functional activities in the hemiplegic limb of subjects post-stroke.

**Number of Subjects :** 10 adults (ages 31-58, 4 female; 6 male, 7-37 months post-stroke, Fugl Meyer Lower Extremity motor score 14-30/34) volunteered to participate in this study.

**Materials/Methods :** Data collection took place at the Pathokinesiology Laboratory at Rancho Los Amigos National Rehabilitation Center in Downey, CA. Using fine wire EMG, a maximal muscle test was used for maximal voluntary isometric contraction (MVIC). The lower gluteus maximus (GM), adductor longus (AL), biceps femoris long head (BFLH) and semimembranosus (SM) muscles were analyzed for timing and intensity of muscle activation on the hemiplegic side. Subjects performed 3 repetitions of each exercise or functional activity at a self-selected speed. The 8 exercises included supine hip abduction, bridging, prone hip abduction, prone hip extension, quadruped hip extension, sidelying clamshell, sidelying hip abduction, standing hip hiking, standing hip abduction, standing hip extension. The 4 functional Activities were sit to stand, step up, walking in tall kneeling and normal walking. Exercises and activities were randomized to eliminate the effects of fatigue. The highest quality repetition was selected and then the start and end time for the interval of hip extensor EMG activity associated with the concentric phase of the exercise/activity was determined. Data was reported as a % MVIC for each muscle tested. PASW Statistics 18 statistical software (SPSS, Inc., Chicago, IL) was used for statistical analysis. Due to the sample size non-parametric statistics were used. Average EMG activity (expressed as %MVIC) across the concentric interval of each exercise/activity was compared for each muscle. A Friedman's Test was used to detect the difference in muscle activity across exercises for each of the 2 muscles. A post-hoc Wilcoxin-Signed Rank test was done to determine differences between pairs of exercises. Level of significance set at  $p < 0.05$ .

**Results :** For GM 3 exercises and 2 functional activities generated muscle activity  $> 40\%$  MVIC. These were step up  $41 \pm 27\%$ , standing hip hiking  $43 \pm 75\%$ , walking in tall kneeling  $46 \pm 34\%$ , standing hip extension  $50 \pm 55\%$  and prone hip extension  $86 \pm 99\%$ . For AM there were two exercise and 4 functional activities with activity  $> 40\%$  MVIC. These were bridging  $41 \pm 43\%$ , sit to stand  $42 \pm 33\%$ , walking  $42 \pm 37\%$ , walking in tall kneeling  $42 \pm 24\%$ , step up  $45 \pm 27\%$  and prone hip extension  $56 \pm 60\%$ . For BFLH and SM only prone hip extension had  $> 40\%$  MVIC ( $49 \pm 48\%$  and  $52 \pm 33\%$ ).

**Conclusions :** This study found that prone hip extension was the most effective exercise in adults post-stroke to effectively recruit all four hip extensors.

**Clinical Relevance :** This information may be helpful for clinicians when designing exercise programs to target the hip abductors in the stroke population.

**TITLE:** Usability and Perceived Efficacy of Neurologic Digital Case Studies to Promote Critical Thinking Skills: A Pilot Study

**AUTHORS/INSTITUTIONS:** S.R. Kiami, C. Augello, L. Mangelinkx, Physical Therapy, Movement and Rehabilitation Sciences, Northeastern University, Boston, Massachusetts, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Critical thinking skills are difficult to teach and evaluate in academic settings due to a lack of authentic patient care experiences, but are essential for the development of physical therapy (PT) students. Educators are tasked with utilizing pedagogies that are effective in fostering these skills and must provide students with opportunities to engage in repeated practice and reflection while using multiple methodologies. Literature supports the use of web based, digital case studies to promote critical thinking among allied health professions students, however further research is required to determine effectiveness within a neurologic physical therapy curriculum. This pilot study aimed to evaluate the usability and perceived efficacy of digital case studies on PT student learning and critical thinking abilities.

**Number of Subjects :** Twenty one (21)

**Materials/Methods :** Articulate Quizmaker® software was used to create a digital library of interactive, neurologic PT case studies. There are several advantages of using this software including (1) ability to create digital decision trees and embed video clips and/or other images (2) tailored feedback can be provided in real-time depending upon student decisions (3) ability to repeat the scenarios until competence with content is achieved and (4) exposure to patient care situations they may not otherwise experience during didactic training. Students voluntarily participated by completing the case studies on line, then answering an online survey using a Likert scale with “strongly agree” rated 5 points to “strongly disagree” rated 1 point on 5 questions regarding the usability and perceived efficacy of this pedagogy. Descriptive statistics were used to summarize survey results and an average score was calculated for each question.

**Results :** Students rated the technology as user-friendly (average rating of 4.86/5) and reported that feedback and tutorials provided in the case studies helped them understand the material (average of 4.62/5). They also reported they would like the opportunity to engage in additional case studies (average of 4.71/5) and endorsed the belief that they would make better clinical decisions in authentic patient care situations after engaging in the digital cases (average of 4.43/5).

**Conclusions :** The use of interactive digital, web based case studies created with Articulate Quizmaker® software appeared to be user friendly and effective in promoting critical thinking skills for the management of neurologic conditions among PT students.

**Clinical Relevance :** Emerging evidence supports the use of digital case studies for the development of critical thinking skills. This pedagogy affords students the opportunity to engage in interactive, dynamic simulated experiences in a cost-effective and safe manner in a less stressful learning environment free from peer, patient or professor critique while providing real-time feedback. Further research is required to examine the efficacy and student outcomes within neurologic physical therapy curriculum.

**TITLE:** A Program Evaluation of Community Wellness Programs for People with Parkinson Disease

**AUTHORS/INSTITUTIONS:** T.R. DeAngelis, T. Ellis, Physical Therapy and Athletic Training, Boston University, Boston, Massachusetts, UNITED STATES|C. Thomas, M. Saint-Hilaire, Department of Neurology, Boston University Medical Campus, Boston, Massachusetts, UNITED STATES|E. Hoover, Speech, Language and Hearing Sciences, Boston University, Boston, Massachusetts, UNITED STATES|M. Sterba, Physical Therapy, The Ohio State University College of Medicine, Columbus, Massachusetts, UNITED STATES|K. Allen, Lahey Hospital and Medical Center, Burlington, Massachusetts, UNITED STATES|V. Allen, C. Miranda, Braintree Rehabilitation Hospital, Braintree, Massachusetts, UNITED STATES|D.L. Church, D. Pidgeon, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire, UNITED STATES|D.R. Ellis, Synergy Rehabilitation Services, Amherst, Massachusetts, UNITED STATES|S.B. Ellis, L. Sommers, Northeast Rehabilitation Hospital, Salem, New Hampshire, UNITED STATES|M. Lucey, E. Whitley, Center for Balance, Mobility and Wellness at Gordon College, Wenham, Massachusetts, UNITED STATES|D. Lucier, Spaulding Rehabilitation Hospital Cape Cod, Sandwich, Massachusetts, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to evaluate the effectiveness of a community based exercise program for persons with Parkinson Disease (PWPd).

**Number of Subjects :** The sample consisted of PWPd over the age of 40 (N=276) that participated in the community wellness programs at 9 different sites in New England between January 2010 and March 2014.

**Materials/Methods :** Healthcare professionals from hospitals and outpatient clinics around the New England area attended a seminar and were trained in evidence-based rehabilitation approaches for PD, general medical and pharmacological management of PD, and how to administer a Community Wellness Program (CWP). The healthcare professionals then began a program in their local communities to meet the needs of PWPd. CWP's were offered 2 times per week for 1.5-hours over a 6-week duration. The CWP's were implemented multiple times throughout the year at many of the sites over a 4-year period. Each CWP was held as a group exercise class that focused on education regarding movement strategies and self-management, strengthening, stretching, gait training and voice exercises. Demographic data was gathered initially (e.g. age, sex, years since diagnosis, and Hoehn & Yahr [H&Y] stage) and functional status and quality of life were assessed pre and post intervention. Outcome measures included the Parkinson Disease Questionnaire 39 (PDQ39), Functional Gait Assessment (FGA) and Six Minute Walk Test (6MWT). Participants completed a satisfaction survey after the program was completed. The change from pre to post intervention was examined using a two-tailed paired t-test with an alpha level set at .05. The data was analyzed using SPSS Version 20.0.

**Results :** The mean age of participants was 73 years (range=49-90) and mean years since diagnosis was 4.5 years (range=0.2- 20). H&Y stages ranged from 1.0 to 3.0, with 45% of participants at stage 2.0. The mean improvement for all participants was 3.5 points (SD=1.2) on the FGA with a statistical significant difference between pre and post measurements ( $P < .001$ ). There was a significant difference between the pre and post walking endurance on the 6MWT ( $P < .001$ ) with an average improvement of 51 meters (SD= 29). The change in total PDQ39 scores was statistically significant ( $P = .003$ ), along with the Mobility (.004), ADL (.032), Emotional (.004), Cognition (.003), Communication (.028), and Body Discomfort (.010) subcategories. The satisfaction survey results at the end of the program found that 86% of participants felt that the program met expectations and 94% found the exercises beneficial.

**Conclusions :** A community wellness program for PWPd is effective in improving quality of life, balance and walking. Participants were satisfied with their experience and found their experiences beneficial.

**Clinical Relevance :** These findings suggest that community-based wellness programs administered by a health care professional can be effective in improving quality of life and physical function in persons with a chronic progressive condition such as PD.

**TITLE:** Utilization of functional electrical stimulation to facilitate pre-running, and return to running, in a young adult male after a stroke.

**AUTHORS/INSTITUTIONS:** J.P. Cepeda, Physical Therapy, NYU Langone Medical Center, RUSK Rehabilitation , New York , New York, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** The rehabilitation process after a stroke for a younger adult differs in multiple areas as compared to an elderly individual, especially with quality of life and community reintegration, which may include pre-running or running activities. Currently, there is minimal research describing the effects of functional electrical stimulation (FES) to assist and improve a person's ability to run after surviving a stroke. The purpose of this case report is to review the utilization of FES to facilitate pre-running activities and return to running.

**Case Description :** Patient was a 27 year old male status post stroke secondary to arteriovenous malformation rupture. On evaluation, patient required assistance to negotiate the environment while using a straight cane and without use of a brace, due to decreased motor control and spasticity to the left upper and lower extremities, repeated falls due to drop foot, homonymous hemianopsia, decreased coordination, and poor endurance. Patient underwent approximately 6 months of physical therapy in an outpatient setting which included 60 minutes individual PT sessions once to twice a week, 30 minute supervised therapeutic exercise class to focus on cardiovascular and progressive resistive exercises, and an extensive home exercise program. Patient incorporated a toe-off brace for everyday use and FES for all activities during treatment sessions that included task-specific training, treadmill training with use of the body weight support system for safety, and plyometric exercises. The FES enhanced motor recovery by providing more sensory and motor input than the brace while performing jumping, shuttle runs, and dynamic balance activities.

**Outcomes :** Initially, the patient completed the 6 Minute Walk Test (6MWT) [1,218 ft] and 50 Foot Gait Speed [3.44 ft/sec] while incorporating a toe-off brace and straight cane. At discharge, patient completed 6MWT [2,056 ft], Gait Speed [4.68 ft/sec], and 50 Foot Run [8.69 ft/sec] using FES. Two month follow up, patient completed 6 MWT [1,440 ft], 50 Gait Speed [4.10 ft/sec], and 50 Foot Run [9.45 ft/sec] without any device.

**Discussion :** Minimal research is available in the literature highlighting the combination of FES and motor learning principles for the progression of ambulation to pre-running or running. However, the principles applied in gait training can be utilized, while incorporating the FES during task-specific training, treadmill training, and plyometric exercises. Currently, rehabilitation focuses on improving a patient's independence with ambulation, but does not take into account higher level activities such as running. Further research is necessary to target a younger population who have experienced a stroke, and are driven to return to higher level of function to improve their quality of life, which has not typically been focused upon in traditional rehabilitation to identify the most effective intervention.

**TITLE:** Stroke Self-Management Rehabilitation Trial (SMART) Local Preliminary Data for an International Study  
**AUTHORS/INSTITUTIONS:** S. Blanton, S. Wolf, A. Acenbrak, M. Phillips, A. Watt, L. White, C. Wurtz, Division of Physical Therapy, Emory University, Atlanta, Georgia, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The transition to home can be difficult for both stroke survivors (SS) and their caregivers (CG). While providing family education has been shown to improve outcomes, research supporting the most effective educational intervention is not conclusive. This pilot study evaluated if a theory-driven educational intervention based on observational learning through a DVD, improves quality of life, self-efficacy, mental health, and burden outcomes in persons with stroke and their caregivers.

**Number of Subjects :** Eleven stroke survivors, 4 weeks to 3 years post stroke, with mild to moderate disability were enrolled with 8 caregivers

**Materials/Methods :** This pilot study was a single-blind, prospective, international clinical trial and data presented are from the Emory site. Participants were randomized to either an educational intervention group (DVD) or an age, gender and disability matched comparison group. The educational intervention involved watching a chapter on the DVD each week over a period of 6 weeks. Chapter content included basic stroke information, rehabilitation exercises, mobility, early care and hygiene, coping strategies and caregiver perspectives. Baseline and immediate follow-up health related quality of life assessments were conducted for both SS and CG.

**Results :** No participant fully adhered to DVD viewing protocol and four of the six participants in the treatment group withdrew from the study prior to completion. No post intervention or between group analyses were performed due to high drop-out rate. Overall SS baseline values indicated moderately high symptoms of depression and these scores were associated with higher levels of disability and worse quality of life scores. The majority of SS and CG were flourishing and had positive psychological change in response to trauma of stroke. Despite high levels of strain, CG had lower levels of depression than SS and higher levels of mental well-being.

**Conclusions :** While all enrolled participants expressed a need for additional stroke education, the non-individualized nature of the educational content was identified by most dyads as the primary reason for limited adherence. The frequency of participant well-being (flourishing) despite symptoms of depression supports a multi-factorial component to post-stroke mental health. This study is the first step in the development of an effective DVD-based stroke education program and future considerations should include methods to better tailor information to meet family needs.

**Clinical Relevance :** Family centered education is an important aspect of post stroke rehabilitation and methods for delivery and individualization of educational content may influence the impact of interventions. The multi-factorial nature of mental health in both stroke survivors and caregivers should be taken into account when designing family education interventions.

**TITLE:** Integration of an Exoskeleton into Neurologic Physical Therapy in a Non-profit Hospital Outpatient Setting  
**AUTHORS/INSTITUTIONS:** C.B. Rodriguez, Reeves Rehabilitation Center, University Health System, San Antonio, Texas, UNITED STATES|

**ABSTRACT BODY:**

**Purpose :** The purpose of this report is to describe the process of integrating an Ekso GT® robotic exoskeleton into the physical therapy practice in the outpatient department of a non-profit hospital system (University Health System (UHS), San Antonio, TX).

**Description :** The Ekso GT® unit was obtained by UHS in February, 2014. Four physical therapists then received level one and level two certification to ensure proper use of the exoskeleton unit over a three month period of intensive study. In order to determine a proper dosage for patients with different types of neurologic involvement, the author undertook a major literature review regarding all types of robotic exoskeleton use for gait training with patients with spinal cord injury (SCI) and cerebral vascular accident (CVA) to explore optimal ways to use the exoskeleton to treat patients with lower extremity paralysis. The literature review revealed common patterns for frequency and duration of treatment with exoskeleton for gait training, criteria seen in patients who respond well to gait training with exoskeletons, progression using an exoskeleton depending on patient diagnosis and methods to transition from exoskeleton use to overground training. All studies reviewed used an exoskeleton unit that provided total assist for participants; some research suggests that more active participation of a patient in an assist-as-needed use of a robotic device may enhance progress with ambulation.

**Summary of Use :** Most articles treating SCI used a dosage of 36 - 60 sessions of about 1 hour of locomotor training (delivered on a 3 - 5x/week over 12 weeks basis). The one hour session also included about 15 mins of exoskeleton device setup, adjustment and removal. Articles regarding patients with CVA were similar with patients being seen for 12 visits of 45 minute sessions. A schedule was developed to work with patients in hour-long sessions up to three sessions/week, run by 1 therapist with level 2 certification, assisted by a physical therapist assistant or a technician.

**Importance to Members:** The use of robotics in rehabilitation has greatly advanced recently. By using robotic exoskeletons to assist with proper gait kinematics and early mobilization, therapists can help drive neuroplasticity requiring repetition and intensive practice in the recovering brain earlier in a patient's recovery process, thus providing better outcomes in a safe, efficient way. Integration of an exoskeleton into a physical therapy practice needs to be done to ensure enhanced patient outcomes in a cost-effective manner. As our robotics use at UHS progresses, we need to assess the financial and business considerations of adding an exoskeleton. Given the advances of the Ekso GT® model exoskeleton in terms of new, variable assistance options (assist-as-needed), several opportunities for research now exist to determine its optimal dosage for various neurologic diagnoses. Determining the best way to progress a patient using an exoskeleton and continuing to over ground walking are areas for further study.

**TITLE:** The effect of sensory reintegration training with virtual reality and vibratory noise on gait in patients with diabetic peripheral neuropathy.

**AUTHORS/INSTITUTIONS:** B. McCrory, N. Bugnariu, Physical Therapy, University of North Texas Health Science Center, Fort Worth, Texas, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Patients with diabetic peripheral neuropathy experience different degrees of sensory loss in their feet and tend to rely heavily on visual inputs to maintain balance. This is an efficient coping strategy for as long as they can attend to the placement of their feet, but becomes a high risk for falls when they have to visually attend to something else, such as crossing a street. The decrease in plantar sensation in diabetic peripheral neuropathy causes an increased fall risk and changes in gait. The purpose of this study was to assess the effectiveness of a training program designed to improve gait function and decrease fall risk through sensory reweighting based on the principles of stochastic resonance and using virtual reality (VR) in subjects with diabetic peripheral neuropathy.

**Number of Subjects :** Four patients, 3 males and 1 female, aged 63 to 69 years old with peripheral neuropathy due to type II diabetes have completed the study; enrollment is ongoing.

**Materials/Methods :** This study was conducted using a V-Gait CAREN system. Subjects had 6, one hour long training sessions in which they walked on the treadmill at self-selected speed while practicing increasingly more challenging mobility tasks while their visual attention was engaged by the VR. During training, subjects were fitted with vibratory devices placed above the level of sensory loss (around the ankles) delivering constant sub-threshold white noise. At visits 1 and 8, pre- and post-training assessments of gait function and fall risk were conducted. Outcome measures included gait speed, Timed Up and Go (TUG), Activity Balance Confidence (ABC) and sway index during the Clinical Test of Sensory Interaction for Balance (CTSIB). Data was analyzed with paired t-tests.

**Results :** Comparisons of pre- and post-training data revealed increased ABC score ( $p=0.02$ ), no significant change in TUG ( $p=0.24$ ), decreased sway index during CTSIB for eyes closed conditions, both on stable and foam surfaces ( $p < 0.05$ ) and increased self-selected gait speed ( $p < 0.05$ ). At the end of the training subjects were able to maintain a straight walking trajectory even in the presence of visual inputs entraining lateral movements.

**Conclusions :** Preliminary results suggest support for the stochastic resonance theory and show that sensory retraining with VR and the vibratory device is feasible in diabetic subjects, holding promise for improvement of function due to an increased ability to integrate all sensory inputs available and a decreased reliance on visual inputs.

**Clinical Relevance :** Due to decreased somatosensory input in diabetic peripheral neuropathy, these patients have a significant increased risk for falls during ambulation in everyday life. This study seeks to determine if a wearable vibration device, coupled with a gait VR training program, can improve sensory integration and decrease fall risk.

**TITLE:** EARLY UTILIZATION OF A SOLID AFO PROMOTES NEUROLOGIC AND FUNCTIONAL RECOVERY IN AN INDIVIDUAL WITH AN INCOMPLETE SPINAL CORD INJURY.

**AUTHORS/INSTITUTIONS:** T.M. Klekar, TIRR Memorial Hermann Neurologic Physical Therapy Residency Program, Houston, Texas, UNITED STATES|C.L. Szot, TIRR Memorial Hermann Rehabilitation Hospital, Houston, Texas, UNITED STATES|A. Laprea, Neurological Outpatient Rehabilitation, TIRR Memorial Hermann Rehabilitation Hospital Northwest, Houston, Texas, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** For individuals post traumatic spinal cord injury (SCI), there continues to be a need to find optimal rehabilitation methods to enhance neurologic and functional recovery. An intervention that is still viewed primarily as a compensatory approach is the utilization of orthotic devices. Among these orthotic devices, ankle foot orthoses (AFOs) have been shown to improve gait speed, step length, swing phase clearance, and stabilization during stance phase. This case study describes the neurologic and functional recovery of an individual post-traumatic SCI utilizing an AFO during walking re-training throughout the continuum of care.

**Case Description :** This case involves a 15 year-old male with an L2 incomplete SCI, presenting with right hemiparesis, who utilized both a trial diagnostic AFO and solid AFO during inpatient and outpatient rehabilitation from 2 weeks to 4.5 months post injury. The individual was fitted with a trial diagnostic, adjustable double metal upright AFO approximately 2 weeks post injury upon the initiation of gait training. At the beginning of outpatient rehabilitation, he was prescribed a solid front entry polypropylene AFO 9 weeks post injury. Total number of sessions consisted of 11 inpatient and 24 outpatient sessions. Both orthotics were utilized in order to optimize gait kinematics, to allow for increased repetition of therapeutic activity, to decrease manual facilitation required, and to allow the individual to participate in walking outside of therapy time without a substantial decline in gait quality. The individual was gradually weaned from the AFO and by 4.5 months post injury, he was no longer utilizing an AFO.

**Outcomes :** Fast walking speed, measured by the 10 Meter Walk Test, improved from 0.0 m/s (2 wks) to 0.91 m/s with AFO (2 mos) to 1.35 m/s without AFO (5 mos) and 1.62 m/s without AFO (10 mos). Walking endurance, measured by the 6 Minute Walk Test, improved from 0 feet (2 wks post) to 951 feet with AFO (2.5 mos) to 1405 feet with no AFO (5 mos). Functional balance, measured by the Berg Balance Scale, improved from 9/56 (2 wks) to 53/56, (3 mos). Neurologic recovery, measured by the ASIA Impairment Scale, improved from 0/5 in L4 through S1 myotomes (1 mo post) to 1/5 in L4/L5 myotomes, and 5/5 in the S1 myotome (3.5 mos) to 4/5 in L4 and 5/5 in L5/S1 myotomes (10 mos).

**Discussion :** The findings presented demonstrate the capacity for functional and neurologic recovery to occur despite early use of an intervention commonly viewed as a compensatory approach to rehabilitation. In this example, the use of a solid AFO allowed the individual to participate in early locomotor training both during and outside of therapy time, and during the transition from inpatient to outpatient rehabilitation, without a significant decline in gait kinematics. Thus, early use of orthotic interventions should be considered as a way to increase the intensity of task specific training, while also decreasing the likelihood of poor habitual compensatory gait mechanics from occurring.

**TITLE:** Sleep Enhances the Cognitive Component of a Functional Task

**AUTHORS/INSTITUTIONS:** A. Al-Sharman, Jordan University of Science and Technology, Irbid, JORDAN|C.F. Siengsukon, department of Physical Therapy and Rehabilitation Science, University of Kansas Medical Center. , Kansas, Kansas, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Sleep has a critical role in learning new motor tasks. Most of everyday activities require two or more tasks to be conducted at the same time. Therefore, it is important to understand the role of sleep in learning functional tasks that include both cognitive and motor components. Recently, we examined the role of sleep in learning a functional motor task that requires walking while performing a cognitive task and found the walking performance of the task was enhanced by sleep. The purpose of the current analysis is to examine if sleep enhances the cognitive performance of the functional walking task.

**Number of Subjects :** Twenty-four young ( $25.71 \pm 2.8$  years of age), 20 middle-aged ( $48 \pm 3.66$  years of age) and 20 older ( $70.4 \pm 3.8$  years of age) adults participated in this study.

**Materials/Methods :** Participants in each age group practiced a novel walking task while performing a cognitive task (counting backwards by 7s ) and then either slept (sleep condition) or stayed awake (no-sleep condition) between practice and retention testing. Primary measures of interest included the correct responses rate on the cognitive task and the percent change in performance of the cognitive task between the last practice block and the retention testing.

**Results :** The results indicated that, in all age groups improvement in cognitive performance is enhanced by sleep but not by a similar period of wakefulness. After 12 hours of wakefulness, cognitive performance reduced by 3.4% in young, 6.02% in middle-aged, and 11.7% in older adults. However, after a night of sleep, cognitive performance improved by 17.5%, 13.04%, and 11.0% in young, middle-aged, and older adults, respectively. Improved performance on the motor component reported previously in young, middle-aged and older adults was not due to decrement or at a "cost" to the cognitive component.

**Conclusions :** These findings provide compelling evidence that sleep enhances cognitive performance even when performed concurrently with a motor task. Both the motor and cognitive components of the functional task improved off-line by the action of sleep

**Clinical Relevance :** The enhancement of cognitive performance of a functional task by sleep has very important clinical implications. Many activities in everyday life require people to perform more than one task at a time such as walking while talking on the phone or walking while remembering a shopping list. Multitasking plays an integral role in our life functions. The current study provides the first evidence that besides training, sleep might be an important factor to maximize the cognitive performance under dual-task intervention. Clinicians should be aware of sleep problems in individuals who undergo rehabilitation.

**TITLE:** Physical Therapy Management and Outcome of a Patient with Chronic Vitamin B Deficiency: A Case Report

**AUTHORS/INSTITUTIONS:** M.A. French, Department of Physical Therapy, University of Delaware, Newark, Delaware, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Vitamin B deficiency has numerous causes including pernicious anemia, vegan diets, and malabsorption. This condition causes spinal cord degeneration particularly in the posterior and lateral columns, which results in sensory and motor impairments and impacts function. When detected early, these impairments are often reversible; however, no literature could be found on the prognosis of functional recovery in persons with chronic Vitamin B deficiency or the role of physical therapy (PT) in the management of these patients. Thus, the purpose of this case report is to describe the treatment and outcome of a person who presented to PT with a 42-month history of Vitamin B deficiency.

**Case Description :** A 47-year-old female diagnosed with Vitamin B deficiency 42 months earlier presented to PT due to weakness and impaired function. Recent blood testing showed Vitamin B levels within normal range; however, the patient was unable to ambulate independently or participate within her community. Primary impairments included decreased proprioception and vibration as well as bilateral lower extremity weakness impacting balance, ambulation, and community participation. The patient was treated for 11 sessions over 6 weeks with treatments focused on improving balance and ambulation to increase community participation through strengthening, functional electrical stimulation (FES), Lower Body Positive Pressure treadmill training, overground gait training, and external feedback, including taping and visual cues.

**Outcomes :** Self-selected Walking Speed (SSWS), Functional Reach (FR), Activity-Specific Balance Confidence Scale (ABC), and Tinetti's Performance Oriented Mobility Assessment (POMA) were used as outcome measures. Initially, the patient's SSWS was 0.3 m/s with a rollator. The average of 3 trials for FR was 7.8 inches and the patient scored a 21.25% on the ABC. On the POMA the patient scored 13. Following 11 treatment sessions, the patient showed improvement in all outcome measures. The patient's SSWS improved to 0.56 m/s with a rollator. The FR improved to 9.3 inches, while the ABC increased to 61%. Lastly, the POMA improved to 16. Additionally, the patient reported increased participation in household chores, community ambulation, and family functions.

**Discussion :** There is limited literature related to the prognosis of persons with chronic impairments from Vitamin B deficiency and the role of PT in this population. As a result, the treatment of this patient utilized interventions that have been shown to improve function in persons with other neurologic conditions with sensory and motor impairments. The improvement in outcome measures and self-reported participation suggest that the PT provided had a significant impact on this patient's functional ability. Further research is needed to determine the most effective treatment and the rehab prognosis in patients' with Vitamin B deficiency.

**TITLE:** Clinical Decision-Making Regarding the Use of an Ankle-Foot Orthosis in Late Stages of Stroke Recovery  
**AUTHORS/INSTITUTIONS:** S.E. Servold, P.M. Spigel, E.J. Fox, Brooks Rehabilitation, Jacksonville, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Following a stroke residual impairments affecting foot and ankle control often limit walking function and may require support from an ankle-foot orthosis (AFO). Ensuring optimal AFO design requires careful consideration to address a variety of factors including: gait impairments, AFO fit and design, and determining the ideal balance between compensation with an AFO versus a focus on motor recovery. Additionally, individuals present with unique clinical characteristics that increase the complexity of the decision-making process. While the biomechanical effects of AFOs have been well studied, there is limited evidence describing the decision-making process regarding AFO use. The purpose of this case report is to describe key factors influencing the clinical decision-making regarding prescription and adjustment of an AFO and the effects of these changes on four ambulatory adults post-stroke.

**Case Description :** Four adults (3 males; ages 39-82 years) within 14 months post stroke were treated in the outpatient setting for the goal of increasing independence with ambulation. Each presented with varying degrees of impaired muscle strength, tone, and motor control limiting walking function and were considered for modifications or initial introduction of an AFO. Factors affecting specific prescription and adjustments were identified for each individual. Video based observational gait analysis was used to determine changes in gait mechanics, and gait speed was measured using the 10-meter walk test. A 5-point self-report assessment, ranging from 1= very insecure to 5= very secure, was used to determine level of confidence during ambulation.

**Outcomes :** Key factors that influenced the decision making process regarding AFO use were: projected improvements in motor recovery, distinguishing gait impairments throughout the gait cycle, and encouraging normalization of gait mechanics by integrating recovery and compensatory focused interventions. Based on the qualitative video gait analysis, AFO use or modifications lead to more normal kinematics that included improved foot clearance during swing and improved weight shifting on to the affected limb during stance. On average, gait speed improved by 0.2 m/sec and self-reported confidence level during walking improved 1-2 levels in 3 of 4 individuals with use of the new AFO.

**Discussion :** Clinical decision-making regarding AFO use is often challenging, and appropriate AFO fitting requires frequent and ongoing assessments. Consideration of key factors may help guide clinicians as they strive to provide the optimal AFO design. While some guidelines for AFO use have been established, they are difficult to apply because each individual post-stroke has unique clinical factors that must be considered. Continued research is necessary to assist clinicians in identifying and prioritizing key factors in the decision-making process to enhance AFO use.

**TITLE:** Neurological Lyme Disease: A Case Study of Physical Therapy and a Multidisciplinary Approach in an Outpatient Setting

**AUTHORS/INSTITUTIONS:** C. Dack, H. Battsek , I. Matejovsky, The Rusk Institute of Rehabilitation Medicine, NYU Langone Medical Center, New York , New York, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Lyme disease is the fastest growing vector-borne disease in the USA; Fourteen percent of cases affect the central and/or peripheral nervous system. Within early to late onset neurological Lyme disease, symptoms vary from Bell's palsy to cerebellar ataxia, sensory disturbances, dyskinesias, cognitive impairments and psychiatric disorders. Neurological Lyme disease is a complex, multi-factorial diagnosis with limited research for physical therapy (PT) intervention. The purpose of this case study is to demonstrate that PT with a multidisciplinary approach may provide beneficial outcomes for this population in an outpatient setting.

**Case Description :** A 42-year-old female was referred to PT with diagnosis of late onset Lyme disease confirmed by a serum antibody test. PMH included antibiotic treatment for 11 months. Brain MRI and EEG were normal. On initial evaluation, the patient complained of gait abnormality, joint pain and fatigue and presented with full body dyskinesias, intensified by light, sound and motion stimulation. Gait analysis revealed two gait patterns: A lateral crouched side step and a low lunge gait, with and without a straight cane. The patient scored 55/56 on the BERG with no history of falls. Goals of treatment were to increase pain-free exercise tolerance, improve gait pattern, speed and endurance. The patient was seen 1-2 x per week for treatment including overground and treadmill gait training. Further gait abnormalities were observed such as trunk and head thrashing, stomping, hip swiveling and changes in cadence and step length; these were captured in video analysis. A team meeting with physiatry, PT, OT, and psychology was held to discuss the possibility of psychogenic factors contributing to the patient's symptoms. Due to the complexity and variety of patient symptoms, the medical team differed in opinion regarding symptom origin. In contrast to the Lyme specialist's diagnosis, a movement disorders specialist suggested psychogenic movement disorder (PMD) as a possible etiology. To address this disparity in diagnosis, PT worked with psychology to implement cognitive behavioral strategies, such as positive feedback, into treatment.

**Outcomes :** The patient has responded positively to PT and a multidisciplinary approach. Her 6MWT increased from 175 ft to 400 ft and gait speed improved from 0.7 ft/s to 1.7 ft/s. Gait analysis, including video footage, shows significant decreases in dyskinesias, as well as a more normalized and consistent gait pattern. The patient now ambulates indoors without assistive device and in the community with a rollator, reporting reduced fatigue and joint pain improved from 8/10 to 4/10.

**Discussion :** The patient continues with PT and will begin psychotherapy to address the psychological component of her diagnosis. This case study demonstrates the importance of an early multidisciplinary approach and differential diagnosis with consideration of a PMD, for improved management and outcomes when treating neurological Lyme disease in an outpatient setting.

**TITLE:** Assessment of Dual-task Performance in Acute traumatic Brain Injury: A Case Report

**AUTHORS/INSTITUTIONS:** L. Rachal, C. Swank, S. Driver, Baylor Institute for Rehabilitation, Dallas, Texas, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Difficulty with dual-task (DT) performance is common following traumatic brain injury (TBI). These deficits can cause difficulty when returning to the community after inpatient rehabilitation. However, there is little evidence on measurement of mobility-related DT deficits in acute rehabilitation. The purpose of this case study is to report on data collected using three measures of DT performance in the acute rehabilitation setting for two individuals following TBI.

**Case Description :** Two individuals participating in acute inpatient rehabilitation following TBI. The first individual (CB) was 26-year-old student. Her initial Glasgow Coma Score (GCS) was unknown. The second individual (PM) was a 44-year-old firefighter with an initial GCS of 6. Both were participating in traditional inpatient brain injury rehabilitation. Upon completion of the rehabilitation stay CB was considered level 7 on the Rancho Los Amigos scale of cognitive functioning and PM level 8. Both received FIM scores of 5 (supervision) for mobility skills.

**Outcomes :** Prior to discharge each individual completed 3 measures of DT performance, the Walking and Remembering Test (WART), the Cognitive Timed Up and Go (TUGcog), and the Walking While Talking Test (WWT). Using the formula described by McCulloch (2007), dual-task costs (DTC) were calculated for each measure, providing a relative percentage of decrease in performance under DT conditions compared to single task performance. DTC for CB were 7% (WWT), 1% (WART), and 6% (TUGcog). DTC for PM were 14% (WWT) and 23% (TUGcog), but actually had improved performance under the dual-task condition of the WART (+10%). The three measures used in these cases required few resources and could be completed quickly.

**Discussion :** Both individuals scored highly on motor FIMs but demonstrated DT deficits when asked to perform a simple secondary task while walking. All measures indicated a change in performance under DTC. Proportionally, CB demonstrated more relative DTC (mean 16%) than PM (mean 5%). Although CB improved her time under DTC of the WART, it is possible that she increased her speed in order to more quickly complete the verbal task due to short-term memory deficits. Interestingly, the differences in performance were reflective of the Rancho Los Amigos levels. CB (level 7) had more DTC than PM, who was level 8, suggesting that he is more ready to return to independence. Frequently motor ability improves faster than cognitive following TBI. Someone may be capable of physically performing certain tasks, but unable to complete them with the same quality in real-life situations. As such, deficits in quality under DT situations are anticipated. Our findings confirm this expectation. Thus, DT deficits have been found to have serious implications for returning to the community. Consequently, physical therapists may consider more than simply motor ability (such as FIM scores) when providing appropriate recommendations for discharge. Further research is needed on the best measures and interventions for DT performance in the acute setting.

**TITLE:** Effect of a Multimodal Intervention on a Person with Multiple Sclerosis Following an Acute Exacerbation.

Lauren Smeltz, SPT, Diane Meyer PT, MSCS

**AUTHORS/INSTITUTIONS:** L. Smeltz, Physical Therapy, Elon University, Elon, North Carolina, UNITED STATES|D. Meyer, Rehab Services, UNC Healthcare, Chapel Hill, North Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Multiple sclerosis (MS) is the most common autoimmune inflammatory disease in young adults and can be very debilitating. The most common type of MS is relapsing-remitting. A relapse can often cause worsening of the disease and can represent new demyelinating activity or inflammation. Currently there is no cure for MS and the goal of treatment is to manage the symptoms and maintain, or improve functional mobility. Common symptoms of MS include gait, balance, and mobility problems. The purpose of this case report is to describe effects of training multimodal intervention, on balance, mobility, and quality of life in a person with MS.

**Case Description :** Case Description: A 47-year-old woman with a 26-year history of MS was admitted to an inpatient rehabilitation hospital with an exacerbation. Along with medical treatment, the patient participated in 12 days of physical therapy: 1-hour sessions twice a day, including balance training, strength training, and functional training. Functional training included gait training, transfers, and wheelchair mobility.

**Outcomes :** Functional outcomes showed an improvement in distance walked and level of independence with functional tasks. Her Berg Balance Scale score improved from 17 to 40/56, greater than the minimal detectable change (MDC) for persons with MS. Her self-reported Multiple Sclerosis Impact Scale (MSIS-29) improved from 77 to 59 (no established MDC). The modified Clinical Test of Sensory Integration of Balance test, measuring sway index on the Biodex Balance System, showed decreased postural sway during eyes open and eyes closed standing on firm and foam surfaces.

**Discussion :** Following medical treatment and 24 sessions of physical therapy for an MS exacerbation, this patient demonstrated decreased fall risk and increased quality of life. A multimodal physical therapy intervention may improve independence in functional mobility and improve quality of life in persons with MS following an exacerbation.

**TITLE:** Physical Therapy Intervention for Unilateral Facial Nerve Dysfunction in Guillain-Barre Syndrome

**AUTHORS/INSTITUTIONS:** S.E. Zaluski, Outpatient Physical Therapy, NYU Langone Medical Center, RUSK Institute of Rehabilitation Medicine, New York, New York, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Bilateral, and more uncommonly, unilateral facial nerve dysfunction can be seen in individuals with Guillain-Barre Syndrome (GBS). People can present with symptoms of facial pain, tightness, weakness, and synkinesis affecting the symmetry of facial muscles at rest and with functional facial movements. There is a lack of current research studying outcomes following a rehabilitation program for someone with unilateral facial nerve dysfunction secondary to GBS. The purpose of this case report is to demonstrate the effectiveness of skilled physical therapy on improving functional facial movement.

**Case Description :** A 42 year old female diagnosed with GBS, presented with complications of unilateral facial muscle pain, tightness, weakness, and synkinesis, causing resting facial muscle asymmetry and difficulty with functional facial movements. Noteworthy, she had one previous episode of Bell's Palsy in her childhood with a complete spontaneous recovery. The patient received individualized physical therapy sessions every 2-8 weeks over a 9 month period which included the following treatments: patient education, pain management, relaxation techniques, soft tissue mobilization, stretching, coordination exercises, neuromuscular re-education, and functional facial movement retraining.

**Outcomes :** The patient improved her Sunnybrook Facial Grading Scale composite score from 40 to 69 (a normal score is 100), demonstrating improved resting symmetry and symmetry of voluntary facial movements. Subjectively, the patient reported that her symptoms continued to fluctuate depending on stress or fatigue, but overall, she had less resting facial tightness as well as improved self acceptance, ability to communicate (i.e.: form certain speech sounds, make facial expressions), eat, drink, and perform oral hygiene without leaking liquid. The patient was independent with a home exercise program in order to continue to self-manage her condition and to maintain gains made during therapy.

**Discussion :** Unilateral facial nerve dysfunction is a rare occurrence in patients with GBS. Physical therapy interventions emphasizing patient education, stretching, relaxation techniques, and facial movement retraining can improve function and quality of life for these individuals.

**TITLE:** Musculoskeletal Adaption after Hemiparetic Stroke: In Vivo Measurements of Shortened Biceps Brachii Fascicle Lengths and Increased Passive Elbow Stiffness

**AUTHORS/INSTITUTIONS:** C. Nelson, W. Murray, Department of Biomedical Engineering, Northwestern University, Evanston, Illinois, UNITED STATES|J.P. Dewald, Department of Physical Therapy and Human Movement Sciences, Northwestern University, Chicago, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Upper extremity dysfunction is common after hemiparetic stroke<sup>1,2</sup>, with impairments including weakness, spasticity, contractures, and loss of independent joint control (notably the flexion synergy)<sup>3-5</sup>, which lead to altered use and an abnormally flexed posture in the paretic arm. Despite evidence for shorter fascicles in the paretic lower extremity<sup>6,7</sup>, how musculoskeletal properties in the paretic upper extremity differ following stroke remains unclear. It is hypothesized that, due to chronic abnormal use and flexed posture of the affected arm, the paretic arm will demonstrate shorter biceps brachii fascicle lengths and increased joint passive stiffness when extending the elbow compared to the non-paretic arm.

**Number of Subjects :** 8 (4 controls, 4 subjects with chronic stroke)

**Materials/Methods :** Biceps brachii fascicle lengths were measured in N=4 control subjects (average age 45 yrs) and N=4 stroke subjects (average age 59 yrs, 3-9 yrs post-stroke). The long head of biceps brachii was imaged with extended field-of-view ultrasound<sup>8,9</sup> in 3 positions with the muscle relaxed. Elbow passive stiffness was also measured in the subjects with chronic stroke. Subjects were casted at the wrist and secured to a six degree of freedom load cell. The elbow was moved through its range at a velocity of 6°/sec while recording the torque produced at the elbow. EMG was monitored to ensure no reflexive muscle activity during data collection.

**Results :** In all stroke subjects, biceps fascicle lengths were shorter in the paretic when compared to the non-paretic extremity, and this difference was substantially larger than interlimb differences in the control subjects. Measured differences in the stroke group ranged from 13 to 25%, while differences in control subjects varied from -8.9% to 4.9% (negative indicating non-dominant fascicles were longer). In addition, all stroke subjects also demonstrated increased passive joint stiffness in the paretic elbow throughout the entire range of motion.

**Conclusions :** Shorter fascicles indicate morphological changes to muscle after stroke, including changes at the fiber and/or sarcomere level, while increased passive stiffness indicates mechanical changes in the tissues crossing the elbow joint. Stroke subjects demonstrated shorter fascicles in the paretic arm in combination with increased passive stiffness. Further work is planned for additional data collection and investigation into the relationship between increases in elbow stiffness after stroke and changes in fascicle lengths of biceps and triceps. We will use a musculoskeletal modeling approach to investigate the effect of these changes on reaching tasks after stroke.

**Clinical Relevance :** If shown that fascicle lengths are altered and may be linked to changes in joint stiffness post-stroke, novel therapeutic interventions could be developed to more effectively diminish or prevent these changes in muscle properties and associated musculoskeletal mechanics. Ultimately, this may result in more functional paretic arm use following stroke.

**TITLE:** How should we evaluate the effects of rehabilitation on dual-task interference?

**AUTHORS/INSTITUTIONS:** P. Plummer, University of North Carolina, Chapel Hill, North Carolina, UNITED STATES|G. Eskes, Dalhousie University, Halifax, Nova Scotia, CANADA|

**ABSTRACT BODY:**

**Purpose :** The purpose of this “Special Interest Report” is to critically review the methods for evaluating the effects of rehabilitation on dual-task interference during walking in individuals with neurological disorders.

**Description :** The relevance of dual-task walking to everyday ambulation is widely acknowledged. With growing interest in evaluation of the effects of interventions on dual-task gait performance, it is necessary to establish methods to accurately describe dual-task interference. At present, most studies have focused only on describing changes in absolute or relative dual-task effects on gait (often gait speed) before and after an intervention; however, focusing only on gait captures just half of the dual-task performance. It is imperative to evaluate single and dual-task performance in both tasks in order to accurately interpret and characterize dual-task interference. Yet, reciprocal dual-task effects on the non-gait task are often ignored, and performances on the two tasks are rarely examined in relation to each other. For example, dual-task effects on gait speed may change following an intervention, but whether this change is due to an actual improvement in dual-task ability or simply the use of a different strategy for dual-task performance after the intervention cannot be determined by evaluating dual-task interference on only one of the tasks. Data examples from rehabilitation research will be presented to highlight how different methods can result in contrasting interpretation of changes in dual-task interference. Whether a change in dual-task strategy represents an improvement in dual-task performance will also be discussed.

**Summary of Use :** Dual-task interference is influenced by the interaction between the two simultaneously-performed tasks. The nature of the interaction may change over time, which can complicate assessment and interpretation of rehabilitation-related changes in dual-task interference on gait. The goal of this paper is to highlight the limitations of typical methods of describing dual-task interference, and to propose a new framework for evaluating dual-task performance.

**Importance to Members:** This information will assist researchers and clinicians to more accurately characterize changes in dual-task gait ability over time due to recovery and/or intervention.

**TITLE:** Diagnostic Accuracy of the Bedside and Video Head Impulse Tests: A Systematic Review and Meta-Analysis

**AUTHORS/INSTITUTIONS:** E. Buice, D.Y. Chen, D.J. Lawton, A. Goode, R. Clendaniel, Community and Family Medicine, Duke University, Durham, North Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The Bedside Head Impulse Test (bHIT) is a common clinical test of vestibular function in patients with suspected vestibular disease. The bHIT consists of a passively applied, small-amplitude, high-acceleration, and unpredictable horizontal head rotation while the patient tries to maintain his eyes on a target. In individuals with abnormal vestibular function, the eyes will not remain fixed on the target and the examiner will observe a corrective saccade. The Video Head Impulse Test (vHIT) uses a similar passively applied head movement, but employs a high speed video camera to track eye movement during the horizontal thrust. Despite the common use of these clinical tests, their diagnostic properties have not been clearly defined. The purpose of this review is to systematically examine the literature to evaluate the diagnostic accuracy of the bHIT and vHIT in a general population of patients with peripheral vestibulopathy seeking care from a provider.

**Number of Subjects :** 1,993 subjects across sixteen studies, 2 diagnostic tests

**Materials/Methods :** A systematic search of the literature was performed across 5 databases, PUBMED, Google Scholar, CINAHL, Web of Science and EMBASE, to capture all studies relevant to the bHIT and vHIT. Articles were eligible for this study if they met the following inclusion criteria: 1) included the bHIT or vHIT as a measure of vestibular hypofunction, 2) provided diagnostic accuracy of the bHIT or vHIT, 3) were available in the English language, 4) were conducted on human test subjects, 5) were in peer-reviewed journal articles. Articles were excluded from this study if they only studied benign paroxysmal positional vertigo. The Quality Assessment of Diagnostic Accuracy Studies version-2 (QUADAS-2) tool was used to examine the quality of each of paper.

**Results :** Sixteen studies met the inclusion criteria for this review. One study met the QUADAS-2 standards for low risk of bias assessment whereas the remaining 15 studies were classified as at risk for bias. For the bHIT compared to caloric testing the meta-analysis revealed that the test has a pooled sensitivity, specificity, and positive likelihood ratio of 43%, 97%, and 15, respectively. For the bHIT compared to scleral search coils the pooled sensitivity, specificity, and positive likelihood ratio was 69%, 69%, and 2.2, respectively. For the vHIT compared to caloric testing the pooled sensitivity, specificity, and positive likelihood ratio was 42%, 93%, and 6.1, respectively.

**Conclusions :** The bHIT is a low sensitivity, high specificity clinical test of vestibular function compared to caloric but not scleral search coil testing. The vHIT does not appear to offer improved diagnostic accuracy over the bHIT. Due to the limited number of studies appropriate for inclusion in the meta-analysis, there is a need for additional large, high-quality studies to further examine the diagnostic accuracy of the bHIT and vHIT.

**Clinical Relevance :** The bHIT and vHIT are clinical tests of vestibular function that can be used to rule in peripheral vestibulopathy.

**TITLE:** Vestibular Rehabilitation following Concussion: An Exploratory Study

**AUTHORS/INSTITUTIONS:** B.M. Moore, Physical Therapy, New York University Langone Medical Center, New York, New York, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To investigate the impact of Vestibular Rehabilitation (VR), by measuring outcomes at three and six months following initiation of VR to address post-concussive symptoms (PCS), deficits of postural control, and decreased social and participation-level activities in individuals with concussion.

**Number of Subjects :** 11 participants who presented to a physician within the NYU Langone Medical Center Concussion Program and met the World Health Organization criteria for post-concussion syndrome were referred to the Vestibular Rehabilitation Clinic. The age of participants ranged from 21-72 years of age, with a median of 37.5 years. Time from onset of injury to initial evaluation ranged from 1 – 32 months (median = 111 days). Causes of concussion included; motor vehicle accident (3), sports-related (3), fall (2), and other (3).

**Materials/Methods :** A battery of tests was completed at initial evaluation to the Vestibular Clinic, at 3 months, and again at 6 months following the initial evaluation. The compilation of tests includes: the Rivermead Post-Concussion Scale, Dizziness Handicap Inventory (DHI), Activities-specific Balance Confidence Scale, Functional Gait Assessment (FGA) and the Balance Error Scoring System (BESS). All individuals were provided customary VR as is described by Gurley et al., (2013): sequenced head turns while sitting, standing, or walking; standing balance exercises eyes open/eyes closed with and without head turns; and when appropriate, dynamic gaze stability exercises. Individuals may have received one or more of the following multi-disciplinary services in combination with VR: Neuropsychology, Occupational Therapy, and/or Orthopedic Physical Therapy.

**Results :** (A quantitative analysis will be presented once all data is collected. This section describes trends in the data of 6 individuals.) A large effect was found in the self-report measures of the Rivermead (RPQ-13) and DHI at 3 and 6 months. These two outcomes measure the impact of one's condition on their participation and function in daily life. Conversely, there was little to no impact, over time, on the cluster of PCS experienced "in the last 24 hours", as measured by the Rivermead (RPQ-3). In general, the balance measures used do not seem to be sensitive to detect a change in performance of this patient population.

**Conclusions :** This report supports previous literature showing a trend for improvement, but only in specific measures. Some outcome measures typically used in VR may not be sensitive to changes in walking and balance performance in individuals with concussion. Further, we recommend clinicians use a measure which evaluates reintegration to social and participation level activities.

**Clinical Relevance :** To the author's knowledge, no study has investigated the performance of concussed individuals, in the civilian population, on outcomes at standardized periods of time. Although this report is exploratory in nature, it can provide important information for treatment approaches and decision making in VR to ameliorate PCS and improve participation in life activities following concussion.

**TITLE:** The Effects of Hearing Loss on Balance in Older Adults: A Systematic Review

**AUTHORS/INSTITUTIONS:** V.C. Kowalewski, N. Bugnariu, Department of Physical Therapy, University of North Texas Health Science Center, Fort Worth, Texas, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Falls due to poor postural control are a common problem within the older adult population, leading to many negative outcomes such as fractures, hospitalization, and even death. Traditionally, three sensory inputs – visual, vestibular, and somatosensory – are associated with the control of balance and have been investigated for their potential contribution to increased risk of falls. However, recent epidemiological research has brought attention to the notion that other sensory impairments, such as hearing loss, may affect balance. The purpose of this review is to systematically document the recent evidence linking hearing loss to balance impairments and increased risk for falls in seniors, and to present various hypotheses regarding the mechanisms by which auditory impairments may affect balance.

**Number of Subjects :** N/A

**Materials/Methods :** A literature search was performed using the key terms: hearing loss, auditory impairment, older adults, elderly, balance, falls, hearing aids, hearing devices, gait, locomotion, cognition, and postural control. The databases PubMed, Scopus, CINAHL, Cochrane, ScienceDirect, and Medline were queried for articles published between January 2000 and August 2013. A total of 346 articles were found.

**Results :** Fifty-seven articles were selected and included in the systematic review based on the relevance to the topic as well as exclusion criteria of an available abstract, humans, English language, and academic journals. Although limited research exists, hearing impairment was directly associated with balance deficits and increased risk of falls in 5 and 6 out of the 57 articles, respectively. The remaining 46 articles linked hearing loss to decreased physical functioning, loss of ADLs, decreased communication, altered cognitive functioning, social isolation and limitations in participation.

**Conclusions :** The exact mechanisms behind why and how hearing loss may affect an older adult's balance are currently unknown. However, several theories exist: an older adult with hearing loss may not be able to perceive dangerous sounds appropriately; the cochlear and vestibular portions of the vestibulocochlear nerve are in close proximity so damage to the cochlear portion may have an effect on the vestibular portion; older adults with hearing loss may socially isolate themselves due to communication issues, which may lead to lack of mobility, decline in physical functioning abilities, and an increased risk of falling; or an older adult with hearing loss needs to increase listening effort to understand speech, particularly in a noisy environment, and utilizes cognitive resources otherwise allocated for control of balance. Most current evidence supports the cognitive load theory.

**Clinical Relevance :** The consequence of hearing loss on a person's ability to maintain balance has not gained attention until recently and minimal research on the effects of hearing loss on balance exists. This report informs physical therapists about potential consequences of hearing loss on an individual's postural control and the need for further research to be performed.

**TITLE:** Meaningful, and ongoing neurologic improvements after 12 months in a complex lumbar surgical patient with central and peripheral deficits secondary to surgery

**AUTHORS/INSTITUTIONS:** S.A. Stemmer, Park Avenue Therapies Inc, Cloquet, Minnesota, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** The number of low back surgeries in the United States is on the rise, with more than 600,000 performed in 2013 alone. Historic goals for neurologic therapy have focussed on the first 12 months for maximal return of function. The purpose of this case study is to look at the longitudinal improvement in an individual undergoing continued physical therapy, as part of recovery from lumbar surgery with extensive surgery-related complications.

**Case Description :** Herein described is the longitudinal recovery, with continued physical therapy, of a 26 year old female status post L3-4,L4-5,and L5-S1 hemilaminectomies (first surgery), surgical findings being L5-S1 disk bulge, central disk herniation L4-5, adhesion of disk to axilla of L5 nerve root resulting in linear tear, L3-4 large central bulge, which palpation revealed to be calcified disk with nerve root involvement at L4 leading to aggressive L4 foraminotomy around L4 nerve root. Immediate postoperative complications included: significant neurologic deficits in motor planning leading to gross weakness of bilateral lower extremities, coordination, proprioception, bladder control, and diminished sensation to light touch, temperature, and sharp/dull. Patient underwent standard 16-day inpatient neurorehabilitation stay before discharging to the home environment. Initial means of mobility included standard wheelchair, bilateral ankle-foot-orthosis (AFO) and front wheeled walker for transfers needing stand-by-assist. As an outpatient, patient was seen for twice weekly, hour long appointments, with therapy focused on neurological re-education of bilateral hips,knees,ankles, core strengthening and gait training.

**Outcomes :** By the 12 month milestone, the patient was ambulating with four wheeled walker, wearing bilateral AFO from inpatient stay in hospital, and bilateral lower extremity tests of strength were antigravity manual-muscle-test (MMT) 3+/5. After 18 months the patient ambulates without assisted device, has regained ankle/foot strength and stability to have bilateral, lateral stay AFO for the prevention of knee hyperextension. Patient's lower extremity strength is MMT 4+/5 at bilateral hips (all motions) and knees, left ankle dorsiflexion and plantar flexion 4-/5 with right ankle respectively 3-/5 Patient has significant increased in dynamic and functional static balance in standing and ambulation. Patient has continued difficulty with bladder emptying, right ankle weakness, and chronic foot pain.

**Discussion :** This case offers hope for further neurologic and functional recovery for some patients with significant neurologic damage, and may support an alteration of physical therapy guidelines to emphasize duration of therapy dependent on ongoing achievement of functional gains over time-dependent milestones.

**TITLE:** Mirror Therapy with Neuromuscular Electrical Stimulation for Improving Motor Function of Stroke Survivors: A Preliminary Study

**AUTHORS/INSTITUTIONS:** D. Lee, Department of physical therapy, Graduate School of Kyungnam University, Changwon-si, Gyeongsangnam-do, KOREA, REPUBLIC OF|J. Jeong, Saessac children's developmental center, Changwon-si, Gyeongsangnam-do, KOREA, REPUBLIC OF|G. Lee, Department of physical therapy, Kyungnam University, Changwon-si, Gyeongsangnam-do, KOREA, REPUBLIC OF|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Maximizing stroke survivors' ability to live as independently as possible through functional recovery is the main goal of rehabilitation, and Mirror therapy(MT) with Neuromuscular Electrical Stimulation(NMES) devices have been suggested and have begun to be used in stroke rehabilitation. Recently, studies using Mirror therapy(MT) with Neuromuscular Electrical Stimulation(NMES) for rehabilitation have been reported. However, some have studies applied the intervention of mirror therapy along with electrical stimulation to the upper extremities of stroke patients, but few applied this intervention to the lower extremities, especially for ankle movement. Therefore, this study applied mirror therapy combined with NMES for the improvement of ankle movement of chronic stroke patients to investigate its effects on motor function, balance, and gait.

**Number of Subjects :** 27 chronic stroke patients

**Materials/Methods :** The study was a randomized controlled trial. Twenty-seven hemiplegic stroke patients who experienced disability for more than 12 months. Twenty-seven participants were randomly allocated to either the experimental or the control group. The experimental group (n = 14) underwent mirror therapy with NMES and a conventional physical therapy, and the control group (n = 13) underwent the conventional physical therapy alone. At the baseline and after 4 weeks of intervention, muscle strength and tone, motor function, balance, and gait abilities were examined. Hand-held dynamometry was performed to test muscle strength, as well as the Modified Ashworth Scale (MAS) for muscle tone, Fugl-Meyer Assessment (FMA) for motor function, Berg Balance Scale (BBS) and Timed Up and Go (TUG) test for balance, and 6-meter Walk Test (6mWT) for gait ability.

**Results :** After the intervention, significant improvements from baseline values in muscle strength and MAS, FMA, BBS, TUG, and 6mWT were observed in the experimental group ( $P < .05$ ). At follow-up, there were significant differences between the two groups in muscle strength, FMA, and BBS ( $P < .05$ ).

**Conclusions :** The mirror therapy performed along with NMES operated by an external switch not only provided electrical stimulation to the affected side but also created a visual illusion. Thus, mirror therapy with NMES may effectively improve muscle strength, motor function, and balance of hemiplegic stroke survivors. Further studies may be needed to demonstrate brain reorganization after mirror therapy with NMES.

**Clinical Relevance :** The results of our study are similar to those of previous studies using such devices, and this shows the potential for the use of Mirror Therapy with NMES in the rehabilitation of post-stroke survivors. Training using Mirror Therapy with NMES may be particularly suitable given the recent trend towards moving rehabilitation out of the hospital environment. Mirror therapy combined with NMES does not require a lot of space. There is little concern of side effects. Can be easily implemented in clinical.

**TITLE:** Locomotor Training using the AlterG in Individuals with Incomplete Spinal Cord Injuries

**AUTHORS/INSTITUTIONS:** M. Ducey, K. Halani, J. Lynskey, Physical Therapy, A. T. Still University, Mesa, Arizona, UNITED STATES|D. Bonaroti, Touchstone Rehabilitation, Phoenix, Arizona, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Body-weight supported locomotor training has been shown to improve walking ability in individuals with incomplete spinal cord injuries. Recently, the AlterG (AlterG Inc. Freemont, CA) antigravity treadmill became commercially available. This treadmill uses air to unweight individuals and was originally used in athletic training and sports/orthopedic rehabilitation. Currently, little evidence exists supporting its use for individuals with incomplete spinal cord injuries. The purpose of this replicated A-B single subject design study was to investigate the ability of locomotor training using the AlterG antigravity treadmill to improve locomotor function in two individuals with incomplete spinal cord injuries.

**Number of Subjects :** Two individuals with ASIA D incomplete spinal cord injuries participated in the study. One had a C6-7 injury secondary to a progressive disc herniation and spinal stenosis that occurred between 2004 and 2012. The second subject had a traumatic injury at T10-11 that occurred in 2011.

**Materials/Methods :** Measurements were taken once a week for three consecutive weeks prior to the initial intervention session and at the completion of weeks 2, 4, and 6 during the intervention phase of the study. The Outcome measures included the spatiotemporal parameters of gait (GAITRite mat), distance walked during the 2 minute walk test, Metabolic cost of walking during the 2 minute walk test (Cosmed K4b2 system), the lower extremity motor score (LEMS), the Walking Index for Spinal Cord Injury II (WISCI- II), and the Rivermead Mobility Index (RMI). The intervention consisted of 18 sessions on the AlterG over 6 weeks. Sessions during weeks 1-2 were 30 minutes with an increase to 45 minutes during weeks 3-6. Body weight support and speed were individualized per each subject's baseline ability, and systematically decreased/increased over the intervention period. The data was analyzed using the 2 standard deviation band method.

**Results :** Both subjects completed all 18 sessions and did not experience any adverse events. Subject one (C6-7 progressive injury) demonstrated significant improvements in multiple spatiotemporal parameters of walking; however these improvements did not translate into changes in walking speed or distance. Subject 2 (T10-11 traumatic) demonstrated significant improvements in spatiotemporal parameters of walking and walking speed, but not distance. Both subjects reported qualitative improvements in their walking ability outside the clinic. Neither subject demonstrated improvements in metabolic cost, lower extremity strength, or functional movement using the Cosmed K4b2, LEMS, WISCI II, or RMI.

**Conclusions :** This study provides preliminary evidence that a 6 week locomotor training program using the AlterG antigravity treadmill may improve the quality and possibly speed of locomotion in individuals with chronic incomplete spinal cord injuries.

**Clinical Relevance :** In addition to providing preliminary evidence, this study introduces a protocol for use of the AlterG in individuals with ASIA D incomplete spinal cord injuries.

**TITLE:** VALIDITY OF A WIRELESS GAIT ANALYSIS TOOL (WI-GAT) IN ASSESSING SPATIO-TEMPORAL GAIT PARAMETERS DURING SLOW, PREFERRED AND FAST WALKING SPEEDS.

**AUTHORS/INSTITUTIONS:** A. DesJardins, E. Eraqi, A.N. Samuels, M. Schiller, S. Galen, Physical Therapy Program, Wayne State University, Detroit, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Assessment of spatio-temporal parameters of gait can help Physical Therapist identify the presence of any movement deviations or abnormalities that may be linked to a particular injury or disease. However due to time, cost and space constraints, performing these assessments in a clinical setting can be challenging. A low cost wireless gait analysis tool (Wi-GAT) was developed to meet these challenges.(1) A recent study comparing the measures of the Wi-GAT with those of a 3D motion capture system, showed excellent agreement, thereby establishing the validity of the Wi-GAT measures.(2) However the validity of the Wi-GAT measures is yet to be established during slow and fast walking speeds. The purpose of this study was to establish the validity of the Wi-GAT measures recorded during preferred, fast and slow gait speeds in healthy adults.

**Number of Subjects :** Twenty-five healthy adult volunteers.

**Materials/Methods :** The spatio-temporal gait parameters of each subject were concurrently recorded using the GaitRite instrumented walkway (CIR systems Inc, Sparta, NJ) and the Wi-GAT system while they walked at their preferred, fast and slow gait speeds. Three trials took place for each of the three walking speeds. Both absolute measurement errors and percentage errors were computed for all the recorded gait parameters. Interclass correlation coefficient (ICC) 2,k were computed to assess the level of agreement between the gait parameters recorded concurrently by the two systems.

**Results :** Twenty two subject's (13 female, mean age: 25.7 + 5.3 years) data were used in the final analysis because 3 subject's data showed a noisy signal. Walking speed measured both by the Wi-GAT and the GaitRite systems showed excellent agreement for preferred (ICC = 0.979 p<0.001), slow (ICC = 0.989 p<0.001) and fast (ICC = 0.967p<0.001) walking speeds. Overall most gait parameters recorded during slow walking speed showed good (ICC > 0.70) to excellent (ICC>0.85) agreement. Gait parameters recorded during fast walking speed showed the least agreement between the two systems.

**Conclusions :** The Gait parameters recorded during slow walking speed showed the greatest agreement between the two systems, compared to fast or preferred walking speeds. The Wi-GAT is limited by its slow sampling frequency of 30 samples a second because of the wireless Bluetooth connection that it uses to send the data to a laptop computer. This we believe directly contributed to some of the poor agreements in the recorded gait parameters during the fast walking speed.

**Clinical Relevance :** The findings of this study indicate that the gait parameters recorded by the Wi-GAT system may be more valid for slow walking speeds as observed in patients with various neurological conditions. Design considerations that will increase the sampling frequency of the Wi-GAT system is currently being considered to improve its accuracy in measuring gait parameters during fast walking speeds.

**TITLE:** Exoskeleton Outcomes for Persons with Spinal Cord Injury (SCI) and Stroke.

**AUTHORS/INSTITUTIONS:** C. Kandilakis, C. Hartigan, D. Apple, D. Leslie, Shepherd Center, Atlanta, Georgia, UNITED STATES|M. Goldfarb, Vanderbilt University, Nashville, Tennessee, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Several different robotic exoskeletons are now in rehabilitation centers across the United States (US). However, very little data exists to support their use. We will present data on one of these devices, named Indego®. Shepherd Center, along with 4 other centers, has been researching Indego® as a means to replace lost mobility and as a rehabilitation tool for progressive gait training for individuals with SCI and stroke. Additional data suggests that upright mobility using Indego® may result in secondary health and wellness benefits. Indego® is a modular, 26 pound exoskeleton that can be donned and doffed independently, and can be worn in a lightweight wheelchair. Functional electrical stimulation (FES), a modality known to enhance neuromuscular re-education, strength, and gait training, has also been integrated into the device. Results from clinical trials characterizing individual's mobility, training efficiency, and real time gait adjustment options, will be presented.

**Number of Subjects :** At the time of this presentation, Shepherd Center and 4 other centers in the US will have enrolled nearly 40 subjects in clinical trials. Subjects will include those with acute or chronic, complete or incomplete SCI, neurological level of injury C4 and below. Results from a pilot study on 3 individuals with CVA performed at Shepherd Center will also be discussed.

**Materials/Methods :** Subjects completed 5 or more gait training sessions using Indego® and an appropriate assistive device ranging from platform walkers to forearm crutches. Subjects trained on both level and unlevel surfaces, and walked over both indoor and outdoor surfaces. Mobility assessments included: Ten Meter Walk Test (10MWT), Timed Up and Go (TUG), 6 Minute Walk Test and a timed 600 Meter walking path. Changes in strength, activities of daily living, satisfaction with life and health questionnaire were also captured.

**Results :** All subjects could safely ambulate with or without assistance using Indego®. Average walking speed for complete paraplegics was 0.35 m/s (0.4 m/s is considered functional community ambulation). Average walking speed for tetraplegics is being investigated at the time of this submission. Using FES, individuals with complete SCI contributed 27% to 95% of the joint torque and power required for walking. Other SCI results to be presented include skill level on indoor and outdoor surfaces, changes in pain, spasticity, and bowel and bladder function. Trials with CVA subjects showed the potential use of Indego® as a rehabilitation tool; all subjects improved in gait speed, step symmetry and stride length.

**Conclusions :** These data suggest that the Indego® has potential to provide personal mobility and serve as a gait training tool for individuals with neurological disorders. Research related to Indego® mobility, dosage, functional recovery and secondary health benefits is ongoing. If accepted as a Platform, a live demonstration will take place.

**Clinical Relevance :** Exoskeletons including Indego® will likely impact how therapists rehabilitate individuals with neurological deficits in the future.

**TITLE:** Cellular changes consistent with spasticity occur within lumbar locomotor networks remote to mid-thoracic spinal cord injury

**AUTHORS/INSTITUTIONS:** T.D. Faw, Neuroscience Graduate Studies Program, The Ohio State University, Columbus, Ohio, UNITED STATES|C.N. Hansen, Center for Brain and Spinal Cord Repair, The Ohio State University, Columbus, Ohio, UNITED STATES|L.C. Fisher, S.D. Kerr, J.A. Buford, D. Basso, School of Health and Rehabilitation Science, The Ohio State University, Columbus, Ohio, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To identify structural changes that occur in the locomotor networks of the lumbar spinal cord following mid-thoracic spinal cord injury.

**Number of Subjects :** Female, Sprague-Dawley Rats (n=22) - Naive (n=5) - Acute Transect (n=4) - Chronic Transect (n=4) - Acute Contusion (n=4) - Chronic Contusion (n=5)

**Materials/Methods :** Fresh, unperfused tissue was collected and stained using FD Rapid GolgiStain Kit (FD Neurotechnologies). Neuron and dendrite tracing was performed using NeuroLucida Neuron Tracing Software (MBF Bioscience) to quantify morphological changes of interneurons and their dendrites in Lamina VI/VII of L3-L6 from naïve and spinal cord injured rats. Quantification of 5 dendrites / animal was performed to model reactive plasticity and examine the effects of sparing in naïves (n=5) and at acute (7d) and chronic (42d) time points after T8 spinal cord transection (TX; Acute TX n=4; Chronic TX n=4) or severe SCI contusion (SCI; Acute SCI n=4; Chronic SCI n=5) delivered using the Infinite Horizons Impactor Device.

**Results :** Dendritic spines increased up to 90µm from the soma after chronic injury regardless of sparing (Naïve = 70.5 +/- 10.2, Chronic TX = 113.4 +/- 9.4, Chronic SCI = 112.2 +/- 3.5; p<.05). After TX, the greatest spine density occurred close to the soma (0-30µm) and increased over time (Naïve = 18.4 +/- 3.6, Acute TX = 30.7 +/- 3.2; Chronic TX = 38.6 +/- 4; p<.05). Interneuron volume decreased over time with TX (Acute TX = 17871.8µm<sup>3</sup> +/- 1207; Chronic TX = 8535.1µm<sup>3</sup> +/- 1147; Naïve = 22759µm<sup>3</sup> +/- 460; p<.05) and was partially attenuated by sparing (Chronic SCI = 16789.1µm<sup>3</sup> +/- 528). In sister groups, neuronal excitability was quantified by stimulus intensity to produce an ankle flexion force of 0.4-0.5N in the tibialis anterior muscle. Stimulus intensity decreased over time after TX (Acute n=6, 1.53mA +/- 0.23; Chronic n=5, 0.64mA +/- 0.19; Naïve n=8; 2.3mA +/- 0.14; p<.05) and was partially attenuated by sparing at 42d (Chronic SCI n=17; 1.53mA +/- 0.14).

**Conclusions :** Maladaptive interneuronal changes occur remote to mid-thoracic SCI and worsen over time with complete SCI. These changes are partially mitigated in the presence of sparing. Our findings provide evidence of cellular changes within interneuronal networks that may underlie the clinical manifestation of hyperreflexia and spasticity after SCI.

**Clinical Relevance :** Spasticity occurs in ~75% of people with spinal cord injury (SCI), with most reporting a negative impact on quality of life. While spasticity is clinically defined as a velocity dependent increase in tonic stretch reflexes, its pathophysiology is largely unknown. One possible mechanism underlying the development of spasticity involves dysfunction of spinal interneurons. Our results provide rationale for evaluating spine density, soma size, and neuronal excitability as novel outcome measures for animal studies investigating interventions designed to reduce spasticity and promote functional recovery following SCI.

**TITLE:** Proposed Guideline For Improved Outcomes In Persistent Horizontal Semicircular Canal Benign Paroxysmal Positional Vertigo: A Case Study

**AUTHORS/INSTITUTIONS:** B.M. Moore, Physical Therapy, New York University Langone Medical Center, New York, New York, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** It is well established that the posterior canal accounts for the majority of Benign Paroxysmal Positional Vertigo (BPPV) cases. What has been less well documented is the occurrence of horizontal semicircular canal BPPV (HSC-BPPV). Once thought to be rare, current literature supports the incidence of HSC-BPPV to be anywhere between 10-30% of all BPPV cases. There is typically lower success rates reported in the treatment of HSC-BPPV compared to the other canals. Reports indicate that 5-26% of HSC-BPPV cases are refractory to treatment with repositioning maneuvers. Further, those cases of HSC-BPPV with the apogeotropic form seem to be even more difficult to treat, as 5-40% of cases are reported to be refractory following repositioning maneuvers. The objective is to present a case study of an 89 year old female with HSC-BPPV who was prescribed Forced Prolonged Positioning (FPP) in a systematic manner as an adjunct to repositioning maneuvers performed in the clinic.

**Case Description :** Two traditional repositioning maneuvers were performed one time per week over the course of six weeks as a means to resolve the apogeotropic form of HSC-BPPV. Repositioning maneuvers, alone, were found to be unsuccessful in resolving the HSC-BPPV. At visit 4, the patient was provided instructions for the FPP as her home exercise program where she was asked to lay with her healthy ear down toward the floor for as long as she could during her night's sleep. Two weeks passed, and the patient continued to have persistent symptoms and apogeotropic direction changing nystagmus with positional testing. The patient was then instructed to switch the FPP with the affected ear positioned down toward the floor for her nightly rest.

**Outcomes :** Following two weeks of performing the FPP on her affected side, the patient reported symptoms had resolved and positional testing confirmed resolution of HSC-BPPV. As of six months follow up, the patient has been symptom free.

**Discussion :** This case study is used to illustrate the intricacies of HSC-BPPV, and to provide strong theoretical rationale for the use of FPP as the home exercise program to supplement repositioning maneuvers performed in the clinic. If a clinician does not account for the possibility that the otoconia can be positioned on either side of the cupula (in the presence of apogeotropic direction changing nystagmus), and modify their therapy management accordingly, the patient could be one of the 5-40% of individuals that never experience resolution of HSC-BPPV. The patient should be instructed to perform FPP with the healthy ear toward the floor, just as prescribed by Vannucchi, 1997. If their symptoms persist following two weeks in this position, the patient should be advised to lie on the opposing side to account for the possibility that otoconia are positioned on the canal side of the cupula in the HSC. Prescribing the FPP technique in this manner as a home exercise program could improve the efficacy of repositioning maneuvers performed in the clinic.

**TITLE:** The Effectiveness of Physical Therapy Interventions on Improving Respiratory Muscle Strength in Patients with Multiple Sclerosis: A Systematic Review

**AUTHORS/INSTITUTIONS:** L. Doyle, A. DiOrio, L. Spitsberg, W. Wang, K. Whitten, Franklin Pierce University, Manchester, New Hampshire, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this systematic review is to evaluate the current literature to determine the most effective physical therapy (PT) interventions for improving respiratory muscle strength in patients with MS.

**Number of Subjects :** This is a systematic review of 9 relevant articles.

**Materials/Methods :** Four databases were explored to identify articles examining the effectiveness of PT interventions for respiratory function in patients with MS. The 222 articles initially identified were evaluated through a systematic screening process resulting in the inclusion of 9 articles. Each article was evaluated for quality using the PEDro scale and the results pertaining to forced expiratory volume (FEV), forced expiratory volume in one second (FEV1), the ratio of forced expiratory volume in one second and forced vital capacity (FEV1/FVC), maximum inspiratory pressure (MIP), and maximum expiratory pressure (MEP) were compared.

**Results :** The average quality of the included articles was 4.89 out of a possible 10 points on the PEDro scale. Interventions evaluated included inspiratory muscle training (IMT), aerobic training, neurophysiologically-based PT, music therapy, in-clinic and at-home respiratory muscle training programs. Of all the interventions examined, IMT was the most commonly evaluated intervention and did consistently show improvement in at least one outcome per applicable study. Other interventions did not have sufficient evidence to warrant their recommendations in practice.

**Conclusions :** While it appears that IMT should be included in respiratory therapy interventions for patients with MS, other methods such as breathing exercises, expiratory resistance training, neurologic rehabilitation, and aerobic training should be further evaluated for their effectiveness in this patient population.

**Clinical Relevance :** Respiratory complications in patients with multiple sclerosis (MS) are a major cause of morbidity and mortality. To date the most effective therapeutic interventions for improving respiratory function in patient with MS remains to be elucidated.

**TITLE:** A Training Program Combining Large Amplitude Movements and Forced Exercise (FE) Cycling to Improve Balance and Mobility in a Community-Dwelling Adult with Early Onset Parkinson's Disease: A Case Report

**AUTHORS/INSTITUTIONS:** R.M. Hakim, M. Gildea, C. Gregowicz, T. Liccione, N. Schrecengost, Physical Therapy, University of Scranton, Scranton, PA, Pennsylvania, UNITED STATES|T. Mellody, Physical Therapy, Allied Services Outpatient Rehabilitation, Scranton, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Recent research on non-pharmacological interventions for patients with Parkinson's Disease (PD) has found evidence that certain types of external cueing (auditory, verbal, visual, and/or somatosensory) facilitate movement initiation and continuation. Clinical application includes training with large amplitude movements, forced exercise (FE), and dance. The purpose of this case report is to describe a physical therapy program with external cueing using large amplitude movements (i.e., LSVT Big concepts) combined with FE cycling in a community-dwelling adult with early onset PD.

**Case Description :** A 47 y/o male with a 2 year h/o PD (H &Y Stage II) presented with c/o impairments of right sided weakness, tremors, and rigidity that resulted in increasing difficulty with functional mobility and ADLs. PMHX included: HTN, lumbar disc herniation, low back pain and elevated cholesterol. He was a freelance writer who lived with his spouse in a 2 story home and ambulated independently without a device. Examination of balance and mobility was conducted before and after the intervention consisting of: the Berg Balance Scale (BBS), Timed Up and Go (TUG), 10 Meter Timed Walk (10MTW), 6 Minute Walk Test (6MWT), and 5 Times Sit to Stand Test (5TSST). Upon initial exam, the patient displayed instability, gait deviations and difficulty with transfers and bed mobility. He participated in 16 one-hour training sessions (over a 4 week period) that included a combination of large amplitude extremity and trunk movement training and FE via the TheraCycle. LSVT Big intervention targeted retraining of sensory awareness with a patient-perceived "bigness" effort rating of at least 80% of maximum on every repetition of mobility and gait activities for 30-45 min each session. The TheraCycle provided FE pacing which was progressed from 11 mph for 15min to 14 mph for 30 min over the 4 week period.

**Outcomes :** Upon post-testing, BBS improved from 47/56 to 56/56 (MDC=5; fall risk <42 with no fall hx), TUG from 10.6s to 7.7s (MDC=4.85s; fall risk >11.5s), 10MTW from N/A to 2.4m/s (norm for males 40-49 =1.46m/s), 6MWT from 990' to 1949'(MDC=269'; norm for 40-49 years = 2004.6'±278.9') and 5TSST from 14.9s to 11.65s (MDC=N/A; fall risk >16s). The patient's post-test scores exceeded the available Minimal Detectable Change (MDC) values compared with baseline for most outcome measures. Subjectively, he reported no longer having difficulty with ADLs, mobility and walking on uneven surfaces and narrow paths.

**Discussion :** After 16 sessions/4 weeks of large amplitude training combined with FE cycling, this patient's balance and mobility improved as indicated by all outcome measures and subjective report. This type of combined training program shows promise as a clinically feasible, non-pharmacological intervention using external cues to improve functional mobility in adults with early onset PD.

**TITLE:** Initiation of running in a 59 year old male with hemiplegia three years after traumatic brain injury  
**AUTHORS/INSTITUTIONS:** K. Sheeran, New York University Langone Medical Center, Rusk Institute of Rehabilitation Medicine, New York, New York, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Minimal research exists on return to running after traumatic brain injury (TBI). Running can improve quality of life post TBI as well as assist in spasticity management, improvement in balance, and cardiovascular health. The goal of returning to running can be valuable to not only young adults, but also middle aged to elderly adults. The purpose of this case report is to describe interventions leading to successful return to running in an older adult 3 years after neurological injury.

**Case Description :** A 59 year old status post TBI secondary to a pedestrian motor vehicle accident, presented with resultant right hemiplegia, clonus, and impairments in balance and motor planning. The patient reported an average of 1 fall per week and inability to run despite utilizing private gym. His goals were to improve balance and return to recreational running, which he participated in regularly prior to sustaining a TBI. Patient participated in approximately 3 months of 30 minute 1:1 physical therapy sessions twice per week in a neurological outpatient setting. Initial sessions focused on balance and bilateral lower extremity strengthening. The patient transitioned to pre-running activities when he no longer presented as a fall risk as determined by functional outcome measures. After his tenth session, treatments emphasized plantar flexor strengthening, plyometrics, high level balance training and treadmill training at high speeds with a body support system for safety.

**Outcomes :** On evaluation, the patient completed the Berg Balance Scale (BBS) [47/56], Five Times Sit to Stand (FTSTS) [14.8 seconds], right single leg stance (SLS) [4 seconds], and left single leg stance [3 seconds]. The patient was re-assessed on his tenth visit: Berg [56/56], FTSTS [11.92 sec], Right SLS [20 sec], and L SLS [18 sec]. At that time, he was unable to initiate over ground running or bound onto single leg. Treadmill training was initiated with fastest walking speed of 3.4 mph. Upon discharge, patient's fast speed was 4.0 mph on the treadmill and performed over ground running for 10 trials of 50 feet.

**Discussion :** Running is an important skill for daily living. It has become a common goal for older adults with neurological injury who live an active lifestyle. This case study suggests that return to running is possible in the older adult post TBI with resultant hemiplegia, after treadmill training, high level balance activities, plyometrics and plantar flexor strengthening. Despite patient's bilateral lower extremity strength and balance, the patient was unable to initiate running. Treadmill training at increased speeds, in addition to pre-running activities, may have provided the patient with the external cues necessary to initiate running. Further research is warranted to determine the effectiveness of treadmill training and pre-running activities, to return the older adult to running after a neurological injury resulting in hemiplegia and impaired motor planning.

**TITLE:** The Integration of Manual Therapy into a Motor Retraining Program for an Individual with Chronic Stroke.

**AUTHORS/INSTITUTIONS:** J.G. Keehan, J.M. Swiers, H.R. Cogswell, C.M. Martin, A. Reinthal, Doctoral Physical Therapy Program, Cleveland State University, Cleveland, Ohio, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Many factors influence an individual's functional recovery after stroke. As a disease of aging, individuals with stroke frequently present with a variety of comorbid impairments. In addition, stroke-related movement impairments can result in secondary musculoskeletal impairments. The purpose of this case report is to demonstrate the importance of a global treatment approach to improve motor control in an individual with chronic stroke and subsequent severe shoulder pain.

**Case Description :** A 67-year-old female with right hemiparesis six years post stroke presented with shoulder pain, increased upper extremity (UE) spasticity and spasms, and decreased functional arm use after a two year secondary diagnosis of right shoulder adhesive capsulitis. Examination revealed impaired trunk and right UE posture including excessive humeral extension, as well as impaired right UE motor control with significant pain. The patient was seen 15 sessions over the course of 8 weeks. Physical therapy interventions focused on manual therapy to the right UE and trunk which addressed the postural malalignment. This was done in conjunction with motor retraining activities.

**Outcomes :** Multiple outcome measures were used in the four month case study including the Fugl-Meyer Assessment (FM), Stroke Impact Scale (SIS), goniometric passive range of motion (PROM), and ongoing postural analysis by photo. The FM UE score improved by 34 points from 15/66 to 49/66 (MCID 6.6 points). The SIS improved in the ADL function category while decreasing in the strength, mood/emotion, and hand function sections. Improvements in PROM included increases from 70 to 120 shoulder flexion (+ 50°). Photo assessment of posture in standing at rest demonstrated initial excessive right shoulder extension, decreasing from approximately 25° to 5° by the end of the course of treatment, and with the scapula moving from an initially downwardly rotated position with the medial border parallel to the spine into a +5° upwardly rotated position. Observation of this individual removing and donning her shirt and jacket at each session became significantly faster and less painful over the course of the treatment.

**Discussion :** This case report describes the integration of manual therapy into a motor retraining program to improve posture and motor control in an individual with chronic stroke. In conjunction with additional motor retraining, the application of manual therapy addressed both preexisting posture deficits as well as newer postural and PROM limitations resulting from both stroke related motor control deficits as well as adhesive capsulitis. As posture and PROM improved, pain decreased to a more tolerable level, allowing motor control, and thereby function, to return to levels similar to before the development of adhesive capsulitis.

**TITLE:** Utility of Gait Speed and Timed Up and Go as Outcome Measures after Lumbar Drain Placement in Patients Suspected of Having Normal Pressure Hydrocephalus

**AUTHORS/INSTITUTIONS:** K. Parlman, N. Skrzyniarz, Department of Physical Therapy, Massachusetts General Hospital, Boston, Massachusetts, UNITED STATES|M. Beninato, MGH Institute of Health Professions, Boston, Massachusetts, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Normal Pressure Hydrocephalus (NPH) is associated with a triad of reversible symptoms, including gait impairments. Lumbar drain trials may be performed to determine if drainage of CSF improves these symptoms. Given the lack of evidence, there is no standard for selecting outcomes measures related to gait changes or functional performance in patients with suspected NPH. Purpose was to examine which clinical test, Gait speed (GS) or the Timed Up and Go (TUG), was the better indicator of change in patients suspected of having normal pressure hydrocephalus (NPH) who were admitted for lumbar drain (LD) placement for extraction of large volume of cerebrospinal fluid. We also sought to determine which time point (48 or 72 hours) was optimal for detecting change after lumbar LD placement.

**Number of Subjects :** 37 patients suspected of having NPH who were admitted for placement of lumbar drain. Mean age was 76.2+/-8.27 yrs; 65% were male.

**Materials/Methods :** 45 patient records were reviewed. Of these, the 37 records analyzed had complete data from physical therapy assessments at admission (baseline) and at 48 and 72 hours after LD placement. Variables included age, sex, GS (10m walk test) and TUG at each time point. Effect sizes and the percentage of patients who achieved at least minimal detectable change (MDC) for GS and the TUG were calculated at 48 and 72 hours post LD. Paired-samples t-tests were conducted to compare GS at 48 hours and 72 hours with baseline scores. Wilcoxon signed rank tests were performed for TUG times at 48 and 72 hours due to skewed data.

**Results :** Mean baseline GS and TUG scores were 0.60+/-0.28 m/sec and 32.3+/-20.7 sec, respectively. Effect sizes for GS were 0.09 and 0.18, and for the TUG 0.10 and 0.24 at 48 and 72 hours, respectively. The percentage of patients who achieved at least MDC for GS were 32% and 11%, and for the TUG were 24% and 66% at 48 and 72 hours, respectively. There were no significant differences in GS between baseline and 48 hours post LD ( $p=0.321$ ) nor between baseline and 72 hours ( $p=0.118$ ). TUG scores were not significantly different from baseline to 48 hours ( $p=0.815$ ) but were significantly faster at 72 hours ( $p=0.021$ ).

**Conclusions :** These results suggest that the TUG may be more responsive than GS in detecting improved mobility after LD, and 72 hours post LD appears to be the time point at which change can best be detected. One limitation of this study is that the subjects may include individuals without NPH and therefore the responsiveness may be limited as we would not anticipate changes in these individuals. The responsiveness of GS and TUG would likely be improved in a sample of individuals with confirmed NPH.

**Clinical Relevance :** Clinical Relevance: In patients suspected of NPH the TUG appears to be a responsive outcome measure and should be considered for use in this population. The TUG likely includes parameters of mobility that are responsive to change following CSF drainage in this population.

**TITLE:** The use of virtual reality enhanced robotics to improve upper extremity function in patients with chronic stroke:  
A systematic review

**AUTHORS/INSTITUTIONS:** C.D. Afshari, A.M. Bencivengo, B.T. Morris, J.A. Page, R.M. Hakim, Physical Therapy, University of Scranton, Scranton, PA, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this systematic review was to determine the most effective training parameters using virtual reality (VR) enhanced robotics to improve upper extremity (UE) function in patients with chronic stroke.

**Number of Subjects :** N/A

**Materials/Methods :** A literature search of PubMed, Cochrane Library, CINAHL, Science Direct, and ProQuest Central was conducted. Key words included: virtual reality, robot\*, CVA, and stroke. Inclusion criteria were: RCTs in English, cognitively intact subjects over age 18 with unilateral stroke (>3mos.) and use of VR enhanced robotics. Studies without UE training were excluded. Two reviewers independently assessed each study for methodological quality and came to consensus based on PEDro Guidelines.

**Results :** A total of 1,613 articles were screened for eligibility. Following detailed appraisals, 6 studies fulfilled the inclusion/exclusion criteria. The PEDro scores ranged from 5 to 9 with a mean of 6.7. Samples ranged from 13 to 127 for a total of 273 subjects with mod-severe hemiparesis based on Fugl-Meyer Assessment of Motor Recovery (FMA-UE). Robotic devices providing either assistive control [i.e., ARMin (UE exoskeleton, 7 dof), MIT-Manus (4 UE modules, 1-3 dof), UL-EX07(UE exoskeleton, 7 dof), HWARD (wrist/hand splint device, 3 dof)] or haptic/error augmented training [i.e., Phantom Premium 3.0 (haptic robotic arm, 6 dof) coupled with WREX (forearm exoskeleton, glove, 6 dof)] were used in each study. All studies included VR using task-specific reaching and/or grasping tasks to a moving or fixed target/path. The intensity/duration varied widely from 6 to 36 total sessions (45 to 90 min) over 2 to 12 weeks for a total of 6 to 36 hrs. All 6 studies found clinically significant improvements (>3.5 points) and 5 of 6 found statistically significant changes in motor impairment levels on the FMA-UE for the robotic training groups. Only those studies that focused distally on training of the wrist/hand (Phantom + WREX and HWARD) showed significant improvement at the functional level in the WMFT (timed tasks), ARAT or Box and Blocks test immediately post training, with HWARD training also resulting in task-specific cortical reorganization.

**Conclusions :** There is moderate to strong evidence in support of using VR enhanced robotics to improve motor impairments in persons with moderate to severe unilateral, chronic stroke. The most effective studies for improving UE function focused on distal wrist/hand training. Limitations included widely varied outcome measures and training protocols. Further research is needed to determine training parameters to optimize functional outcomes.

**Clinical Relevance :** VR enhanced UE robotic training offers advantages such as objective recording, consistent, non-fatigable assistance, and motivational environments. High repetition, task-specific training with distal UE emphasis may promote practice-dependent neuroplasticity and optimize functional outcomes for patients with chronic stroke. Future applications will be dependent upon the availability of resources/equipment.

**TITLE:** Instrumented sway assessments detect effects of attentional demand on postural sway in young healthy individuals.

**AUTHORS/INSTITUTIONS:** J. To-Alemanji, S. Lydick, K. Terry, P. Jo, Rehabilitation Science, George Mason University, Fairfax, Virginia, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Current clinical balance assessments may not be sensitive enough to detect balance deficits in individuals with mild neurological impairment. One common clinical assessment used to determine balance deficits is the modified Clinical Test of Sensory Interaction on Balance (mCTSIB). However, the Neurology Section of APTA states that mCTSIB is inappropriate for intervention research studies and not explicitly recommended for clinical settings, primarily due to a lack of sensitivity. Therefore, the purpose of this study is to determine if instrumented assessments have better sensitivity to the effects of attentional demand on postural sway.

**Number of Subjects :** 8

**Materials/Methods :** Healthy volunteers age 18-35 completed the Activity-specific Balance Confidence Scale (ABC) and High Level Mobility Assessment Tool (HiMAT) to screen for balance deficits. Subjects then performed three 30-sec. repetitions of the mCTSIB under the following conditions: eyes open or closed on both firm and foam surfaces. The same four conditions were repeated under two levels of attentional demand - counting backward by 10 and 7. Center of mass postural sway distance and velocities were quantified using the Instrumented CTSIB (ICTSIB) and Instrumented Sway (ISWAY) assessments with accelerometer data (APDM, Portland,OR,USA). ISWAY velocities and ICTSIB scores were analyzed using a mixed model ANOVA comparing effects of vision, support surface, and attentional demand by individual.

**Results :** ABC, HiMAT and mCTSIB scores revealed no balance deficits. The mCTSIB showed no effects of attentional demand. For the no-counting condition, the ICTSIB identified five individuals with significant differences from the mean and the ISWAY anterior/posterior (A/P) velocity identified two. Significant attentional demand and individual interactions were found for the ICTSIB ( $p < 0.001$ ), ISWAY (A/P) velocity ( $p = 0.034$ ) and medial/lateral (M/L) velocity ( $p = 0.046$ ). There were also significant individual interactions for vision and attentional demand for the ICTSIB ( $p < 0.001$ ) and the ISWAY A/P velocity ( $p = 0.011$ ).

**Conclusions :** Standard clinical assessments did not reveal effects of attentional demand, however, instrumented assessments were sensitive to individual effects of attentional demand in young healthy adults with no signs or symptoms of balance deficit. Additionally, attentional demand effects may be more evident with vision than without. Although the instrumented assessments show greater sensitivity to attentional demand, the specificity of these assessments must still be evaluated for patient populations.

**Clinical Relevance :** Instrumented assessments using commercially available accelerometers are more sensitive to attentional demand effects. This increased sensitivity is necessary to detect diminished attentional capacity in individuals with mild neurological impairment not detected by standard clinical assessments. This finding may lead to a functional assessment that can establish return to play or return to duty status for athletes or military personnel, respectively.

**TITLE:** Longitudinal effects of boxing training on walking function and balance in people with Parkinson disease

**AUTHORS/INSTITUTIONS:** S.A. Combs-Miller, K. Prusinski, B. Mary, K. Wendholt, Krannert School of Physical Therapy, University of Indianapolis, Indianapolis, Indiana, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to compare walking and balance outcomes overtime between people with Parkinson disease (PD) who participate in boxing training and those who do not.

**Number of Subjects :** Eighty-eight participants with PD were enrolled in a two-year longitudinal cohort study. Those participants who completed at least two of five testing sessions were included in the current analysis [n=83; mean age 66.3(9.3) years; male 69%; months post diagnosis 67.4(53.7), Hoehn and Yahr range 1-3, mean 2(0.8)].

**Materials/Methods :** Participants were tested at baseline, 6, 12, 18, and 24 months. Participant demographics and PD characteristics were collected at baseline. Exercise behavior, walking function (comfortable/fast 10-meter walk tests and 6-minute walk test) and balance (functional reach and miniBEST test) were assessed at each testing session. All participants were tested during the ON cycle of their anti-Parkinson medications. Participants were categorized as “boxer” if they reported participating in boxing training at 2 or more of the testing sessions. The remaining participants were categorized as “non-boxers.” Scores from the previously recorded testing session were carried forward for participants who were not assessed at all intervals. Data were analyzed with a 2x5 mixed-model ANOVA ( $p \leq 0.05$ ). Because the boxers exercised significantly more minutes per week compared to the non-boxers, this variable was applied as a covariate to the model when assumptions for analysis of covariance were met (indicated with \*).

**Results :** Groups did not significantly differ in age, gender, months since diagnosis, Hoehn and Yahr levels, and history of falls ( $p > .05$ ). Boxers demonstrated significantly better walking function overtime compared to the non-boxers on the comfortable 10-meter walk test [boxers 1.29(0.22)m/s vs. non-boxers 1.15(0.23)m/s;  $p = .00$ ], fast 10-meter walk test [boxers 1.87(0.38)m/s vs. non-boxers 1.64(0.35)m/s;  $p = .01$ ] and 6-minute walk test [boxers 497.3(112.1)m vs. non-boxers 423.3(95.2)m;  $p = .01^*$ ]. Boxers reached a significantly farther distance than non-boxers on the functional reach test [boxers 26.96(6.21)cm vs. non-boxers 24.52(4.87)cm;  $p = .03^*$ ]. Significant differences between groups on the miniBEST test not were found [boxers 22.9(3.9) vs. non-boxers 21.6(4.4);  $p = .26^*$ ].

**Conclusions :** Despite the boxers spending more time exercising, they maintained higher levels of walking function and balance over a 2-year period through participation in boxing training compared to people with PD who chose to participate in other modes of exercise. Further investigation of boxing as an alternative form of exercise for people with PD is warranted.

**Clinical Relevance :** Boxing training is a safe and feasible non-traditional mode of exercise for people with PD. Boxing for persons with PD has primarily been implemented in community-based fitness settings. Physical therapists can incorporate boxing-related concepts into their clinical practices and should consider providing consultation services to boxing centers in their community.

**TITLE:** Does body-weight supported or robot-assisted gait training ameliorate gait dysfunction in persons with multiple sclerosis? A systematic review of the literature.

**AUTHORS/INSTITUTIONS:** E.T. Cohen, M. Andrade, R. DiMaio, M. Ferreri, T. Graciano, S. McAndrew, N. Zimmerman, Rehabilitation and Movement Sciences, DPT-South, Rutgers, the State University of New Jersey, Stratford, New Jersey, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Gait dysfunction is a common cause of disability in persons with multiple sclerosis (MS). Body-weight supported gait training (BWSGT) and robot-assisted gait training (RAGT) have come into widespread use in gait rehabilitation for persons with other neurologic diseases, but evidence for their usefulness in persons with MS is limited. The purpose of this systematic review was to examine the effectiveness of BWSGT and RAGT in ameliorating gait dysfunction in persons with MS, and to make relevant recommendations based on the results.

**Number of Subjects :** N/A

**Materials/Methods :** A search of Ovid/Medline and CINAHL databases was performed in September 2013 using the keywords body weight supported treadmill training, body weight supported gait training, robot assisted treadmill training, robot assisted gait training, and multiple sclerosis. Inclusion criteria were experimental or quasi-experimental studies of a sample of persons with MS, an intervention that included body-weight or robot-assisted gait training, and English language.

**Results :** Seven studies met the inclusion criteria and were included in this systematic review. Each was examined for threats to internal validity by two group members using the Physiotherapy Evidence Database (PEDro) scale. The PEDro scale has a range from 0-11, with 11 indicating the fewest threats to internal validity. The final rating score for each article was the average score of the two team members. The mean PEDro score for all studies was 7.17 (range 3-8).

**Conclusions :** Generalizability of the conclusions is hampered by substantial inconsistency between the interventions provided in the included studies. Interventions varied widely in frequency and duration, in amount of body weight support and movement assistance, and in program progression. The evidence suggests that BWSGT and RAGT may lead to improvements in walking speed and endurance, and temporal-spatial parameters of gait in persons with MS. In general, BWSGT and RAGT resulted in significant improvements immediately following the intervention period; however, these changes did not persist at follow-up. The results of the studies that compared BWSGT or RAGT intervention to conventional walking therapies (CWT) found that BWSGT or RAGT was, generally, no more effective than CWT. The decision to use these interventions would be better substantiated by further study of their cost-effectiveness.

**Clinical Relevance :** With the current understanding of the effects of task-specific training, it is not surprising to see that BWSGT or RAGT result in improvements in walking ability. The literature does show beneficial effects of BWSGT or RAGT for persons with moderate to severe disability due to MS, but there is not adequate evidence to recommend either to be the first-line intervention for gait rehabilitation in persons with MS. CWT has been shown to be an equally effective intervention without the additional resources (e.g. personnel, space, etc.) inherent in the use of BWSGT or RAGT.

**TITLE:** Age-related Effects of Cognitive and Manual Tasks on Phases of Timed Up-and-Go

**AUTHORS/INSTITUTIONS:** F.S. Porciuncula, Biobehavioral Sciences, Movement Science, Teachers College Columbia University, New York, New York, UNITED STATES|A.K. Rao, Rehabilitation and Regenerative Medicine (Physical Therapy), College of Physicians and Surgeons, Columbia University, New York, New York, UNITED STATES|T. McIsaac, Physical Therapy, Arizona School of Health Sciences, A.T. Still University, Mesa, Arizona, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Gait decrements during dual-task walking are associated with fall risk in aging. Daily mobility consists of straight and curved locomotion, and transitions, thus postural challenges change throughout activity. It is unclear how young and older adults modulate dual-task gait under changing postural challenges. This study examined individual phases of the dual-task Timed Up-and-Go test (TUG). The purpose was to examine phase-specific effects of age and type of secondary task on gait performance.

**Number of Subjects :** Twelve young ( $26.13 \pm 5.36$  yr.) and 12 older ( $74.18 \pm 5.21$  yr.) healthy adults.

**Materials/Methods :** Movements were assessed using body-worn inertial sensors during single-task TUG and 4 conditions of dual-task TUG: 1) serial-three subtractions, 2) carrying cup of water, 3) combined tasks of subtraction and carrying water, and 4) dialing a cell phone. The primary outcome measure was the dual-task effect (DTE) on the TUG (percent change from single- to dual-task), to examine effects on duration and velocity of: a) the whole TUG, b) sit-to-stand, c) straight gait, d) turn, and e) turn-and-sit portions. Secondary analysis examined cognitive performance based on age (young, old) and phase of TUG (walk, transition).

**Results :** Dual-task gait performance was worse in straight-ahead gait in older adults than young adults ( $p = .039$ ), but transitions were similarly affected in both groups ( $p > .05$ ). Both groups slowed the rate of subtracting and made fewer math errors during transitions compared with straight walking ( $p < .001$ ). Conversely, older adults had worse transitions than young adults ( $p < .05$ ) when performing TUG without dual-task challenge. The type of secondary task determined the extent of interference during the dual task TUG. Cognitive subtractions had the least DTE on gait, and combined cognitive-manual tasks had the worst DTE on gait ( $p < .05$ ).

**Conclusions :** Prioritization of gait or secondary task was modulated differently across phases of the TUG, possibly weighted according to postural demand and hazard estimation.

**Clinical Relevance :** Most daily activities involve fluctuating task and postural challenges, hence it is important to assess how older adults flexibly modulate prioritization based on these terms. DT training during straight and non-straight steps may be useful in eliciting problem-solving related to prioritization, which is an important cognitive mechanism required for effective mobility.

**TITLE:** A Systematic Review of the Effects of High Intensity Treadmill Training on Balance and Mobility in Adults with Parkinson's Disease

**AUTHORS/INSTITUTIONS:** M.C. Saverino, K.M. McAllister, T.R. Corker, B.R. Sakar, R.M. Hakim, Physical Therapy, University of Scranton, Scranton, PA, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this systematic review was to determine the effects of high intensity treadmill training (HITT) on balance and mobility in adults with Parkinson's disease (PD).

**Number of Subjects :** N/A

**Materials/Methods :** A literature search of PEDro, ProQuest, Science Direct, CINAHL and PubMed using search terms: Parkinson AND treadmill training AND (high intensity OR speed dependent). Inclusion criteria: English, RCTs, subjects at least age 18 with PD, and use of HITT with either speed dependent (SDTT; defined by short intervals of fast or maximum speed) or progressive speed protocols (using systematic speed and/or incline increases with a target heart rate of 70-80% of APMHR). Studies were excluded if robotic training was used. Two reviewers independently assessed each study for methodological quality and came to consensus based on PEDro guidelines.

**Results :** A total of 349 articles were screened for eligibility. Following detailed appraisals, 6 RCTs fulfilled the criteria. PEDro scores ranged from 5 to 7/10 (avg=5.9). Samples ranged from 17 to 67 subjects (286 total) with mild-moderate PD (H&Y Stages I-III). HITT was performed 1-3 days per week (30-45 min/session) averaging 8.6 weeks duration (range 1-24 wks). Primary outcomes included temporal-distance gait parameters, endurance, balance, ADLs and quality of life (QOL). No adverse events were reported. There were statistically significant within-group improvements noted in gait/stepping following HITT in 5 studies, with descriptive gains in gait and sit to stand symmetry reported in 1 study. There were no significant between-group differences when comparing HITT to groups of Rhythmic Auditory Cued overground walking (RAC using music), low intensity treadmill training (LITT) and controls in 5 of 6 studies. One study found statistically significant improvements for SDTT vs. controls for balance and gait. Another study found statistically significant gains for LITT over HITT for gait distance (6MWT), but equal benefits for cardiovascular fitness (VO<sub>2</sub>). None of the 3 studies that examined QOL and/or ADLs found significant changes (PDQ-39, UPDRS). One study found dose-dependent benefits for HITT which normalized corticomotor excitability in early PD indicating activity-dependent neuroplasticity.

**Conclusions :** There is moderate evidence in support of HITT to improve gait and balance in patients with PD. HITT using SDTT protocols did not have an advantage over RAC overground gait training. Limitations included small samples, varied outcome measures and a lack of long-term follow up. Future RCTs should focus on determining the optimal mode and parameters for externally cued gait training.

**Clinical Relevance :** The outcomes for HITT were comparable to other types of externally cued gait training (i.e., LITT, RAC). Effective HITT protocols used SDTT for 3 5-minute intervals of max walking speed for 30 minutes, 2 times/wk for 8 weeks. All of the externally cued gait training programs were safe and feasible methods for improving balance and mobility in patients with mild-moderate PD.

**TITLE:** Quantifying command following in disorders of consciousness after brain injury: a novel methodology using accelerometry

**AUTHORS/INSTITUTIONS:** K.V. Day, Physical Therapy, Arcadia University, Glenside, Pennsylvania, UNITED STATES|J. Whyte, Moss Rehabilitation Research Institute, Elkins Park, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose :** To sustain interdisciplinary rehabilitation for persons with disorders of consciousness (DoCs), accurate assessment of consciousness is vital. Command following provides powerful evidence of consciousness. Standardized neurobehavioral tests examine command following, but depend on a limited number of trials which may not be sufficient if movements are equivocal or infrequent. Further, although movements often appear involuntary or random, their frequency and magnitude relative to specific commands may provide ample evidence to indicate volition. The purpose of this special interest report is to present findings from a proposed, novel methodology for detecting command following in persons with DoCs.

**Description :** We conducted the following methods with three participant groups: healthy individuals, persons with severe brain injury (BI) who recovered ability to follow commands, and persons with DoCs undergoing inpatient rehabilitation. While seated, 3D accelerometers were adhered to the dorsum of each person's hands bilaterally. Audio-recorded commands to "move hands" and "hold still" were randomly administered over approximately 20-60 total trials. The interstimulus response intervals were 10 seconds. Following continuous data collection, accelerations were extracted into epochs and grouped by command type. The mean of 3D accelerations from each trial (excluding the first second after command delivery) within each command type was calculated. Means were analyzed visually via dot density graphs to examine the continuum and classification of data. Wilcoxon Signed Ranks tests were performed to determine statistical significance ( $p < .05$ ).

**Summary of Use :** This analytic approach demonstrated the capacity to classify 100% of trials accurately in our samples of healthy persons and higher functioning persons with BI ( $p < .0001$ ). For a participant diagnosed in vegetative state with an absence of overt behavior, all trials were classified in the same manner ( $p = .627$ ), consistent with diagnosis. However, for a participant diagnosed in minimally conscious state based on automatic motor responses (without command following) on the Coma Recovery Scale-Revised, our analysis revealed command following ( $p < .008$ ), albeit with a greater overlap of trial types compared to the other participants. This participant recovered consistent command following on standardized testing within 11 days of accelerometry.

**Importance to Members:** Physical therapists are integral to the assessment of consciousness post-BI. In an attempt to accurately quantify conscious behavior in this population, the proposed methodology may offer an objective, clinically-feasible, and inexpensive strategy to confirm, refute, or supplement standardized test findings. This approach employs a large number of trials, makes minimal to no assumptions about reaction time and duration of movement, and detects even subtle movements via accelerometry. Uncovering evidence of consciousness is critical in order to ensure continued rehabilitation efforts for patients with DoCs.

**TITLE:** Functional near-infrared spectroscopy neuroimaging of sensory integration during balance in older adults  
**AUTHORS/INSTITUTIONS:** C. Lin, P.J. Sparto, Physical Therapy, University of Pittsburgh, Pittsburgh, Pennsylvania, UNITED STATES|J.M. Furman, Otolaryngology, University of Pittsburgh, Pittsburgh, Pennsylvania, UNITED STATES|T. Huppert, Radiology, University of Pittsburgh, Pittsburgh, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Functional near-infrared spectroscopy (fNIRS), a neuroimaging method which is able to measure brain activity during upright dynamic movements, has been used previously to detect changes in cortical vestibular processing regions during sensory integration balance tasks in young adults. The purpose of this study was to extend this research to identify changes in brain activation during sensory integration in older adults.

**Number of Subjects :** Thirteen community-ambulating older adults (mean age:  $73 \pm 5$  y; 7 male) with a normal neurological and orthopedic examination participated in this study.

**Materials/Methods :** A Smart Equitest<sup>TM</sup> posturography platform (NeuroCom, Clackamas, OR, USA) was used to provide the sensory integration test conditions. An A-B-A block design consisting of baseline-test-baseline conditions was used to elicit changes in brain activation while subjects stood comfortably on a force platform during the following test configuration: 1) Fixed platform - Sway-referenced platform (Sway)-Fixed with Eyes Open (EO), 2) Fixed-Sway-Fixed with Eyes Open in the Dark (EOD), 3) EO-EOD-EO on fixed platform, and 4) EO-EOD-EO on sway-referenced platform. Each block lasted for 40 s (i.e. 2 min total trial time), and the four test configuration were randomly presented. A 32-channel continuous wave fNIRS instrument (CW6 real-time system; TechEn Inc., Milford, MA, USA) was used to record the hemodynamic response bilaterally over the dorsolateral frontal cortex, temporo-parietal (i.e. vestibular) cortex, and occipital cortex. A custom Matlab program was used to analyze the fNIRS data based on a spatial-temporal version of a general linear model. Group-level analysis across the subjects was performed using a random-effects model of brain activity.

**Results :** Extensive activation (i.e. oxyhemoglobin absorption) of the frontal, temporo-parietal, and occipital regions occurred during configuration 1 (Fixed-Sway-Fixed with EO) and 4 (EO-EOD-EO on Sway platform). During configuration 3 (EO-EOD-EO on Fixed), there was increased activation, but less in magnitude, in frontal and temporo-parietal regions. Configuration 2 (Fixed-Sway-Fixed with EOD) elicited the smallest increase in activity, primarily in the left frontal region.

**Conclusions :** Older adults demonstrate widespread areas of increased brain activity in response to changes in sensory information used for maintaining upright stance. During configuration 4, which relies primarily on vestibular processing, activation of cortical vestibular areas was consistent with findings in young adults. However, the same pattern did not occur during configuration 2, suggesting an alternative pattern of brain activation in comparison with young adults.

**Clinical Relevance :** Understanding the control of upright balance in healthy older adults will provide a foundation for the study of the origin of balance dysfunction in older adults. Identification of abnormal control patterns will lead to more specific interventions to address the balance impairments.

**TITLE:** Feasibility and Impact of Different Dosages of Intensive Mobility Training in Individuals with Chronic Traumatic Brain Injury

**AUTHORS/INSTITUTIONS:** D.M. Peters, D.M. Liuzzo, A. Middleton, J.V. Greene, S.L. Fritz, Department of Exercise Science, Physical Therapy Program, University of South Carolina, Columbia, South Carolina, UNITED STATES|S. Jain, R. Raman, Department of Family and Preventative Medicine, University of California-San Diego, San Diego, California, UNITED STATES|E.L. Blanck, Department of Cell Biology & Anatomy, University of South Carolina, School of Medicine, Columbia, South Carolina, UNITED STATES|S. Sun, Biostatistics Research Center, University of California-San Diego, San Diego, California, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Intensive Mobility Training (IMT) is a multifaceted treatment approach designed to increase dosage by utilizing a mass practice schedule, and has proven feasibility in individuals with stroke and spinal cord injury. The purpose of this study was 1) to determine the feasibility of IMT in individuals with chronic traumatic brain injury (TBI), and 2) to examine the impact of different dosages of IMT (3 hours/day for 10 days compared to 20 days) on mobility, balance, and gait speed in this patient population.

**Number of Subjects :** Ten participants (8 male, 2 female) with chronic TBI ( $\geq 3$  months post-TBI, able to ambulate 3.05 m with or without assistance); median age was 35.4 (IQR: 23.5, 46) years, median time post-TBI 9.9 (IQR: 6.3, 14.2) years.

**Materials/Methods :** Participants underwent 20 days (5 days/week x 4 weeks, 150 minutes/session) of repetitive, task-specific training equally divided among 1) balance activities, 2) gait training with a body-weight supported treadmill system, and 3) strength, coordination, and range. Pain and fatigue levels were obtained before and after each session to assess feasibility (Aim 1). A number of gait, mobility and balance assessments were administered prior to the intervention (pre-test), after 10 sessions (interim), after 20 sessions (post-test), and at 3 months follow-up. Nonparametric comparisons for each outcome measure between pre-test and subsequent testing sessions were calculated. Number of participants meeting or exceeding published minimal detectable change (MDC) values was also determined (Aim 2).

**Results :** Aim 1: All treatment sessions were completed, with participants averaging 150.1 (2.7) minutes/session. Across 20 sessions, median pre-session and post-session pain scores were 0/10; median pre-session fatigue scores ranged 0-2.5/10 and post-session scores ranged 3-5.5/10. Aim 2: After 10 days of IMT (pre-test to interim), participants demonstrated significant improvement on Dynamic Gait Index, Timed Up and Go, fast gait speed, and Falls Efficacy Scale, with participants exceeding MDCs for Timed Up and Go and fast gait speed. After 20 days of IMT (pre-test to post-test), two additional measures (self-selected gait speed and 6-minute walk) were also significant, with participants exceeding MDCs on more measures (Timed Up and Go, 6-minute walk, fast and self-selected gait speed). Only changes in fast gait speed and Timed Up and Go were still significant at 3 month follow-up.

**Conclusions :** Aim 1: IMT is a feasible intervention for individuals with chronic TBI, as participants were able to tolerate the average target treatment time of 150 minutes/session with limited fluctuations in pain and fatigue scores. Aim 2: Improvements in gait speed and mobility were seen following 10 days of IMT, with additional gains exhibited after a higher dosage of therapy.

**Clinical Relevance :** Individuals with chronic TBI can tolerate intensive therapy offered at doses of 3 hours/day for 20 days. Improvements were variable with the heterogeneous sample, but still demonstrated at 9.9 years (median) post-injury.

**TITLE:** A Multimodal Approach to the Assessment and Treatment of a Patient with Post-Concussive Syndrome.

**AUTHORS/INSTITUTIONS:** K. Cherian, Rehabilitation and Sports Therapy, Cleveland Clinic, Cleveland, Ohio, UNITED STATES|S.M. Linder, Concussion Center, Cleveland Clinic, Cleveland, Ohio, UNITED STATES|J. Alberts, Biomedical Engineering, Cleveland Clinic, Cleveland, Ohio, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Post concussion syndrome (PCS) is a combination of physical, cognitive and emotional symptoms that persist more than 3 weeks after a mild traumatic brain injury. Evidence supporting treatment for PCS is limited, but a multidisciplinary approach is suggested. The purpose of this case report is to describe the physical therapy management of a patient with PCS using manual therapy, repeated motions and vestibular rehabilitation exercises.

**Case Description :** The patient was a 28 year-old female who sustained a concussion after a fall. Dizziness and headaches were present for 10 months and worsened with cognitive challenges and computer use. Objective findings included decreased upper cervical range of motion, weakness in deep neck flexors, core stability, imbalance, gait and soft tissue tenderness in the cervical spine and jaw. Additional symptoms reported were headache, sensitivity to light and loud sounds, dizziness, "in a fog", reduced concentration, floating and intermittent fainting.

**Outcomes :** Objective measures included balance assessment, reaction time, gait analysis, and subjective measures of dizziness, headache disability and neck disability were included. Approximately 50% improvement was noted in each of the outcome measures (HDI, NDI, and DHI) after completing 12 treatment sessions. The patient also demonstrated functional improvements in Neurocom SOT testing, iPad C3 testing and in gait analysis on the CAREN system.

**Discussion :** Patients with PCS often present with multiple system involvement. An orthopedic and vestibular exam with objective outcome measures is often indicated to ensure deficits are clearly identified and addressed. This case displays how self-reported outcomes and objective measures can be used to identify deficits in concussion patients and to monitor symptoms to guide the selection of appropriate interventions.

**TITLE:** An app to measure the cost of visual acuity on a walking task

**AUTHORS/INSTITUTIONS:** E. Anson, University of Maryland, College Park, Maryland, UNITED STATES|J. Carey, Johns Hopkins Medical Institutes, Baltimore, Maryland, UNITED STATES|S. Hwang, R. Tierney, J. Jeka, Kinesiology, Temple University, Philadelphia, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** It is well known that dual tasking has a negative impact on walking behavior. Gait speed slows down ~15% when talking on a cell phone and ~33% when texting. Performance of the 3 meter get up and go test also results in slower performance under either a manual or cognitive dual task. Individuals with vestibular disease also have reduced gait speed when tasked with a secondary cognitive task. Using a visual stimulus-response may be a valuable method for evaluating dual task ability that does not depend on mental subtraction ability. The purpose of this study was to determine if an app with specific visual acuity requirements can identify changes in walking from a single task condition to a dual task condition.

**Number of Subjects :** 40 healthy individuals, 10 of whom participated in a sub-concussive soccer heading experiment, and 6 individuals with vestibular disorders participated in this experiment.

**Materials/Methods :** All individuals performed a 6 meter get-up-and-go task while either carrying a tablet and observing but not responding to the display (STwalk), or while carrying the tablet and verbally identifying the orientation of a tumbling "E" (DTwalk). The "E" optotype was presented for 200ms at a size of 0.1 logMAR (Snellen 20/25) once per second. A sub-set of the healthy individuals participated in a sub-concussive soccer heading experiment and performed the STwalk/DTwalk testing prior to and following repeated heading. Paired t-test was used to determine if there was a difference between the STwalk time and the DTwalk time. Repeated measures ANOVA identified the effect of sub-concussive soccer heading on the cost of DTwalk. Subjects were grouped as "responders" or "non-responders" based on whether they slowed down > 5% under DTwalk conditions.

**Results :** Healthy individuals slowed down 0.85 seconds during DTwalk conditions ( $p = .001$ ). Healthy responders slowed down ~1.5 seconds and non-responders sped up 0.6 seconds under DTwalk conditions ( $p < 0.001$ ). Following sub-concussive soccer heading, responders and non-responders show similar trends as healthy individuals. Sub-concussive soccer heading may increase susceptibility to negative dual task costs as some non-responders became responders following the sub-concussive soccer heading. Individuals with vestibular disease on average slowed down ~4.2 seconds and were less accurate than healthy individuals during DTwalk.

**Conclusions :** The visual acuity task was challenging enough to elicit changes in walking speed but still allow a high degree of accuracy for healthy individuals. Most individuals responded to the DTwalk by slowing down, but some individuals increased their walking speed, regardless of health status. Optotype inaccuracy more so than time change may be specific to vestibular disease.

**Clinical Relevance :** Testing dual tasking while walking with a visual task reduces the problems associated with mental subtraction and may be more specific for vestibular disease.

**TITLE:** A pilot study to increase the number of steps achieved in stroke survivors during inpatient rehabilitation.

**AUTHORS/INSTITUTIONS:** A.M. Devers, M. Wilks, A.H. Chan, J. Vaught, L. Derenthal, Inpatient Rehabilitation, Sheltering Arms Physical Rehabilitation Centers, Mechanicsville, Virginia, UNITED STATES|P. Pidcoe, School of Physical Therapy, Virginia Commonwealth University, Richmond, Virginia, UNITED STATES|

**ABSTRACT BODY:**

**Purpose :** There is an emphasis on repetition of task-specific activities to achieve neuroplastic change for stroke recovery. Additionally, the shifting healthcare landscape requires innovative use of limited resources to improve patient care and outcomes in an efficient manner. Previous literature has shown extra physical therapy (PT) reduced length of stay and improved mobility in stroke survivors in an inpatient rehabilitation facility. The purpose of this study was to gain data that compares amount of steps per day and functional outcomes during an inpatient rehabilitation stay after stroke when some patients are given opportunities for extra walking practice.

**Description :** This pilot study included a total of 8 stroke survivors. Steps per day were measured on all patients included in the study using a step activity monitor (SAM): the StepWatch. Four patients who met inclusion and exclusion criteria wore the SAM during their entire inpatient rehabilitation stay and participated in conventional, high-quality rehabilitation. An additional four patients were given a maximum of two opportunities per day for 30 minutes of extra walking practice at least 5 days per week. The extra practice consisted of use of walking aids the therapist deemed safe to use during extra practice. A rehabilitation technician and nursing staff were trained on walking with each patient specifically and provided the opportunity for extra practice. If caregivers were available and deemed safe to perform walking with patient, they could also provide extra walking practice after the primary therapist entered an order in the medical record.

**Summary of Use :** Primary outcomes were FIM, length of stay, Timed Up and Go, 6 minute walk test, BERG balance assessment, Dynamic Gait Index, self-selected gait speed, and the Stroke Impact Scale. Differences between the two groups were examined. There was a wide range of steps per day in both groups of subjects. Regression statistics within groups can also help analyze how the number of steps for each individual was related to outcome.

**Importance to Members:** Repetition has been reported to be one important facet in effective gait rehabilitation after stroke. However, there are barriers in a traditional rehabilitation environment to providing sufficient repetition. This pilot study presents a safe and feasible method to incorporate additional walking practice which may lead to improved functional outcomes in stroke survivors.

**TITLE:** Subject Perceptions of High Intensity Interval Training for Post-Stroke Rehabilitation

**AUTHORS/INSTITUTIONS:** J.L. Westover, A. Williams, P. Boyne , B.D. Rockwell, G.R. Keeton, D. Carl, S. Buhr, K. Dunning, Department of Rehabilitation Sciences, University of Cincinnati, Cincinnati, Ohio, UNITED STATES|M.J. McCarthy, School of Social Work, University of Cincinnati, Cincinnati, Ohio, UNITED STATES|B. Kissela, Department of Neurology, University of Cincinnati, Cincinnati, Ohio, UNITED STATES|J. Khoury, Division of Biostatistics and Epidemiology, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, UNITED STATES|M.C. Gerson, Departments of Internal Medicine and Cardiology, University of Cincinnati, Cincinnati, Ohio, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Aerobic treadmill training improves walking ability, cardiovascular health, and aerobic capacity in persons with stroke. Recent evidence suggests high intensity interval training (HIT) may be more effective than conventional treadmill training, but subject perspective has not been reported. Subject perspective is important to consider for clinical translation of HIT. The purpose of this study was to assess subjects' perspectives after 4 weeks of HIT treatment.

**Number of Subjects :** Three subjects (2 males) (2 Caucasians, 1 African American) ranging from 54-77 years old and 1-10 years post-stroke.

**Materials/Methods :** After negative stress tests, each subject received HIT treadmill training sessions 3 times per week for 4 weeks. Each session consisted of 5 minutes warm up, 20 minutes HIT and 3 minutes cool down. HIT included repeated 30 sec bursts of treadmill walking at maximum speed, alternated with 30-60 sec rest periods. As an objective marker of intensity, treadmill speed during training was recorded. After 4 weeks HIT, a semi-structured interview was conducted. Interview duration ranged from 10-30 minutes depending on quantity of information provided and was recorded using a digital voice recorder. A phenomenological approach was used to reduce, organize, manage, and extrapolate the most meaningful sections of the data.

**Results :** When asked about fatigue, 2 subjects stated they experienced fatigue after sessions (not during treatment). One subject reported no fatigue and stated he felt more energized. Phenomenological analysis revealed four themes: (1) apprehension, (2) confidence, (3) enjoyment and (4) intensity. Subjects were apprehensive at the start of training for the following reasons: not familiar with treadmill walking, fear of falling and unsure about training protocol. All three subjects stated that their confidence improved due to: safety harness, therapist encouragement and their own successful performance. All subjects enjoyed the therapy. All subjects reported that HIT was more intense than previous rehabilitation they had received. Baseline overground fast gait speed in the 3 subjects was 0.56, 0.42, and 1.46 m/s. Throughout the 4 weeks, treadmill speed during training ranged from 122-287% of individual baseline gait speed.

**Conclusions :** Although subjects noted that HIT was more intense than previous rehabilitation, all three tolerated it and, in fact, found it enjoyable. Subjects began the treatment with some hesitation and nervousness, but this turned into confidence by the end of the four weeks.

**Clinical Relevance :** Patient preferences are an important aspect of evidence-based practice. These results suggest HIT is acceptable to patients. Clinicians may want to consider apprehension and fatigue when implementing high intensity protocols in the clinic.

**TITLE:** Standardized User Methodology Improves Knowledge Translation and Achieves Superior Outcomes in Gait and Balance Recovery for Persons with Neurologic Disorders

**AUTHORS/INSTITUTIONS:** A.M. Devers, M. Wilks, M. Banta, J. Moore, Inpatient Rehabilitation, Sheltering Arms Physical Rehabilitation Centers, Mechanicsville, Virginia, UNITED STATES|P. Pidcoe, School of Physical Therapy, Virginia Commonwealth University, Richmond, Virginia, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Recently, there has been agreement that high-intensity, repetitive and error-inducing training strategies can improve gait and balance function in people with many types of neurologic injuries and illnesses. Although physical therapy practice has evolved to emphasize use of these evidence-based strategies, knowledge may not necessarily change therapist actions for a variety of reasons. Emerging research investigates knowledge translation (KT) activities: the bridge of knowledge to practice that can maximize outcomes. The present study implemented specific strategies to address therapists' lack of familiarity, lack of agreement and lack of self-efficacy related to an evidence-based protocol for walking recovery. This unique methodology, called standardized user (SU) protocol, was hypothesized to achieve superior, statistically-significant outcomes in the study subjects when compared to matched control subjects.

**Number of Subjects :** Twenty four subjects with a primary diagnosis of acute stroke

**Materials/Methods :** The experimental group (n=12) was selected as a convenience sample. Experimental group participants were matched to controls (n=12) by age, gender, diagnosis, motor function, severity of comorbidities, cognition, admission date, and anticipated length of stay. The SU methodology included clear expectation, curricula, and proficiency assessment for clinicians. The experimental group received treatment from SU according to a practice guideline related to the use of intensive interventions for walking recovery, while the control group received standard care. Motor FIM and FIM total change, Timed-up-and-Go, Berg Balance, gait speed, Dynamic Gait Index, Functional Ambulation Category, and gait capacity were compared between groups.

**Results :** Statistically significant changes ( $p<.033$ ) were noted for all outcome variables in favor of the experimental group. Additional analysis of the improved motor FIM changes showed that there was a meaningful difference in the groups in the achievement of independent walking and stair climbing.

**Conclusions :** SU methodology, as a KT strategy, is effective to improve application of evidence-based interventions and achieve superior results when compared to usual care.

**Clinical Relevance :** Based on the results of this study, it is feasible to develop clinical KT applications that will change practice behaviors and increase the use of evidence-based practice to ultimately make meaningful improvements in patient outcomes.

**TITLE:** Balance and Vestibular Rehabilitation Quality Improvement

**AUTHORS/INSTITUTIONS:** M.A. ALMohiza, College of Applied Medical Sciences, King Saud University, Riyadh, SAUDI ARABIA|P.J. Sparto, A. Delitto, S. Whitney, School of Health and Rehabilitation Sciences, University of Pittsburgh , Pittsburgh, Pennsylvania, UNITED STATES|G. Marchetti, Rangos School of Health Sciences, Duquesne University, Pittsburgh, Pennsylvania, UNITED STATES|J.M. Furman, School of Medicine, University of Pittsburgh , Pittsburgh, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Variation in practice is one of the leading causes of sub-optimal outcomes in healthcare. Quality improvement in healthcare aims at minimizing the variation in care so that higher performance can be achieved. The lack of well-established clinical practice guidelines for balance and vestibular rehabilitation may lead to variations in care. Therefore, an effective implementation of practice guidelines could improve health care for people with balance and vestibular disorders. The aim of this study was to examine adherence to the clinical decision rules (CDRs) of physical therapists who treat persons with balance and vestibular disorders. We hypothesized that physical therapists would be more adherent to the CDRs after a quality improvement intervention that included educational training and adherence reminders.

**Number of Subjects :** Nineteen physical therapists who performed vestibular rehabilitation in outpatient clinics participated in this study; 9 were randomly assigned to the intervention group and 9 to the wait-listed group.

**Materials/Methods :** A randomized controlled trial was designed to compare two groups of physical therapists in adherence with the CDRs. The minimum data set (MDS) and CDRs were developed via meetings with experienced physical therapists. Both groups received educational materials about compliance to the MDS and adherence to the CDRs before the study began. Also, both groups received educational training and reminders regarding compliance to the MDS and adherence to the CDRs but at different time points during the 16-week duration of this study (8th week for the intervention group and 12th week for the wait-listed group). The main outcome in the study was the percentage of adherence to the CDRs. Data from initial physical therapy evaluation forms of 580 persons with balance and vestibular disorders were entered (276 records in the intervention group and 304 in the wait-listed group). These evaluation forms were used to extract adherence to the CDRs. We used a mixed-factor repeated measures ANOVA to examine differences between groups and over time.

**Results :** The effect of the intervention was examined over the 16 weeks to examine the effect of intervention on both intervention and wait-listed groups. Average adherence rates before intervention were  $83\% \pm 18$  for the intervention group and  $83\% \pm 21$  for the wait-listed group; these averages increased after intervention to be  $92\% \pm 10$  for intervention group and  $95\% \pm 8$  for wait-listed group. There was a significant time effect ( $p=0.008$ ), indicating that the intervention had an effect on the adherence rates, but no significant difference was found between groups ( $p=0.8$ ). Also, no significant interaction was found between time and groups ( $p=0.6$ ).

**Conclusions :** This quality improvement project was effective in increasing the adherence to the CDRs in both groups. Also, over-utilization of treatment decreased and the compliance to the MDS.

**Clinical Relevance :** The findings supported that evidence-based practice can be achieved via a planned quality improvement projects that involved clinicians education and clinical behavior monitoring.

**TITLE:** Effects of a 12-week community based exercise program on physical function and mobility for stroke survivors

**AUTHORS/INSTITUTIONS:** K. Ivanchak, M. Kaiser, P.D. Gillette, J.E. Hanks, Doctor of Physical Therapy Program, Bellarmine University, Louisville, Kentucky, UNITED STATES|M. Lampe, L. Wallace, Rehabilitation Department, Baptist Health Louisville, Louisville, Kentucky, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To determine the effects of a physical therapist designed and supervised 12-week community-based exercise program on physical function and mobility for stroke survivors.

**Number of Subjects :** Seven males, age ranged 44-75 years (mean age = 60), time post-stroke ranged from 1.5 to 9 years (mean = 5.4 years).

**Materials/Methods :** Participants were deemed eligible for testing if they were at least 3 months post-stroke, could ambulate 25 feet with or without an assistive device, were not receiving physical therapy, had physician approval, and scored at least a 16 on the Mini Mental State Exam (MMSE). Heart rate and blood pressure were monitored before, during and after each session. Intervention sessions lasted 45 minutes twice a week, for 12 weeks. Participants completed aerobic and strength exercises during each session. Effort during the aerobic exercise was monitored using the Rating of Perceived Exertion (RPE) scale or Karvonen method as appropriate. Pre and post-testing consisted of the following: Timed Up and Go (TUG), Six Minute Walk Test (6MWT), Modified Physical Performance Test (MPPT), and Hand Grip Strength with dynamometer. The level of frailty was assessed by the MPPT. The Characteristics of Respondents Survey (CORE) was included in pre-testing. Data analysis was conducted using SPSS software and the Wilcoxon signed-rank test was used to compare pre and post outcome scores.

**Results :** Four out of the 7 participants improved in all outcome measures. There was a statistically significant difference in gait speed ( $p = 0.027$ ) and TUG time ( $p = 0.043$ ). All participants improved or maintained the same level of frailty according to the MPPT. Three out of the 7 participants showed a minimal clinically important difference in 6MWT distance; however, there was no statistically significant difference in 6MWT, grip strength, or MPPT.

**Conclusions :** A 12-week physical therapist – led community-based exercise program is effective at improving gait speed and TUG scores in stroke survivors. This type of community-based program may lessen frailty and improve mobility in individuals with chronic stroke.

**Clinical Relevance :** Chronic stroke survivor's physical function and mobility may benefit from a physical therapist supervised program of aerobic exercise and strength training.

**TITLE:** A Conceptual Framework for the Progression of Balance Exercises in Persons with Balance and Vestibular Disorders

**AUTHORS/INSTITUTIONS:** B. Klatt, C. Lin, S. Fuhaid, S. Whitney, Physical Therapy, University of Pittsburgh , Pittsburgh, Pennsylvania, UNITED STATES|W. Carender, Otolaryngology, University of Michigan Health System, Ann Arbor, Michigan, UNITED STATES|C.R. Kinnaird, Mechanical Engineering, University of Michigan, Ann Arbor, Michigan, UNITED STATES|K.H. Sienko, Mechanical and Biomedical Engineering, University of Michigan, Ann Arbor, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose :** There is little information in the literature to specifically guide the choice of exercise in persons with balance and vestibular disorders. Therefore, the purpose of this study is to provide a rationale for developing a logical sequence in progressing balance exercises. Our theoretical framework for exercise progression is based on established principles of exercise and theories of motor control and considers how variations in sensory input of the visual, somatosensory, and vestibular systems alter the degree of challenge for the patient.

**Description :** The theoretical framework was developed by a multidisciplinary team of physical therapists and engineers from the University of Pittsburgh and the University of Michigan with extensive experience with people with vestibular disorders. Balance exercises are grouped into six different categories or “buckets”: static standing, compliant surface, weight shifting, modified center of gravity, gait, and gaze stabilization and vestibulo-ocular reflex (VOR). Through literature reviews, interviews and focus group discussions with physical therapists and postural control experts, and pilot studies involving repeated trials of each exercise, exercise progressions for each “bucket” were developed and ranked in order of degree of difficulty. Clinical expertise and experience guided decision making for some of the exercise progressions. There were over 450 combinations of exercises that were discussed and research is ongoing to validate the hypothesized order of advancing difficulty of the exercises.

**Summary of Use :** Each of the six different types of balance tasks (“buckets”) should be incorporated into a balance training program. We suggest that patients should be provided with six exercises (one from each bucket) during a given session and progressed throughout the sequence within the given bucket in order to optimally challenge the patient’s balance. We believe that physical therapists may under dose their patients, thus we have suggested progressions involving high-level exercises.

**Importance to Members:** Our framework of exercise progression can be used to guide less experienced practitioners in the development of a balance program. It also will assist clinicians and researchers to design, develop, and progress interventions within a treatment plan of care, or within research trials. A structured exercise framework has the potential to optimize postural control, decrease symptoms of dizziness/visual vertigo, and provide “rules” for exercise progression for persons with balance and vestibular disorders.

**TITLE:** Balance outcomes and fear of falling in adults with cerebral palsy

**AUTHORS/INSTITUTIONS:** E.D. Thompson, E.A. Keshner, C.A. Tucker, Y. Yu, J.M. Skrzat, S. Snell, I. Chudnovskaya, R. Lauer, Physical Therapy, Temple University, Philadelphia, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** People with cerebral palsy (CP) experience impairments in balance and functional mobility. However, the lack of adult clinics for CP may mean a less comprehensive approach to addressing these deficits in adults than in children. Adults with CP report impairments and restrictions that progress over time, including earlier osteoarthritis, decreased time spent in walking/standing, and higher incidence of falls when compared to adults with typical development (TD). Recent work in these adults has focused on movement efficiency, but there is still little information on best measures to assess balance, or how balance may be affected by characteristics such as age, sensory deficits or spasticity. The purpose of this work was to explore the relationship between self-reported balance confidence scores and clinical balance scales, as well as how sensation, spasticity or age may be related to balance function and confidence in adults with CP.

**Number of Subjects :** 60 participants, ages 15-50 (22 with spastic di-, tri-, or tetraplegic CP;38 with TD). All could stand independently and unsupported for two minutes.

**Materials/Methods :** This work was part of an ongoing cross-sectional study. As part of the study, all participants completed the Activities-specific Balance Confidence Scale (ABC), Falls Efficacy Scale (FES), Berg Balance Scale (BBS), Balance Error Scoring System (BESS), and all were screened for lower extremity spasticity and sensation deficits. Pairwise correlations were performed between ABC, FES, BBS, and BESS scores, somatosensory deficits, and spasticity (number of muscles exhibiting spasticity, maximum of 6 tested). Results of the youngest group with CP (<25 yrs, n=7), the oldest (>35 yrs, n=7) and those in the middle (25-35 yrs, n=8) were compared.

**Results :** Participants with CP showed the highest correlations between BBS and ABC scores ( $r=.80$ ) and ABC and FES scores ( $r=.76$ ). No other correlations  $r>.75$  were found in this group, and none  $r>.75$  were found for the group with TD. When scores for the youngest participants with CP were analyzed separately, these associations became stronger and new ones were evident, including between BBS and BESS scores and spasticity ( $r=.80$  and  $r=.86$ , respectively.) When the scores for the oldest participants were analyzed separately, spasticity showed no correlations with  $r>.75$ , but impairment to light touch was correlated with both FES and BBS scores ( $r=.99$  and  $r=.94$ , respectively.) The correlations for participants in the middle age range did not show  $r>.75$  with either spasticity or impaired sensation.

**Conclusions :** Strong correlations were found between the BBS, ABC and FES scores for participants with CP. However, other correlations were different between age groups, with balance and fear of falling more associated with spasticity in younger participants and with somatosensory impairment in older participants.

**Clinical Relevance :** Though the larger balance study is still in progress, this preliminary work indicates the need for more research on the effects of spasticity, sensory impairment, and age on balance in adults with CP.

**TITLE:** Vestibular Loss: Differences in Gaze Stability Between Active and Passive Walking

**AUTHORS/INSTITUTIONS:** E. Anson, T. Kiemel, University of Maryland, College Park, Maryland, UNITED STATES|J. Carey, Johns Hopkins Medical Institutes, Baltimore, Maryland, UNITED STATES|J. Jeka, Temple University, Philadelphia, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Traditional vestibular testing relies on artificial or isolated stimuli presented with the individual passively rotated in a chair or lying down. These tests are unable to completely characterize functional deficits in gaze stability encountered during walking. Active head movements have been suggested as a more natural probe of vestibular function, but movement predictability limits the interpretability of those tests. Head motion during walking includes both rhythmic and random movements. Characterizing gaze stability during walking may provide a window for assessing functional limitations to daily activities in a more natural way for individuals with vestibular loss. The primary purpose of this study was to determine if gaze stability during active walking is better than that which would be predicted by tests that passively replicate sagittal plane head motion.

**Number of Subjects :** Six Individuals with vestibular loss (BVL) and four healthy subjects participated in this experiment.

**Materials/Methods :** Subjects walked on a treadmill at 2 km/hr while fixating a target presented on an LCD 2.2m in front of them. Head kinematics were recorded (Optotrak) and converted offline to control motion of a 6-degree of freedom platform mounted chair (Moog, Inc). All subjects sat on the Moog and passively experienced head trajectories from their walking trials while performing the same fixation task. Head velocity and eye motion were recorded (EyeSeeCam) while walking and on the Moog. Frequency response functions (FRFs) were calculated to characterize gaze stability. A multiple input single output (MISO) gaze stabilization system including angular and linear velocity and the relationship between each head movement was compared to more traditional single input single output (SISO) FRF. Active walking and "passive seated walking" MISO FRFs were compared to determine if walking enhances gaze stability in a way not predicted by passive motion testing.

**Results :** Below 1 Hz, "passive seated walking" MISO responses are equivalent to passive pitch SISO responses; however, above 1 Hz pitch SISO and MISO responses are not equivalent. Differences between treadmill walking and "seated passive walking" conditions in healthy adults were primarily an under-estimation of low frequency (< .3 Hz) gaze stability during "seated passive walking." Increased phase lag is also evident at higher frequencies (> 2 Hz) more for individuals with BVL than healthy controls.

**Conclusions :** There may be a low-frequency, locomotion-specific augmentation to gaze stabilization not identified during passive vestibular testing.

**Clinical Relevance :** Gaze stability may be better during walking than diagnostic tests would predict, suggesting that walking specific gaze stability exercises may be of benefit for individuals with BVL.

**TITLE:** Reliability and Normative Values of the InVision™ Dynamic Visual Acuity Test in Older Adults

**AUTHORS/INSTITUTIONS:** C.D. Hall, K. Riska, Rehabilitation Research & Development, James H Quillen VAMC, Mountain Home, Tennessee, UNITED STATES|C. Keck, J. Kerley, A. King, B.W. Kington, K. Lamie, Physical Therapy, East Tennessee State University, Johnson City, Tennessee, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** It is well documented that there is an increase in falls incidence and fall-related injury with increased age (1, 2). Dizziness is a major risk factor for falls doubling the risk of falling (3). The normal vestibulo-ocular reflex (VOR) generates eye movements that are equal and opposite to head rotation, which ensures gaze stability during head motion. Measurement of visual acuity during head movements provides a functional assessment of gaze stability. Computerized systems are available commercially, although little information is available regarding reliability and normative values (4, 5). The purpose of this study was to examine interrater and intrarater reliability as well as to obtain normative values for the DVA test of the InVision™ System.

**Number of Subjects :** Twenty-four older participants (10 female and 14 male; mean age= 72.2 + 6.6 years; range: 62-86 years) with normal vestibular function were tested.

**Materials/Methods :** Inclusion criteria included normal vestibular function and age at least 60 years old. Exclusion criteria included: 1) limited neck mobility; 2) dizziness with head movement; 3) corrected static visual acuity worse than 20/60. Vestibular and VOR function were determined using caloric testing and ocular motor screening. Participants were tested twice during each of two sessions that were scheduled 2-7 days apart. Visual acuity testing was performed first with the participant's head stationary (static visual acuity, SVA) and then with the head moving actively in the horizontal and vertical directions (dynamic visual acuity, DVA). The optotype was displayed when the subject's head velocity was at least 120°/s for horizontal and 100°/s for vertical head turns. The best Parameter Estimate by Sequential Testing (best PEST) adaptive algorithm was used for scoring. Outcome measures include static and dynamic visual acuity, and DVA loss scores (difference between static and dynamic visual acuity). Interrater and intrarater reliability was assessed using ICCs. Age related differences were examined using independent t-tests.

**Results :** Interrater and intrarater reliability was very good to excellent (ICCs: 0.70-0.94) for single measures (SVA and left/right/up/down DVA), poor for left DVA loss scores (ICC = 0.08-0.16), and moderate for other DVA loss scores (ICCs: 0.54-0.58). No significant ( $p > 0.05$ ) age-group differences were found for DVA loss scores.

**Conclusions :** The reliability of the InVision™ DVA test in healthy older individuals is poor to moderate. The reliability of the absolute DVA scores was better than that of the DVA loss scores.

**Clinical Relevance :** DVA tests provide valuable information about the functional performance of the VOR. The InVision system's DVA test appears to have moderate to very good reliability with the exception of left DVA loss.

**TITLE:** Estimated Pre-Stroke Fitness Is Associated with Insulin-Like Growth Factor 1 During Acute Stroke

**AUTHORS/INSTITUTIONS:** A.E. Mattlage, S.A. Karcher, S. Billinger, Physical Therapy and Rehabilitation Science, University of Kansas Medical Center, Merriam, Kansas, UNITED STATES|M.A. Rippee, Neurology, University of Kansas Medical Center, Kansas City, Kansas, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Insulin-like Growth Factor-1 (IGF-1) may be neuroprotective after stroke. Some evidence in experimental models suggests that exercise can increase circulating levels of IGF-1. Understanding how IGF-1 is regulated after stroke and understanding its relationship to aerobic fitness can give further insight on the implications of stroke recovery. Therefore the purpose of this study was to determine the level of IGF-1 during acute stroke and its relationship to pre-stroke estimated aerobic fitness levels using estimated peak oxygen uptake (peak VO<sub>2</sub>). We hypothesized that pre-stroke estimated fitness would be moderately correlated to IGF-1 levels during acute stroke.

**Number of Subjects :** 12 people with acute stroke

**Materials/Methods :** Twelve individuals (5 male, average age of 56.4 + 11.4 years) were enrolled into our study between 24 - 48 hours of hospital admission with diagnosis of acute stroke. Pre-stroke fitness was estimated using a previously established equation to predict peak VO<sub>2</sub>. This equation utilized sex, age, body mass index, resting heart rate and a self-report measure of physical activity. Blood was drawn from the antecubital vein from patients within 48 of admission to the hospital. Serum samples were centrifuged within an hour of sampling to obtain plasma, aliquotted into 1.5mL tubes, and stored in -80 degree Celsius freezers until assaying. Insulin-like Growth Factor-1 during acute stroke was quantified using enzyme-linked immunoassay. A Pearson's Correlation was performed to determine the relationship between estimated peak VO<sub>2</sub> and IGF-1 level.

**Results :** Mean IGF-1 level was 166.62 + 61.82 ng/mL within 48 hours of admission to the hospital with acute stroke. A moderate and significant correlation ( $r = 0.66$ ,  $p = 0.02$ ) was observed between estimated peak VO<sub>2</sub> and IGF-1 level in people with acute stroke.

**Conclusions :** Individuals who exhibited higher estimated peak VO<sub>2</sub> prior to their stroke event had greater levels of IGF-1. Greater aerobic fitness prior to stroke may provide increased neuroprotection following cerebrovascular events such as stroke. Future research should determine whether this may be related to improved recovery following stroke.

**Clinical Relevance :** Those who have increased physical fitness may exhibit more favorable outcomes after acute stroke due to increases in neuroprotective hormones such as IGF-1. Clinicians should consider encouraging their patients after stroke to engage in physical activity.

**TITLE:** Physical Therapists' Attitudes and Beliefs Toward Concussion Management and Knowledge of Concussion Legislation

**AUTHORS/INSTITUTIONS:** A.M. Yorke, K. Stockdale, B. Alsalaheen, Physical Therapy, University of Michigan-Flint, Flint, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study is to describe the current attitudes and beliefs toward concussion management and knowledge of concussion legislation among physical therapists.

**Number of Subjects :** 775 physical therapists (417 females/358 males) who reported seeing at least one patient within the last year with a diagnosis of concussion. Average age of the sample was 41 years (SD 10).

**Materials/Methods :** An electronic survey was developed and consisted of 55 questions divided into six sections: (1) demographics, (2) current practice, (3) knowledge of concussion legislation, (4) attitudes and beliefs toward concussion management, (5) concussion knowledge, and (6) clinical decision making. The survey was distributed online through APTA section newsletters, e-mails, and list-servs. The findings pertinent to attitudes and beliefs toward concussion management and knowledge of concussion legislation are described in this report.

**Results :** Two-thirds of respondents reported knowledge of concussion legislation in youth athletes in their respective states. Of those respondents who answered affirmatively to knowledge of state concussion legislation, one half reported their state does not allow physical therapists to make return to play (RTP) decisions for a youth athlete. Approximately 9 out of 10 respondents reported confidence in recognizing a concussion; 8 out of 10 respondents reported confidence in concussion management, while only 7 out of 10 reported confidence in making return to play decisions. Overwhelmingly, more than 95% of respondents strongly agreed or agreed with the APTA position statement stating that physical therapists should be one member of a multidisciplinary team that provides concussion management and that concussions have a significant impact on the health of individuals and society.

**Conclusions :** All 50 states and the District of Columbia have passed legislation on concussion in youth sports, and in 27 out of 50 states, physical therapists are clearly not listed as a health care provider allowed to make return to play decisions for a young athlete who has sustained a concussion. Two-thirds of physical therapists reported having knowledge of state concussion laws and are confident in making return to play decisions. The majority of physical therapists responding agreed with the APTA position statement on the role of the physical therapist in a person who has sustained a concussion. Professional educational programming may be developed to improve advocacy efforts and the knowledge of concussion management, including return to play, for physical therapists.

**Clinical Relevance :** Physical therapists should consider the impact health care policy has on practice and advocate for young athletes whom have sustained a concussion to have access to physical therapy services.

**TITLE:** Running during high-intensity interval training in persons with chronic stroke

**AUTHORS/INSTITUTIONS:** B.E. Barney, P. Boyne, D. Carl, B.D. Rockwell, S. Buhr, G.R. Keeton, J. Wilkerson, K. Dunning, Rehabilitation Sciences, University of Cincinnati, Cincinnati, Ohio, UNITED STATES|J. Khoury, Biostatistics and Epidemiology, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, UNITED STATES|M.C. Gerson, Internal Medicine and Cardiology, University of Cincinnati, Cincinnati, Ohio, UNITED STATES|B. Kissela, Neurology and Rehabilitation Medicine, University of Cincinnati, Cincinnati, Ohio, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Hemiparetic stroke is associated with gait impairments and increased energy cost for mobility, which leads to a vicious cycle of immobility and poor cardiorespiratory fitness. Exercise intensity is a key factor to improve gait function and aerobic capacity post-stroke. High intensity interval training (HIT) maximizes exercise intensity by using bursts of concentrated effort alternated with recovery periods. Due to the high relative speeds during treadmill HIT, some persons may achieve running gait for the first time since stroke onset. However, the functional impact of running HIT on stroke recovery has not been previously studied. Therefore, the purpose of this single group pre-post test design study was to assess changes in gait function and aerobic capacity associated with running HIT after stroke.

**Number of Subjects :** This preliminary analysis includes the first 3 subjects who achieved running gait in an ongoing trial of treadmill HIT in chronic stroke.

**Materials/Methods :** Subjects (age, 50-57 years; 1.5-5.2 years post stroke) performed HIT for 25 minutes, 3x/week for 4 weeks. HIT involved repeated 30 sec bursts of treadmill gait at maximum tolerated speed, alternated with 30-60 sec rest periods. Training variables included peak treadmill speed and average heart rate, expressed as percentage of peak HR achieved during a maximal-effort exercise test. Outcomes, measured by a blinded rater before (PRE) and after (POST) training, included: overground gait speed (10m walk test, comfortable and fastest speed), the 6 minute walk test (6MWT), gait efficiency (oxygen [VO<sub>2</sub>] cost during comfortable speed gait), peak oxygen uptake during a maximal-effort exercise test (VO<sub>2</sub>peak), and VO<sub>2</sub> at the ventilatory threshold (VO<sub>2</sub>-VT). Due to the preliminary nature of the research, we are reporting the range of values across subjects and the standardized effect sizes (ES), defined as the mean change divided by the standard deviation of change.

**Results :** Peak treadmill speed during training progressed from 1.79-2.10 to 2.19-2.73 m/s. Average training HR progressed from 57-84 to 77-91 % HR<sub>peak</sub>. From PRE to POST, comfortable 10m walk test speed increased from 0.96-1.45 to 1.15-1.42 m/s (ES=0.57). Fast 10m walk test speed increased from 1.17-1.46 to 1.43-1.59 m/s (ES=2.99). Distances for 6MWT increased from 371.1-447.0 to 392.8-476.1 m (ES=1.85). Gait efficiency (VO<sub>2</sub> cost) improved from 162.8-219.6 to 143.1-160.8 ml/kg/km (ES= 0.91). VO<sub>2</sub>-peak changed from 16.4-25.7 to 15.7-24.6 ml/kg/min (ES=0.26). VO<sub>2</sub>-VT increased from 10.5-15.2 to 10.7-19.4 ml/kg/min (ES=0.89).

**Conclusions :** This preliminary analysis showed large effect sizes for fastest gait speed, 6MWT, gait efficiency, and aerobic capacity (VO<sub>2</sub>-VT). Given the improvement in aerobic capacity (VO<sub>2</sub>-VT), the small effect size for VO<sub>2</sub>-peak may be due to improved gait efficiency. A larger sample size is needed to confirm and expand on these results.

**Clinical Relevance :** Running HIT is a promising strategy for improving gait function and aerobic capacity in chronic stroke.

**TITLE:** Assessment of Cerebral Blood Flow in Mild Traumatic Brain Injury

**AUTHORS/INSTITUTIONS:** J.M. Tosto, L.A. Reyes, M.M. Blatt, War Related Illness and Injury Study Center, Department of Veterans Affairs, East Orange, New Jersey, UNITED STATES|M.J. Falvo, J.M. Serrador, Graduate School of Biomedical Science, Rutgers University, Newark, New Jersey, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Mild traumatic brain injury (mTBI) has become a modern health epidemic and has been associated with long term problems. Despite this, there continues to be diagnostic difficulty within current technology. The goal of this work was to determine if changes in blood pressure or cerebral blood flow regulation immediately post head trauma could provide a more sensitive marker of mTBI. We hypothesized that individuals who sustain a mTBI will exhibit impairments of cerebral blood flow regulation immediately post-injury.

**Number of Subjects :** 42 rugby players (age 28 +/-7.5) volunteered for this study. 17 concussed and 25 healthy controls participated. Subjects were recruited for on field assessment at five international rugby tournaments. Concussed subjects were referred from medical staff at the field following a head injury.

**Materials/Methods :** We assessed dynamic blood pressure and cerebral blood flow regulation while changing from a sitting to standing position and while lying supine as well as in a 60o reclined seated position. Cerebral blood flow velocity of the middle cerebral artery was obtained using noninvasive Transcranial Doppler Ultrasonography. Beat by beat arterial blood pressure measures were obtained using digital photoplethysmography on the nondominant finger held at heart level.

**Results :** Concussed players had higher mean arterial pressure (MAP) and cerebrovascular resistance (CVR) as well as lower heart rate during both sitting and standing ( $p < 0.05$ ). This increase in MAP was associated with increased low frequency blood pressure variability, suggestive of increased total peripheral resistance. However, they did not show significant impairment in CBF regulation. ( $p > 0.05$ )

**Conclusions :** : These data demonstrate that individuals who sustain a mild head injury have increased MAP that appears to be the result of increased peripheral sympathetic outflow which will cause peripheral vasoconstriction. However, it remains unclear what is causing increased sympathetic outflow. It is also surprising that cerebral blood flow regulation was normal in this group. One possible explanation for this is that increased MAP is necessary to maintain adequate cerebral blood flow. In fact, recent data from Paton et al. has found that cerebral hypoperfusion precedes increased blood pressure; supporting the idea that hypertension may be an adaptive response to help maintain cerebral blood flow.

**Clinical Relevance :** Accurate assessment of mTBI status could provide for early intervention to improve outcomes. These data demonstrate that non-invasive physiological measures may provide important diagnostic indicators that can be assessed on the field. Such findings may inform rehabilitation clinical decision making and long term functional outcomes.

**TITLE:** Alterations of Center of Mass Acceleration Resulting from Lower Extremity Muscle Power Training

**AUTHORS/INSTITUTIONS:** P.J. Morgan, A.E. Embry, L.C. Perry, C.M. Gregory, Health Science and Research, Medical University of South Carolina, Charleston, South Carolina, UNITED STATES|M.G. Bowden, Rehabilitation Research & Development, Ralph H. Johnson VA Medical Center, Charleston, South Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study is to assess the effects of a lower extremity muscle power training program on anterior/posterior center of mass acceleration (COMa) during walking. COMa is a surrogate for force production and presents the opportunity to translate biomechanical outcomes to a clinical environment. We hypothesize that an intensive program aimed to build walking capacity will significantly improve peak positive COMa, integrated positive COMa, and symmetry between the two propulsive peaks as a result of the training program.

**Number of Subjects :** Ten subjects (6-60 months post-stroke) participated in 24 training sessions (3 sessions/week for 8 weeks).

**Materials/Methods :** Exercises included bilateral and single leg press, calf raises, and jump training all performed at high concentric velocity as well as trials of fast walking overground. Each participant was evaluated on an instrumented treadmill at their self-selected walking speed (SSWS) for 2 trials, 30 seconds each. Follow-up testing was performed at treadmill speeds matching the pre-SSWS to control for speed-dependent effects of COMa. COMa was calculated by summing the A/P ground reaction forces normalized by body mass. Gait events were determined by the ground reaction forces. Statistical significance was assessed using 1-tailed paired samples t-test with an alpha = 0.05.

**Results :** Following training, significant improvements in lower extremity muscle strength and power were realized and accompanied by improvements in SSWS as well as fastest comfortable walking speeds. Integrated positive COMa was significantly increased ( $p=0.02$ ) as a result of the intervention. Peak COMa was not significantly different. Deviations from symmetry decreased from 19.8% to 16.2% but were not statistically significant. Those individuals with high paretic propulsion values (relative to symmetry) improved by an average of 10% ( $n=3$ ).

**Conclusions :** The investigation of COMa importantly addresses a biomechanical element that may be directly clinically translated. Integrated positive COMa increased with an intense, lower extremity muscle power training intervention, but peak COMa and propulsive symmetry did not improve. The intervention was aimed at increasing functional capacity. Forcing slow walking speeds (e.g. matching pre-SSWS) may not accurately reflect improvements in capacity that could translate to biomechanical gait function. In addition, this type of intervention may specifically benefit certain subsets of those with stroke. Future work must investigate the optimal way to capture pre-post capacity changes in those who improve SSWS.

**Clinical Relevance :** COMa remains a potential measurement tool that is directly translatable from the research lab to the clinic via low cost inertial measurement units. Methodological issues must be addressed in order to present clinicians with the optimal data collection techniques and meaningful outcome measures to improve quantification of clinical decision-making.

**TITLE:** Multidimensional Treatment Approach of a Patient Sustaining Hearing Loss and Lucunar Infarcts As a Result of Bacterial Meningitis Infection: A Case Report.

**AUTHORS/INSTITUTIONS:** M.K. Root, Vestibular Physical Therapy Outpatient Department, NYU Langone Medical Center Rusk Rehabilitation, New York, New York, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Research shows there is no rehabilitation protocol in treating patients with functional impairments following bacterial meningitis infection. Bacterial meningitis infections can cause cerebral vasculitis, brain infarction, and spread of infection to the cochlear aqueducts leading to cochlear ossification and hearing loss. Cochlear implants are indicated as the primary treatment approach following bacterial meningitis infection resulting in hearing loss. The case study follows a patient who sustained both lucunar infarcts and total bilateral hearing loss following bacterial meningitis. The patient was referred to general outpatient physical therapy (PT), but was found to have benefitted from additional vestibular physical therapy intervention to address all impairments. The purpose of this case report is to demonstrate the effectiveness of this treatment approach.

**Case Description :** A 66 year old male with diagnosis of bacterial meningitis, acquired subsequent lacunar infarcts with resulting total bilateral hearing loss. The patient underwent inpatient rehabilitation and obtained cochlear implants as an outpatient. At initial evaluation, he presented with right hemiparesis, required supervision with bed mobility, minimal assistance with transfers, up to maximal assistance with ambulation (rolling walker utilized for safety outside of clinic), as well as imbalance and dizziness associated with head turns and busy environments. The patient was seen for twice a week for 30-60minute sessions, and general PT included progressive treadmill training and forced use activities of the patient's weaker right lower extremity. Following cochlear implantation, vestibular PT was initiated in conjunction with general PT. The patient underwent gaze stability training with use of vestibular ocular reflex adaptation exercises (VORx1), and habituation exercises including walking with head turns and progressive turning. With strong family involvement, strict compliance of a progressive home exercise program was reinforced for at least 30minutes a day.

**Outcomes :** At discharge, the patient was independent in all indoor mobility without an assistive device, ambulating with a cane within the community with supervision, and performing supervised jogging both over ground and on the treadmill. Functional outcome measures included improvements in Berg Balance Scale from 11/56 to 51/56, Dynamic Gait Index from 7/24 to 19/24. The patient presented with improved gaze stability based on a 40% improvement in his VOR without dizziness, contributing significantly to the patient's improved dynamic balance.

**Discussion :** The case study illustrates an effective treatment approach to address functional impairments following bacterial meningitis. Current approaches may indicate only general PT or cochlear implants, though as demonstrated in the above case study, integrating vestibular PT intervention was found to maximize gains.

**TITLE:** Quantification of postural control deficits in people with multiple sclerosis

**AUTHORS/INSTITUTIONS:** G. Dutta, F.B. Horak, Neurology, Oregon Health Sciences University, Beaverton, Oregon, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Aim of this study was to gain better understanding of imbalance related to the deficits in postural responses in people with MS (PwMS). In non-neurologically impaired individuals, scaling of postural responses to displacement amplitude is observed when displacements of different amplitudes are presented in predictable blocked manner. The cerebellum is considered to be responsible for this predictive scaling. We hypothesized that PwMS who have predominantly cerebellar involvement will show more deficits in predictive scaling than those with somatosensory impairments.

**Number of Subjects :** In this ongoing study, 5 PwMS (four relapsing-remitting and one primary progressive; age:56.4±5.3 yrs.;5F) and 5 control subjects (age:51.2±12.3 yrs.,4F;1M) participated so far.

**Materials/Methods :** A clinical battery for PwMS included the Expanded Disability System Score (EDSS), International Co-operative Ataxia Rating Scale (ICARS) and mini Balance Evaluation Systems Test (miniBESTest). Average EDSS, ICARS and the miniBESTest scores for the MS subjects were 3.6±0.9 (maximum score:10), 16±10.9 (maximum score:100) and 18±6.9 (maximum score:28) respectively. We investigated amplitude scaling of automatic postural responses to changes in the amplitude of backward displacement of the support surface. The subjects stood on two computer-servocontrolled custom-made, hydraulic platforms that translated backward together causing forward body sway. Responses to four different displacement amplitudes (3.6, 6.0, 8.4, and 12 cm), all at a velocity of 15 cm/second, were presented in blocks of 5 repetitions, with increasing amplitude, for a total of 20 trials. This block presentation was used to allow for predictive amplitude scaling based on experience from prior trials. Postural responses were estimated by computing the rate of change of center of pressure under each foot. Postural scaling of the automated responses, i.e. central set scaling, to gradually increased perturbation amplitudes was computed as the slope of the regression between the postural response and perturbation amplitudes.

**Results :** Control subjects demonstrated the ability to scale postural responses with the perturbation amplitude. The magnitude of central set scaling for control subjects approached 1.0 (0.9±0.06), whereas for PwMS this value was 0.62±0.14. Correlation coefficients of the linear regression between the central set scaling with the cerebellar component of EDSS as well as that of ICARS were strong and negative (EDSS: -0.98, ICARS: -0.76), whereas correlation between central set scaling and sensory score of EDSS was low, i.e. 0.37.

**Conclusions :** These preliminary results support our hypothesis that the cerebellar feedforward control contributes more towards the deficits in postural response scaling than their somatosensory deficits.

**Clinical Relevance :** Lack of specific balance and mobility impairment interventions in PwMS are attributed to poor understanding about the relationship of underlying disease impairments and balance deficits. This proposed study would target these critical barriers in our understanding.

**TITLE:** Walking with External Lateral Stabilization Induces a Temporary Decrease in Mediolateral Stability in an Individual with Incomplete Spinal Cord Injury.

**AUTHORS/INSTITUTIONS:** J.H. Matsubara, M. Wu, K.E. Gordon, Physical Therapy and Human Movement Sciences, Northwestern University, Evanston, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Stability assistance is often provided during locomotor training. For people with balance deficits due to incomplete spinal cord injury (SCI), some assistance (e.g. gait belts, parallel bars) is beneficial because it allows for safe walking practice. However, too much assistance may impede reacquisition of crucial balance control strategies by decreasing the need for the nervous system to sense and respond to destabilizing perturbations [1, 2]. Thus, when given stability assistance people may adopt simplified locomotor control strategies that do not appropriately address the balance requirements of unassisted gait. The purpose of this study was to examine the effect of external lateral stabilization on dynamic balance. We hypothesized that mediolateral stability would be decreased following a brief conditioning period of walking with lateral stabilization provided by stiff springs attached to a hip belt.

**Case Description :** A 52 year old male subject with chronic C6, AIS D SCI completed two treadmill walking trials of 2 minutes each (Baseline and After-effects), separated by a 5 minute walking trial with external lateral stabilization (Stabilization). Motion capture cameras were used to measure mediolateral pelvis kinematics. To examine gait stability we calculated the power spectral density of the subject's mediolateral pelvis position during each walking condition.

**Outcomes :** During Baseline the subject displayed both a higher frequency mediolateral oscillation of the center of mass (0.625 Hz, -19.21 dB) that was consistent with step frequency and a slower frequency oscillation due to mediolateral veering back and forth across the treadmill occurring over the course of every 15-20 steps (0.025 Hz, -7.67 dB). During Stabilization, the higher frequency oscillation was similar to Baseline (0.575 Hz, -17.96 dB), while the slower frequency oscillation power was drastically attenuated (0.025 Hz, -27.81 dB) because the subject was constrained by the springs. When stabilization was removed, the faster frequency oscillation was essentially unchanged (0.675 Hz, -19.41 dB), but the slower frequency oscillation power (0.025 Hz, -1.07 dB) was amplified, indicating that mediolateral sway contributed more to the pelvis position signal after stabilization than before stabilization.

**Discussion :** The results support our hypothesis that when provided with high levels of stability assistance people adapt their locomotor control strategies in a manner that minimizes their ability to dynamically balance. This was evident as the subject displayed an after-effect of increased amplitude of mediolateral veering after 5 minutes of walking with external lateral stabilization. This case study has practical implications for locomotor training. It is important that balance training is incorporated into rehabilitation protocols targeting community ambulation so that neural control strategies are learned that address the requirements of real world walking.

**TITLE:** Musculoskeletal Effects of Two Functional Electrical Stimulation Cycling Paradigms for People with Spinal Cord Injury

**AUTHORS/INSTITUTIONS:** T.E. Johnston, R.J. Marino, C.V. Oleson, B.E. Leiby, Thomas Jefferson University, Philadelphia, Pennsylvania, UNITED STATES|C.M. Modlesky, University of Delaware, Newark, Delaware, UNITED STATES|M. Schmidt Read, Magee Rehabilitation Hospital, Philadelphia, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Compare the musculoskeletal effects of a novel low cadence cycling paradigm (LOW-CAD) with functional electrical stimulation (FES) to a high cadence paradigm (HIGH-CAD) for people with spinal cord injury (SCI). It was hypothesized that LOW-CAD would show greater changes in bone and muscle as greater resistance and thus greater loading could be obtained.

**Number of Subjects :** Fourteen men and 3 women ages 22-67 years with C4-T6 motor complete chronic SCI participated. Nine subjects were randomized to LOW-CAD and eight to HIGH-CAD.

**Materials/Methods :** LOW-CAD cycled at 20 rpm and HIGH-CAD at 50 rpm. Resistance increased automatically if cadence was maintained. Pre and post training, bone changes were measured via dual-energy x-ray absorptiometry to assess areal bone mineral density at the distal femur, magnetic resonance imaging (MRI) to assess microarchitecture (mid/distal femur), and biochemical bone markers to assess bone formation and resorption. Thigh muscle volume was measured via MRI.

**Results :** LOW-CAD obtained maximal resistance of  $2.9 \pm 2.8$  Nm and HIGH-CAD of  $0.8 \pm 0.2$  Nm. Over time, LOW-CAD showed greater decreases ( $p < 0.05$ ) in bone-specific-alkaline-phosphatase (BALP) compared to HIGH-CAD (LOW-CAD:  $12.9 \pm 3.6$  to  $10.6 \pm 3.4$   $\mu\text{g/L}$ ; HIGH-CAD:  $13.4 \pm 4.9$  to  $14.7 \pm 6.1$   $\mu\text{g/L}$ ) indicating less bone formation. However, N-telopeptide decreased within LOW-CAD ( $p < 0.05$ ,  $53.4 \pm 25.3$  to  $34.1 \pm 15.5$  mg/dL), suggesting less bone turnover. BALP to N-telopeptide ratio (formation/resorption) increased non-significantly from  $0.29 \pm 0.14$  to  $0.36 \pm 0.16$  for LOW-CAD and  $0.35 \pm 0.21$  to  $0.39 \pm 0.21$  for HIGH-CAD, indicating less bone turnover for LOW-CAD. Both groups increased muscle volume (LOW-CAD:  $1193 \pm 603.7$  to  $1361.1 \pm 546.4$   $\text{cm}^3$ ; HIGH-CAD:  $1215.6 \pm 331.8$  to  $1335.1 \pm 342.6$   $\text{cm}^3$ ). LOW-CAD showed a non-significant increase ( $1.08 \pm 0.23$  to  $1.13 \pm 0.22$ ) in trabecular bone number (measured at 12 images proximal to condyles) while HIGH-CAD showed a non-significant decrease ( $1.17 \pm 0.33$  to  $1.14 \pm 0.27$ ).

**Conclusions :** This preliminary study suggests that LOW-CAD may stimulate greater musculoskeletal changes. Research is needed with a larger sample size.

**Clinical Relevance :** People with SCI rapidly lose bone mass following injury. Rate of loss slows within 2 years but bone loss continues, increasing fracture risk especially in the distal femur and proximal tibia.

**TITLE:** Estimated MET Levels using Accelerometers Is Associated with the Physical Performance Test at Discharge in Acute Stroke

**AUTHORS/INSTITUTIONS:** A.E. Mattlage, S.A. Karcher, S. Billinger, Physical Therapy and Rehabilitation Science, University of Kansas Medical Center, Merriam, Kansas, UNITED STATES|M.A. Rippee, Neurology, University of Kansas Medical Center, Kansas City, Kansas, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Previous studies have shown that people with chronic stroke typically have lower physical activity and work at lower metabolic equivalent (MET) levels when compared to their healthy counterparts. Very few studies have quantified physical activity and estimated energy costs during the acute stroke hospital stay. The purpose of this study was to determine the overall MET level of stroke patients during their acute hospital stay with the use of tri-axial accelerometers and to assess its relationship to functional performance at discharge as tested by the Physical Performance Test (PPT). We hypothesized that the MET level of stroke patients would be moderately and significantly correlated with functional performance at discharge.

**Number of Subjects :** 32 people with acute stroke

**Materials/Methods :** Thirty-two individuals (18 male; average age 56.53 + 12.73 years) were enrolled into the study within 48 hours of hospital admission with diagnosis of acute stroke. National Institutes of Health Stroke Scale on admission was 3.47 + 4.5. To estimate overall MET level, tri-axial accelerometers were placed on participants' stroke affected ankle and were worn 24 hours per day for up to 4 days or until discharge from the hospital (whichever came first). The PPT was used as measure of physical function since it uses tasks that simulate activities of daily living. Participants performed the PPT following consent and after accelerometer placement and was conducted on Day 4 or at discharge. A partial Correlation was performed to determine the relationship between the estimated MET level during the acute hospital stay and performance on the PPT at discharge, while controlling for baseline performance.

**Results :** Mean metabolic rate during the hospital stay estimated from tri-axial accelerometers was 1.04 + .05 METs. Mean score on the PPT at baseline was 15.9/36 + 10.2. A moderate and significant correlation ( $r = .65$ ,  $p < 0.001$ ) was observed between the estimated MET level and the discharge PPT when controlling for baseline performance and size of stroke.

**Conclusions :** Overall estimated MET levels were below community-dwelling older adults. Individuals who performed activities at a higher estimated MET level during the acute stroke hospital stay performed better on the PPT at discharge compared to those who were at lower MET levels.

**Clinical Relevance :** People following an acute stroke may benefit from increased activity during their acute hospital stay. Those who increase their estimated MET level by engaging in more activity may have better outcomes at discharge from an acute stroke unit.

**TITLE:** Measuring Post-Stroke Rehabilitation Community Mobility Using Global Positioning System Technology: A Pilot Study

**AUTHORS/INSTITUTIONS:** T.A. Hanke, C.C. Evans, Physical Therapy Program, Midwestern University, Downers Grove, Illinois, UNITED STATES|S. Hwang, Geography Department, Depaul University, Chicago, Illinois, UNITED STATES|S. Keller, D. Zielke, Physical Therapy, Marianjoy Rehabilitation Hospital, Wheaton, Illinois, UNITED STATES|T. Hailey, Rehabilitation, Rush Copley Medical Center, Aurora, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Survivors of a cerebrovascular accident (CVA) experience difficulty navigating the community and returning to meaningful social, leisure, and occupational-related destinations. GPS is used to measure navigation, but little is known about its use for measuring community mobility post-stroke. **PURPOSE:** Directly measure community mobility in stroke survivors and examine the relationship between clinical outcome measures and community mobility.

**Number of Subjects :** Post-rehabilitation subjects (RS) with a CVA were recruited from two rehabilitation hospitals and control subjects (CS) were recruited from the local community. Inclusion criteria: confirmed CVA within one month of admission, discharged home, safely ambulate > 50 feet, and Mini Mental Status Exam score (MMSE) >21. 14 RS and 6 age and location-matched CS are currently enrolled.

**Materials/Methods :** The study was approved by an IRB and all subjects provided written, informed consent. Subjects were fitted with a belt or clip with a GPS unit and asked to wear it at all times when out of bed except during bathing during the 1st, 5th and 9th week post discharge from the hospital as well as at 6 and 12 month follow up. Functional independence measure (FIM), MMSE, Berg Balance Test (BBT) and Six Minute Walk Test (SMWT) were obtained at discharge, 9 weeks and at follow up. Subjects identified 10 community leisure, social, and occupational target locations. A custom program detected trips and target visits from GPS track data. A trip is a route from an origin to a destination that a subject visited for an activity of more than 3 minutes. The program checked for inaccurate, incomplete or duplicate track logs and modified a density-based spatial clustering algorithm to detect trips. The program classified track logs into trips accurately 88% of the time in preliminary analysis. Travel was quantified by number of trackpoints, distance and time traveled within specific radii around subjects' home.

**Results :** Data are reported as mean +/- SEM. Independent t-test and Pearson's correlation were used for analysis ( $p < 0.05$ ). Of the 14 RS, 12 completed 9 weeks, 9 completed 26 weeks and 7 completed or are completing 52 weeks. At week 1, RS had a FIM score (mobility) of 5.6 (0.2) and MMSE score of 28.9 (0.3). SMWT was decreased for RS (CS= 2294 (145.9) ft. versus RS= 622.8 (107.6) ft.,  $p < 0.05$ ). RS reached fewer target locations compared to CS during week 1 (RS= 44.3 (4.0)% versus CS= 85.0 (9.6)%) and week 9 (RS= 34.2 (4.3)% versus CS= 63.3 (8.8)%) ( $p < 0.05$ ), but only a trend for a difference at week 26 ( $p = 0.09$ ). There was a weak, but significant correlation between SMWT and targets attained ( $r^2 = 0.23$ ,  $p < 0.01$ ). There was no difference in number of trips between CS and RS at any time.

**Conclusions :** RS returned to fewer destinations during the first months after discharge compared to CS. Over 75% of the variance of target attainment was not explained by walking function.

**Clinical Relevance :** GPS technology directly measures community navigation in stroke survivors and may offer insight into participation.

**TITLE:** Long-term retention of a short-burst of community-based mobility training for individuals with chronic stroke: A case series

**AUTHORS/INSTITUTIONS:** S.A. Combs-Miller, E. Aloia, K. Jones, S. Bavishi, Krannert School of Physical Therapy, University of Indianapolis, Indianapolis, Indiana, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Short-burst interventions carried out in high frequency, short duration protocols have shown promise for persons with chronic stroke with improvements in function following the intervention period. However, the long-term retention of improvements beyond 3-6 months is not clear. The purpose of this case series was to examine the long-term retention of a short-burst dose of a community-based mobility training (CBMT) intervention after one year on walking function, balance confidence, and mobility in individuals with chronic stroke.

**Case Description :** Five individuals with chronic stroke [mean age 56.4(9.5)yrs.; mean time post stroke 58.6(31.4)months; 3 male; 4 left hemiparesis] participated in CBMT five times a week, for two consecutive weeks, 30 minutes each session. CBMT consisted of navigating environmental barriers in a community setting including stairs, curbs, ramps, uneven terrains, intersections, carrying loads, and postural transitions. A moderate training intensity was maintained throughout the intervention using the Borg Rating of Perceived Exertion Scale. Participants were assessed at baseline, immediately post-intervention, 3-months and 1-year retention with walking speed (comfortable and fast 10-meter walk tests/10MWT), walking endurance (six-minute walk test/6MWT), balance confidence (activities-specific balance confidence scale/ABC), and perception of mobility (mobility and self-care questionnaire/MOSES). A semi-structured interview was conducted at the one-year retention test to evaluate participants' perceptions of their community mobility over the past year.

**Outcomes :** Three participants' maintained improvements in walking speed at the 1-year retention, with all three exceeding minimal detectable change (MDC) over baseline values on the comfortable 10MWT. Two participants exceeded the MDC on the fast 10MWT at the 1-year retention compared to baseline. All five participants' maintained improvements on the 6MWT at the 1-year retention, with four exceeding MDC values compared to baseline. Only one participant maintained self-reported improvements on the ABC and MOSES scales, with the other four participants returning to baseline values at the 1-year retention. In contrast to these findings, all five participants reported an increased level of confidence in negotiating environmental barriers in the community over the year since participating in CBMT. While the short-burst protocol did not change exercise habits of any of the participants following the intervention period, participants commented that they were less likely to avoid community-based activities after CBMT.

**Discussion :** All five participants maintained an improved level of walking function one year following participation in CBMT indicating that the short-burst protocol may have provided the necessary booster to alter community-based walking behaviors. Although the participants reported having increased confidence in community mobility one year after CBMT, this was not reflected in their scores on the ABC or MOSES.

**TITLE:** The Vestibular Head Impulse Test (vHIT) in Persons with Concussion

**AUTHORS/INSTITUTIONS:** P.J. Sparto, J.M. Furman, S. Whitney, University of Pittsburgh, Pittsburgh, Pennsylvania, UNITED STATES|M.M. Alshehri, Physical Therapy, Jazan University, Jazan, SAUDI ARABIA|A. Mucha, UPMC, Pittsburgh, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Dizziness and imbalance are two of the most frequent complaints after concussion. The origin of these complaints has been attributed to traumatic injury to the peripheral vestibular end-organs. Studies of dizziness after concussion in adults have demonstrated peripheral vestibular abnormalities in 50-70% of the cohort. However, the incidence of peripheral vestibular abnormalities after sports-related concussion in children is not known. The aim of this study is to determine if there is dysfunction in the horizontal vestibulo-ocular reflex (VOR) after concussion, as assessed with the video head impulse test (vHIT). Furthermore, the goal was to determine if the VOR gain differs between children and adults after concussion.

**Number of Subjects :** Twenty-nine children (19 F/12 M, mean age 15 (SD 3) y, range 10-20 y) and 27 adults (14 F/13 M, mean age 32 (SD 11) y, range 21-68 y).

**Materials/Methods :** Patients with cervical pain greater than 5/10 and without sufficient head turn angle of motion were excluded. The video Head Impulse Test (Interacoustics AS, Denmark) was performed by sitting the subjects 1.5 meters in front of a wall where a circular target was placed at eye level. Eye movements were calibrated using 10 deg vertical and horizontal eye movements. With the head flexed 30 deg down to place the lateral canal in the horizontal plane, impulses were delivered unpredictably to the left and right while the subject kept his/her eyes on the target, until five impulses were acquired in the correct velocity range. Gain of the VOR was computed for both the left and right sides, as was the gain asymmetry (difference in gains / sum of gains). Asymmetry greater than 25% was considered to be clinically abnormal. The Dizziness Handicap Inventory (DHI) was also recorded in order to provide a self-report of dizziness.

**Results :** No subject had a clinically significant VOR gain asymmetry, which ranged from 0 to 14%. The mean asymmetry was 4.8 % (SD 3.8 %). There were no differences in asymmetry, left VOR gain or right VOR gain, between children and adults who had a recent concussion ( $p > 0.2$ ). Across all subjects left and right VOR gains averaged 1.03 (SD 0.11) and 1.06 (SD 0.12), respectively. DHI scores ranged from 0 to 48; children (mean 13, SD 10) had significantly lower scores than adults (mean 20, SD 12,  $p = 0.017$ ).

**Conclusions :** Our sample of recently concussed adults and children did not demonstrate any peripheral vestibular abnormality in the horizontal VOR, which is mediated by the lateral semicircular canal. This finding suggests that complaints of dizziness and imbalance after concussion may be attributed to dysfunction in other organs.

**Clinical Relevance :** The vHIT is a quick and inexpensive test that assesses the horizontal VOR. The ability to determine if dizziness and imbalance after concussion is caused by peripheral vestibular injury will aid in the management of these individuals. The results challenge previous reports of the cause of dizziness after concussion. Future research is needed to resolve the differences in these studies.

**TITLE:** Progress in the Development of an Interactive Smartphone / Tablet “App” to Teach / Review Rancho Normal Gait and the Problem Solving Approach: Pathologic Gait and MOPS Brace Modules

**AUTHORS/INSTITUTIONS:** K.L. Kubota, Physical Therapy Department, Rancho Los Amigos National Rehabilitation Center, Downey, California, UNITED STATES|V. Eberly, S. Mulroy, Pathokinesiology Service, Rancho Los Amigos National Rehabilitation Center, Downey, California, UNITED STATES|P. Requejo, Rehabilitation Engineering, Rancho Los Amigos National Rehabilitation Center, Downey, California, UNITED STATES|

**ABSTRACT BODY:**

**Purpose :** The Rancho Observational Gait Analysis (OGA) System is a well-known method to analyze normal and pathologic gait. Materials utilized for teaching have evolved with advances in media and technology. Our NIDDR Field-Initiated Development Grant (#H133G100268) was designed to develop an interactive program for teaching clinicians and students how to utilize a decision-making algorithm (the Rancho R.O.A.D.M.A.P.) for lower extremity orthotic prescription. The first step was to develop a means to teach Rancho normal and pathologic gait as a foundation for use with the R.O.A.D.M.A.P. End-user feedback from prior educational sessions on OGA requested mobile multimedia resources, shifting our focus from creating a DVD initially to an app-based program currently. This special interest report will describe the ongoing evolution of this project.

**Description :** The Normal Gait module of our app was completed in 2013. For the Pathologic Gait module, we videotaped each gait deviation represented on the Rancho Full Body OGA Form. Multiple voice-over audio describing each gait deviation were recorded by a physical therapist expert in the Rancho OGA System. The technical team combined the audio and video. After completion of this process a Use Case document describing the interaction between user and app was used to guide app programming. The RanchoGait app continues to undergo extensive beta testing to assess functionality and usability.

**Summary of Use :** The Normal Gait module of the app is the first in a series to provide instruction for evaluating normal and pathologic gait; with the final module for prescribing lower extremity orthoses. The RanchoGait app allows the user to be an active participant in learning the essential elements of normal and pathologic gait while engaging critical thinking in the process. To use the Pathologic Gait module of the RanchoGait app, the user selects buttons for deviations of interest on the smartphone or tablet. An interactive player allows the user to view a video clip describing each gait deviation listed on the Rancho Gait Form. The MOPS brace (adjustable trial brace developed as part of the project) module describes how to adjust the modular orthosis as well as how to set a dorsiflexion stop, plantar flexion stop, and dorsiflexion assist. The RanchoGait app can be used as a stand-alone learning aid or in coordination with an in-person course as a supplement to principles presented in a lecture/lab-based format.

**Importance to Members:** The RanchoGait app is a significant advancement for learning gait analysis with end-user accessibility in the digital age. The combination of the normal and pathological gait components of the app will facilitate identification of the most significant gait deviations in persons with neurological disorders and provide a framework for targeted interventions. This app’s availability to members, ease of use, portability, and utility will be demonstrated live during the presentation.

**TITLE:** Repetitive acute intermittent hypoxia down-regulates inflammatory gene expression in the rat ventral cervical spinal cord

**AUTHORS/INSTITUTIONS:** B.J. Dougherty, G.S. Mitchell, J.J. Watters, Department of Comparative Biosciences, University of Wisconsin - Madison, Madison, Wisconsin, UNITED STATES|A.S. Roopra, Department of Neuroscience, University of Wisconsin - Madison, Madison, Wisconsin, UNITED STATES|

**ABSTRACT BODY:**

**Purpose :** Intermittent hypoxia exerts both pathologic and beneficial effects in the CNS, depending on the dose and duration (Dale et al., 2014). Although hundreds of hypoxic episodes per day simulating obstructive sleep apnea promote neuroinflammation, "low dose" protocols such as repetitive acute intermittent hypoxia (rAIH; 10 episodes of 10.5% O<sub>2</sub> per day, 3 days/week, 4 weeks), upregulate growth/trophic factors (Satriotomo et al., 2012) and promote spinal motor plasticity (Lovett-Barr et al., 2012). Because rAIH increases protein levels of key molecules associated with spinal respiratory motor plasticity, we hypothesized that the mRNAs for these and other molecules contributing to neuronal plasticity would be similarly increased.

**Description :** Neuronal gene chip microarrays were used to profile transcript levels in the spinal ventral horn (C4-C6) of male Lewis rats exposed to normoxia or rAIH (n=3 arrays/condition). There was little evidence of increased mRNA levels of pro-plasticity genes, and these results were confirmed with qRT-PCR for specific genes of interest. Instead, there were significant decreases in inflammatory genes including cyclooxygenase-2, tumor necrosis factor family members, chemokines and interleukins 1 $\beta$  and 6. To explore the cause of these changes, we used whole genome Vista bioinformatics to identify transcription factors likely accounting for gene expression changes induced by rAIH. Signal Transducer and Activator of Transcription 1 and 2 (STAT1/2) and nuclear factor kappa B (NF- $\kappa$ B) were over-represented (p<0.005), suggesting that rAIH may decrease STAT1/2 and NF- $\kappa$ B transcriptional activity.

**Summary of Use :** In contrast to chronic intermittent hypoxia, rAIH appears to be anti-inflammatory, depleting spinal NF- $\kappa$ B and STAT 1/2 target genes.

**Importance to Members:** rAIH holds promise as a safe, non-invasive intervention to restore motor function in persons with chronic SCI (Dale-Nagle et al., 2010; Hayes et al., 2014); the discovery of rAIH-induced anti-inflammatory activities may extend its clinical application. Indeed, an understanding of cellular and molecular mechanisms giving rise to the anti-inflammatory actions of rAIH may broaden its therapeutic potential in diverse clinical disorders associated with systemic and/or neural inflammation.

**TITLE:** The perception of hand grasp force post-stroke.

**AUTHORS/INSTITUTIONS:** A.R. Ruvolo, M. Pierce, K.P. White, V. Pardo, D. Adamo, Physical Therapy, Wayne State University, Detroit, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Stroke survivors have unique challenges when overcoming deficits associated with grasp force control. However, grasp force deficits unique to each hand (affected, less affected) are not clearly characterized and hand dominance pre-stroke, if reported, typically combines both right and left-handers. To address these gaps in the literature, this study investigated the relationship between the control of grasp force and lesion location in stroke survivors who were right handed before their stroke.

**Number of Subjects :** 21

**Materials/Methods :** Twenty-one participants, (13 with right hemisphere lesion – RHL); 8 with left hemisphere lesion – LHL) performed a force-matching task. Participants matched a 20 % reference force established with their affected and less affected hand with the same or opposite hand. Visual feedback was provided during the establishment of the reference force but was not available during the match. Constant error (CE) in Newtons (N) was the dependent variable. A handedness inventory, right and left maximum voluntary grip exertions (MVE) and the Mini Mental State Exam (MMSE) were also administered.

**Results :** RHL and LHL participants showed no significant differences in MMSE scores ( $p > 0.05$ ). Handedness scores (mean  $\pm$  SD) were not significantly different before the stroke RHL =  $.86 \pm 1.5$ , LHL =  $.91 \pm .09$  ( $p > 0.05$ ). However, were significantly different post stroke; RHL =  $.92 \pm .09$  and LHL =  $.59 \pm .24$  ( $p < 0.05$ ). For RHL, the MVE\_R (mean  $\pm$  SD) =  $29.6 \pm 11.5$ kg and MVE\_L =  $20.24 \pm 12.2$ kg were significantly different ( $p < 0.01$ ). However, for LHL significant grip strength differences MVE\_R =  $20.0 \pm 7.4$ kg and MVE\_L =  $23.68 \pm 8.8$  kg were not found ( $p > 0.05$ ). For CE, the three-way ANOVA was significant for lesion location (RHL, LHL) x matching hand x reference hand  $F(2,38) = 4.4$ ,  $p < 0.05$ . When matching with the opposite hand, RHL showed right hand overshoots ( $20.3 \pm 3.0$ N) and left hand undershoots ( $-5.6 \pm 3.7$ N). For LHL, the opposite pattern emerged showing left hand overshoots ( $19.1 \pm 8.9$ N) and right hand undershoots ( $-4.5 \pm 7.1$ N). When matching with the same hand, RHD and LHD showed similar results.

**Conclusions :** Shifts in handedness scores indicated that post stroke, those with RHD used their right hand more to perform everyday tasks, while those with LHD increased use of their left. Force matching was asymmetric and dependent on lesion location. Further, those with RHL showed greater right – left hand differences in force matching compared to LHL.

**Clinical Relevance :** Post stroke individuals are unaware of the how the differences in the control of grasp force may influence their ability to perform everyday tasks despite knowing that one hand may be weaker than the other. By providing visual feedback during force generation, these individuals were better able to realize their potential for improving grasp control in both hands. Lesion location and hand preference are factors to consider in designing hand rehabilitation programs that may benefit from using visual feedback in the restoration of unimanual and bimanual grasp force control.

**TITLE:** Incidence of lower extremity somatosensory deficits and its association with mobility problems in persons with multiple sclerosis

**AUTHORS/INSTITUTIONS:** C. Sorgani, E.C. Held Bradford, J.M. Wagner, Physical Therapy & Athletic Training, Saint Louis University, Saint Louis, Missouri, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To determine the incidence of lower limb somatosensory deficits in persons with multiple sclerosis (pwMS) and if the association between somatosensory deficits and walking limitations differs depending on level of clinical disability.

**Number of Subjects :** 52 pwMS (age:  $45 \pm 10$ , 35 female, EDSS 3.6 (0-6.0)) and 14 persons without disability (age  $42 \pm 10$ , 7 female).

**Materials/Methods :** Lower limb somatosensation was assessed bilaterally: (1) vibration perception threshold (VPT) at the great toe using a 68 Hz Rydell-Seiffer tuning fork, (2) joint position sense (JPS) at the great toe using a clinical test and (3) light touch sensation threshold (LTS) using Semmes-Weinstein monofilaments at 4 locations on each lower limb. PwMS completed the Timed 25-Foot Walk Test (T25W), Six Minute Walk Test (6MWT), and the 12-item Multiple Sclerosis Walking Scale version 2 (MSWS-12). PwMS were divided into mild (0-2.5, n = 16), moderate (3-4, n = 20) and severe (4.5-6.0, n = 16) clinical disability groups based the Expanded Disability Status Scale (EDSS) score. Composite somatosensation scores were used for analyses: VPT = mean score from both limbs; JPS = impaired if either limb abnormal; LTS = mean transformed score both limbs. Spearman rank order correlation coefficients indexed associations between measures of somatosensation and walking. Chi<sup>2</sup>-tests were used to assess group differences in age, sub-type of MS, gender, and EDSS scores. One-way ANOVAs with Tukey post-hoc tests were used to assess group differences in VPT, LTS, JPS, T25FW, 6MWT, and MSWS-12.

**Results :** Somatosensory deficits were found in 8-25% of pwMS (VPT 25%; LTS 8%; JPS 13%), and most prevalent with pwMS with severe disability (VPT: mild = 13%, moderate = 25%, severe = 38%; LTS: mild = 13%, moderate = 5%, severe = 13%; JPS: mild = 6%, moderate = 6%, severe = 27%). PwMS with severe disability had significantly lower VPT ( $4.3 \pm 2.6$ ) than those without disability ( $6.3 \pm 1.3$ ,  $p = 0.028$ ), and pwMS with mild disability ( $6.3 \pm 1.9$ ,  $p = 0.025$ ). No other differences between groups were significant. Across pwMS, LTS and JPS were not significantly associated with standardized clinical scales of walking ( $|p| = 0.02$  to  $0.18$ ). VPT was significantly associated with walking endurance (VPT vs. 6MWT  $p = 0.34$ ,  $p < 0.05$ ) and self-perceived walking limitation (VPT vs. MSWS-12,  $p = -0.36$ ,  $p < 0.05$ ). In general, the association between somatosensation and walking did not vary depending on disability level.

**Conclusions :** Lower limb somatosensory deficits were found in up to 25% of pwMS and were pronounced with increasing disability. These impairments are not strongly associated with walking limitations, regardless of the degree of clinical disability or the clinical test used to assess somatosensation.

**Clinical Relevance :** An understanding of the relative contribution of somatosensory deficits to walking dysfunction in pwMS is required for targeted therapeutic interventions.

**TITLE:** Postural sway, clinical disability, and self-perceived limitations in balance and walking in persons with multiple sclerosis

**AUTHORS/INSTITUTIONS:** A. Garbin, J.M. Wagner, Physical Therapy & Athletic Training, Saint Louis University, Saint Louis, Missouri, UNITED STATES|R.T. Naismith, Neurology, Washington University, St. Louis, Missouri, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To document postural sway during quiet stance across different sensory conditions and determine the relationship between postural sway and self-reported mobility problems and if sway parameters worsen as disability increases in persons with multiple sclerosis (pwMS). We hypothesized that postural instability would be associated with mobility problems and greatest in those with severe disability, particularly in conditions of compromised vision, somatosensation, or both.

**Number of Subjects :** 93 pwMS (age:  $48 \pm 11$ , 74 female, EDSS 2.4 (0-6.5)).

**Materials/Methods :** PwMS completed the modified Clinical Test of Sensory Interaction and Balance (mCTSIB) wearing Opal body-worn sensors, the Activities-specific Balance Confidence (ABC) scale, and the 12-item Multiple Sclerosis Walking Scale (MWSW-12). Mobility Lab software calculated sway area (SA, m<sup>2</sup>/s<sup>5</sup>) during postural tasks. Clinical disability was determined by Expanded Disability Status Scale (EDSS) score. Spearman rank-order correlations were used to evaluate associations between sway area, clinical disability and self-perceived limitations. A one-way between groups ANOVA and Tukey's post-hoc test compared sway area between mild (EDSS 0=2.5, n = 58) vs. moderate (EDSS 3-4, n = 25) vs. severe (EDSS =4.5- 6.5, n = 10) disability subgroups.

**Results :** Across subjects, the mean values ( $\pm$ SD) of sway area (SA) EO-Fi, SA EC-Fi, SA EO-Fo, SA EC-Fo, ABC, and MSWS-12 were  $0.006 \pm 0.012$  m<sup>2</sup>/s<sup>5</sup>,  $0.013 \pm 0.029$  m<sup>2</sup>/s<sup>5</sup>,  $0.020 \pm 0.091$  m<sup>2</sup>/s<sup>5</sup>,  $0.097 \pm 0.337$  m<sup>2</sup>/s<sup>5</sup>,  $78 \pm 21\%$ , and  $28 \pm 26$ , respectively. Increased sway area was associated with greater clinical disability (EO-Fi:  $\rho = 0.41$ , EC-Fi:  $\rho = 0.49$ , EO-Fo:  $\rho = 0.49$ , EC-Fo:  $\rho = 0.43$ ;  $p < 0.01$ ), reduced balance confidence (EO-Fi:  $\rho = -0.31$ , EC-Fi:  $\rho = -0.51$ , EO-Fo:  $\rho = -0.51$ , EC-Fo:  $\rho = -0.56$ ;  $p < 0.01$ ) and self-perceived limitation in walking (EO-Fi:  $\rho = 0.36$ , EC-Fi:  $\rho = 0.50$ , EO-Fo:  $\rho = 0.54$ , EC-Fo:  $\rho = 0.54$ ;  $p < 0.01$ ). The mild and moderate disability groups did not differ in SA for any condition (SA EO-Fi =  $0.004 \pm 0.004$  vs.  $0.008 \pm 0.013$  m<sup>2</sup>/s<sup>5</sup>; SA EC-Fi =  $0.008 \pm 0.007$  vs.  $0.014 \pm 0.008$  m<sup>2</sup>/s<sup>5</sup>; SA EO-Fo =  $0.007 \pm 0.012$  vs.  $0.014 \pm 0.020$  m<sup>2</sup>/s<sup>5</sup>; SA EC-Fo =  $0.061 \pm 0.218$  vs.  $0.069 \pm 0.089$  m<sup>2</sup>/s<sup>5</sup>,  $p > 0.05$  for all). The severe disability group had greater sway area (SA EO-Fi =  $0.019 \pm 0.026$  m<sup>2</sup>/s<sup>5</sup>; SA EC-Fi =  $0.044 \pm 0.082$  m<sup>2</sup>/s<sup>5</sup>; SA EO-Fo =  $0.105 \pm 0.272$  m<sup>2</sup>/s<sup>5</sup>; SA EC-Fo =  $0.371 \pm 0.864$  m<sup>2</sup>/s<sup>5</sup>) than the mild or moderate disability group across all conditions (all,  $p < 0.04$ ).

**Conclusions :** Postural instability, as documented by increased sway area during quiet stance, is associated with greater clinical disability and self-perceived mobility problems, particularly when vision, somatosensation, or both are compromised. Postural sway is similar in pwMS with a wide range of clinical disability (EDSS 0-4.0), suggesting postural instability is present early in the disease process.

**Clinical Relevance :** Understanding the impact of postural instability on mobility and its progression with disability is required for targeted interventions aimed at improving mobility in pwMS.

**TITLE:** Impact of High Frequency Epidural Spinal Cord Stimulation on Respiratory Function After Incomplete Cervical Spinal Cord Injury in Rats

**AUTHORS/INSTITUTIONS:** E.J. Gonzalez-Rothi, S.M. Turner, K.A. Streeter, D. Fuller, Physical Therapy, University of Florida, Gainesville, Florida, UNITED STATES|D.M. Baekey, Physiological Sciences, University of Florida, Gainesville, Florida, UNITED STATES|P.J. Reier, Neuroscience, University of Florida, Gainesville, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Injury to the cervical spinal cord disrupts descending bulbospinal pathways innervating the phrenic motor pool (C3-C5/6), resulting in diaphragm paralysis and impaired ventilatory function. High frequency epidural stimulation (HF-ES) is a promising therapy for activating paralyzed muscles after spinal cord injury (SCI). HF-ES of the thoracic spinal cord has been shown to effectively drive the phrenic motor system in a physiologic respiratory pattern that maintains alveolar ventilation following complete spinal transection. However, the impact of HF-ES on phrenic motor output has not been examined in cases of incomplete spinal lesion. This is an important translational consideration, as incomplete SCIs are far more common clinically. We hypothesize that thoracic HF-ES will enhance respiratory motor output when descending drive to the phrenic motor pool is partially spared. Thus, in ongoing studies, we are using our established rodent model of cervical SCI (C2 hemisection) to evaluate the effects of HF-ES on respiratory motor output.

**Number of Subjects :** 32 adult Sprague Dawley Rats

**Materials/Methods :** In terminal neurophysiology experiments, phrenic and hypoglossal motor output were recorded from anesthetized, vagotomized, and mechanically ventilated rats at either 2 or 12 weeks post-injury. Using a bipolar silver wire electrode, short duration (60s) bouts of HF-ES (300Hz) were administered to the ventrolateral spinal cord (ipsilateral to the side of injury).

**Results :** Preliminary results indicate that HF-ES triggers both tonic and phasic bursting in the ipsilateral phrenic nerve. The magnitude of this response correlates with the intensity of stimulation, and facilitation of medullary (hypoglossal) output occurs only high stimulation intensities.

**Conclusions :** These initial results suggest that HF-ES may represent a novel therapy for enhancing respiratory function after cervical SCI. This new approach may be paired with conventional respiratory rehabilitation approaches or with pharmacological interventions to improve respiratory function in individuals with chronic cervical SCI.

**Clinical Relevance :** These studies are timely and translationally relevant, as ongoing pre-clinical studies at the University of Louisville are currently investigating the effects of HF-ES of the lumbar spinal cord on locomotor function in humans with SCI. Thus the studies presented here will enable us to determine the clinical efficacy of implementing HF-ES in clinical trials to enhance respiratory function in humans after cSCI.

**TITLE:** Preliminary comparison of high-intensity interval training and moderate-intensity continuous exercise in chronic stroke

**AUTHORS/INSTITUTIONS:** P. Boyne, K. Dunning, D. Carl, B.D. Rockwell, S. Buhr, G.R. Keeton, J. Wilkerson, M.C. Gerson, B. Kissela, University of Cincinnati, Cincinnati, Ohio, UNITED STATES|J.C. Khoury, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, UNITED STATES|R. Jeffreys, Florida Gulf Coast University, Fort Myers, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Post-stroke exercise guidelines recommend moderate-intensity continuous exercise (MICE) to improve aerobic fitness, mobility and cardiovascular health. However, accumulating evidence suggests that higher exercise intensity may be more effective. High-intensity interval training (HIT) is a strategy that augments exercise intensity using bursts of concentrated effort alternated with recovery periods. HIT has been shown to be more effective than MICE for improving aerobic capacity among healthy adults and persons with heart disease. However, no previous study has compared HIT to MICE among persons with stroke.

**Number of Subjects :** This preliminary analysis includes the first 8 subjects in an ongoing trial.

**Materials/Methods :** Subjects (mean  $\pm$  SD age,  $58 \pm 8$  years; years post stroke,  $5.2 \pm 2.6$ ) were randomized to HIT (n=5) or MICE (n=3), each 25 minutes, 3x/week for 4 weeks. HIT involved repeated 30 sec bursts of treadmill gait at maximum tolerated speed, alternated with 30-60 sec rest periods. MICE involved continuous treadmill gait at a speed that elicited 45-50% heart rate reserve. Outcomes, measured by a blinded rater, included: peak oxygen uptake during a maximal-effort exercise test (VO<sub>2</sub>peak), VO<sub>2</sub> at the ventilatory threshold (VO<sub>2</sub>-VT), gait efficiency (VO<sub>2</sub> cost of gait at comfortable speed), gait speed (10m walk test, comfortable and fastest speed) and the 6 min walk test. Due to the preliminary nature of the research, we are reporting standardized effect sizes (ES), defined as the difference between HIT and MICE mean change scores divided by the larger of the two standard deviations of change.

**Results :** VO<sub>2</sub>peak changed from 16.7 ( $\pm 2.5$ ) to 21.0 ( $\pm 6.2$ ) ml/kg/min in the HIT group and from 21.3 ( $\pm 2.8$ ) to 21.3 ( $\pm 2.9$ ) ml/kg/min in the MICE group (ES: 0.86). VO<sub>2</sub>-VT changed from 11.9 ( $\pm 1.5$ ) to 17.2 ( $\pm 4.4$ ) ml/kg/min in the HIT group and 13.9 ( $\pm 2.5$ ) to 14.1 ( $\pm 1.5$ ) ml/kg/min in the MICE group (ES: 1.42). Gait efficiency changed from 352 ( $\pm 218$ ) to 286 ( $\pm 167$ ) ml/kg/km in the HIT group and 266 ( $\pm 80$ ) to 272 ( $\pm 125$ ) ml/kg/km in the MICE group (ES: 1.12). Comfortable gait speed changed from 0.65 ( $\pm 0.54$ ) to 0.72 ( $\pm 0.57$ ) m/s in the HIT group and 0.64 ( $\pm 0.46$ ) to 0.65 ( $\pm 0.49$ ) m/s in the MICE group (ES: 0.52). Fastest gait speed changed from 0.71 ( $\pm 0.57$ ) to 0.81 ( $\pm 0.66$ ) m/s in the HIT group and 0.77 ( $\pm 0.58$ ) to 0.76 ( $\pm 0.55$ ) m/s in the MICE group (ES: 0.96). Six-min walk test distance changed from 220 ( $\pm 179$ ) to 234 ( $\pm 189$ ) m in the HIT group and 210 ( $\pm 155$ ) to 214 ( $\pm 161$ ) m in the MICE group (ES: 0.79).

**Conclusions :** This preliminary analysis showed large effect sizes for HIT compared to MICE for most outcomes, including aerobic capacity (VO<sub>2</sub>peak and VO<sub>2</sub>-VT), gait efficiency and fastest gait speed. A larger sample size is needed to confirm and expand on these results.

**Clinical Relevance :** HIT is a promising exercise strategy for improving aerobic capacity and gait function among persons with stroke. These preliminary data suggest HIT may be more effective than MICE in this population.

**TITLE:** Very Intensive Early Walking post-Stroke (VIEWS): A randomized, single-blind clinical trial.

**AUTHORS/INSTITUTIONS:** C. Holleran, A. Leddy, P. Hennessy, Rehabilitation Institute of Chicago, Chicago, Illinois, UNITED STATES|T. Hornby, University of Illinois at Chicago, Chicago, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The amount and intensity of task-specific practice is thought to facilitate improvements in motor recovery of patients early post-stroke.<sup>1-4</sup> However, few studies have evaluated the effects of high intensity stepping interventions as compared to traditional rehabilitation interventions, and without the confounding effects of “usual” rehabilitation interventions. We hypothesized that high-intensity stepping practice will improve stepping outcomes in patients with subacute stroke as compared to low-intensity interventions focusing on practice of multiple walking and non-walking tasks.

**Number of Subjects :** Individuals with self-selected walking speeds < 0.9 m/s with 6 months following a unilateral, supratentorial stroke were recruited. Thirty-two individuals completed at least 4 weeks of the training protocol.

**Materials/Methods :** Using a single-blinded randomized design, patients received up to 40 sessions of training over 10 weeks, with outcomes at baseline, mid- and post-training, with a follow-up evaluation at 2 months post-training. The protocol for the experimental training 2 focused only on stepping in a specific direction on the treadmill, overground, or over stairs, with goals to maintain intensity between 70-80% of heart rate reserve. Control interventions attempted to provide similar amounts of repetitions of exercise tasks as detailed previously<sup>4</sup>, with heart rate targeted for 30-40% heart rate reserve. Patients were asked to wear an accelerometer throughout the duration of training to detect stepping activity, and could not be enrolled in additional physical therapy. Outcomes included overground walking velocity at self-selected speeds (SSS) and fastest possible speeds (FS), the 6 min walk test, (6MWT), and daily stepping (steps/day). Secondary measures included Berg Balance Scale (BBS) and the duration of 5-times STS (5XSTS).<sup>5</sup>

**Results :** Baseline assessments of participants were not significantly different between training groups. A two-way repeated measures ANOVA (main effect of intervention, repeated for time) indicate significantly greater improvements in SSS ( $0.27 \pm 0.21$  vs  $0.09 \pm 0.09$  m/s), FS ( $0.35 \pm 0.36$  vs  $0.11 \pm 0.15$  m/s) and 6MWT ( $111 \pm 114$  vs  $28 \pm 32$  m) favoring the experimental group (all  $p < 0.01$ ), with improvements correlated with the amount of stepping practice. In contrast, there were no significant differences in improvements in steps/day ( $893 \pm 1542$  vs  $536 \pm 1406$  steps/day), and no significant differences in BBS or 5XSTS.

**Conclusions :** High intensity stepping training in individuals with subacute stroke elicits substantially greater improvements in walking function as compared to lower intensity interventions focus on walking and non-walking tasks. Additionally, improvements in BBS and 5XSTS were similar despite no explicit practice on these tasks in the experimental group.

**Clinical Relevance :** Provision of large amounts of stepping practice in patients with subacute stroke may facilitate improvements in locomotor outcomes, with nearly equivalent improvements in non-locomotor functional tasks.

**TITLE:** Reactive balance in chronic stroke survivors: Biomechanical factors related to risk of falling

**AUTHORS/INSTITUTIONS:** P. Salot, P. Patel, T. Bhatt, Physical Therapy, University of Illinois at Chicago, Chicago, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Environmental falls are a leading cause of limited functional mobility and reduced quality of life in ambulatory stroke survivors. Understanding the fall-inducing and recovery mechanisms from external perturbations in these people is thus important. We aimed to examine biomechanical factors of fall risk in community-dwelling people with chronic stroke in response to a large forward perturbation induced in upright stance. We hypothesized that compared to healthy controls, stroke survivors would demonstrate a higher fall risk resulting from a lower postural stability and insufficient vertical limb support at touchdown of the compensatory step(s).

**Number of Subjects :** Fifteen healthy controls ( $24.57 \pm 4.24$ ) and 13 chronic independently ambulating stroke survivors ( $57.83 \pm 6.59$ ).

**Materials/Methods :** Subjects were exposed to a sudden, large magnitude, forward perturbation induced via a motorized treadmill and were asked to maintain their balance and upright posture upon the perturbation. Slip outcome, classified as either a) backward loss of balance (BLOB) with fall, or b) backward loss of balance with recovery was recorded, along with the number of steps taken. Postural stability was assessed by computing the center-of-mass (COM) position relative to the base-of-support (BOS, most posterior heel position) during liftoff and touchdown of the compensatory step. A BLOB occurred when subjects resorted to compensatory stepping for recovering upright stance. Compensatory step was classified into aborted step (AS) or backward step (BS). Kinematics of the compensatory response (step initiation time and step length) were also obtained. Vertical limb support was quantified by the descent in vertical hip height post-slip.

**Results :** There was a 100% BLOB for both healthy controls and stroke survivors. Out of the 100% BLOB in each group, 92.30% of the stroke survivors experienced a fall (33% AS; 67% BS), compared to only 7.16% of healthy controls that fell (all with a BS). The stroke group took significantly more number of steps ( $2.83 \pm 1.23$ ) compared to healthy controls ( $1.93 \pm 0.27$ ,  $p < 0.05$ ). Stroke survivors had a significantly delayed and shorter 1st step (always with non-paretic limb) compared to healthy controls ( $p < 0.05$  for all comparisons). This was accompanied by significant postural instability during both liftoff and touchdown ( $p < 0.05$ ) of the step and a significantly lower hip height ( $p < 0.05$ ). During 2nd step touchdown, stroke survivors were more unstable compared to controls whereas the controls established complete stability (more anterior relative COM position) at this instance ( $p < 0.05$ ).

**Conclusions :** Despite being independent ambulators, chronic stroke survivors demonstrated a high fall-risk resulting from impaired reactive balance control as demonstrated by poor postural stability, inefficient compensatory stepping and inability to provide adequate vertical limb support.

**Clinical Relevance :** Balance rehabilitation interventions in this population should thus focus on improving both reactive stepping and paretic-limb weight bearing ability for fall-risk prevention.

**TITLE:** High-intensity interval treadmill training and over ground translation in chronic stroke: A single subject design

**AUTHORS/INSTITUTIONS:** G.R. Keeton, P. Boyne, D. Carl, B.D. Rockwell, S. Buhr, M.C. Gerson, B. Kissela, K. Dunning, University of Cincinnati, Cincinnati, Ohio, UNITED STATES|J.C. Khoury, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** High-intensity interval training (HIT), a method involving short bursts of intense exercise alternated with recovery periods, has shown greater improvements in gait than other forms of treadmill (TM) training during inpatient stroke rehabilitation. However, the impact of HIT on chronic gait impairment has not been previously studied, nor has the use of over ground (OG) HIT as an effort to better translate gait improvements on the treadmill to a more real-world context. Therefore, the purposes of this study were to: 1) assess gait changes associated with HIT for a person with gait impairment due to chronic stroke, and 2) compare the effects of TM HIT alone to TM HIT plus OG translational HIT.

**Case Description :** The subject (66 years old, 7 years post ischemic stroke, comfortable gait speed 0.25 m/s) underwent 2 treatment phases: A) TM HIT, 3x/week for 4 weeks, followed by B) TM HIT plus OG translational HIT, 3x/week for 4 weeks. In both phases, TM HIT included a 3 minute (min) warm up, 20 min of HIT (30 sec bursts, 30-60 sec recovery) and a 2 min cool down. Handhold (HH) was progressed, based on subject ability, from using a handrail for the full session to using an elastic band for part of the session, then no HH for part of the session. During phase B, TM HIT was followed by 5 min of OG HIT (30 sec bursts, 30 sec recovery), where the subject walked as far as possible during bursts. Peak TM speed for each HH was recorded each session during both phases and peak OG HIT speed was recorded each session during phase B. Blinded outcomes, assessed at baseline, 4 weeks (POST-A) and 8 weeks (POST-B), included the fast 10m walk test, 6-min walk test and gait efficiency (oxygen cost of comfortable speed gait).

**Outcomes :** During phase A, peak TM HIT speed increased, both for the handrail HH (1.03 to 1.88 m/s) and elastic band HH (0.36 to 0.85 m/s). The subject progressed to no HH during the last session of phase A. During phase B, TM HIT speed for the handrail HH showed no further improvement, but increases occurred for the no HH condition (0.40 to 0.72 m/s) and for OG HIT (0.46 to 0.87 m/s). From baseline to POST-A to POST-B, blinded outcome changes were: fast 10m walk test, 0.29 to 0.29 to 0.43 m/s; 6-min walk test, 90 to 88 to 104 m; gait efficiency (oxygen cost), 306 to 296 to 270 ml/kg/km.

**Discussion :** Gait efficiency improved throughout both training phases, but 10m walk speed and 6-min walk distance only improved during phase B, when OG HIT was initiated. This suggests that OG translation training may be critical for transferring gains on the treadmill to real-world function for some persons with chronic stroke. Incidentally, the subject was also able to progress TM speed with no HH during phase B, which could explain the improvement in gait outcomes. Therefore, future study of OG translation effects should control for HH progression. Gait speeds during training were well above speeds found during outcome testing, suggesting that there may be potential for further improvement with additional intervention.

**TITLE:** Impact of active arm cycling on spasticity in adults with cerebral palsy

**AUTHORS/INSTITUTIONS:** C.P. Phadke, J. Kunju Kunju, N.E. Moghaddam, F. Ismail, C. Boulias, Spasticity Research Program, West Park Healthcare Centre, Toronto, Ontario, CANADA|A. Centen, University of Toronto, Toronto, Ontario, CANADA|W.H. Gage, York University, Toronto, Ontario, CANADA|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Spasticity and arm function can deteriorate from lack of physical activity in adults with cerebral palsy (1). Cycling is known to decrease reflex size and improve function; however the best type of arm cycling is not clear. Variable resistance compared to constant resistance cycling has been shown to induce neural adaptations and lower H-reflexes. The purpose of this study was to compare the effect of two types of active arm cycling on spasticity, H-reflexes, and arm function.

**Number of Subjects :** Seven adults with cerebral palsy (mean age 45+/-12 years; 5 females).

**Materials/Methods :** Arm cycling: 1) constant resistance and 2) variable resistance were performed for 20 minutes each on two days one week apart. Six participants received the constant resistance cycling first. Outcome Measures: a) Elbow spasticity measured using Tardieu scale (quality and angle of muscle reaction), b) reflex excitability using flexor carpi radialis H-reflex amplitude, c) biceps and triceps brachii electromyography in the 1st and the 20th minute of arm cycling, d) active and passive elbow range of motion, and e) arm function using repetitive active elbow flexion and extension movements in 10 seconds. All outcome measures were tested immediately before and after the cycling bout.

**Results :** We were unable to compare the two types of cycling because the effect of first bout of exercise carried over to the second bout. a) Tardieu angle substantially decreased in 3 subjects, did not change in 3 subjects, and marginally increased in 1 subject after constant resistance cycling. Tardieu angle remained low a week later when tested immediately before the second cycling session. The quality of muscle reaction was not significantly different before and after both types of cycling. b) H-reflex amplitude decreased in 2 subjects, did not change in 3 subjects, and increased in 1 subject after constant resistance cycling. H-reflex amplitude decreased in 4 subjects, did not change in 1 subject, and increased in 1 subject after variable resistance cycling. c) Triceps and biceps muscle coactivation decreased and reciprocal activation emerged in the 20th minute of both types of cycling. Peak muscle activity also increased in the final minute compared to the first minute of both types of cycling. d) Active and passive elbow range of motion was not significantly different before and after both types of cycling. e) Repetitive active elbow flexion extension movements increased post both types of cycling and gains made after constant resistance cycling were maintained one week later.

**Conclusions :** Significant decrease in Tardieu angle (ranging from 25-82 degrees), decrease in reflex excitability as shown in previous studies, improvement in electromyography patterns, and improvement in repetitive elbow movements all show a robust effect of arm cycling. There appeared to be a sustained effect of cycling lasting at least 1 week and future studies need to explore this in greater detail.

**Clinical Relevance :** Arm cycling may be a helpful adjunct to current physical therapy approaches to improve function in adults with cerebral palsy.

**TITLE:** A Dose-response Analysis of Change in Walking Speed and Distance Associated with Different Forms of Locomotor Training in Persons with Motor-incomplete SCI

**AUTHORS/INSTITUTIONS:** E.B. Sandler, S.L. Hiser, L.A. Stewart, Department of Physical Therapy, University of Miami Miller School of Medicine, Miami, Florida, UNITED STATES|E.C. Field-Fote, Crawford Research Institute, Shepherd Center, Atlanta, Georgia, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Different approaches to body weight supported locomotor training have been demonstrated to improve spatiotemporal parameters of walking. However, little is known about the relationship between training dose and walking outcomes in individuals with spinal cord injury; one reason for this is that study protocols vary dramatically. The purpose of this study was to identify the relationship between training dose and improvement in walking distance and speed among four different locomotor training approaches. Training dose was defined as total distance walked during locomotor training, ie distance-dose. We hypothesized that individuals with a greater distance-dose would demonstrate a larger increase in walking speed and distance.

**Number of Subjects :** Seventy-four participants with a chronic motor-incomplete SCI were enrolled; 64 subjects completed the study.

**Materials/Methods :** Subjects were stratified based on lower extremity motor scores (LEMS) and randomized to either: treadmill-based training with manual assistance (TM=17), treadmill-based training with stimulation (TS=18), overground training with stimulation (OG = 15), treadmill-based training with robotic assistance (LR=14). Subjects trained 5 days a week for 12 weeks. Distance-dose was calculated based on the total distance traversed over all sessions combined. Distance change was assessed based on the 2 minute walk test (2MWT), measuring total distance walked in 2 minutes. Speed change was assessed with the 10 meter walk test (10MWT). ANOVA with a post-hoc Tukey test was used to compare the groups on distance-dose. A Pearson correlation was calculated to examine the relationship between distance-dose and distance change and speed change.

**Results :** The groups were equivalent at baseline in age, height, weight, sex, and LEMS. The LR group distance-dose (14793m) was the largest, and significantly greater than all other groups. Distance-dose for the OG (2989m), TS (1191m), and TM (1700m) groups was not significantly different. There was no relationship between distance-dose and speed change and distance change when groups were combined ( $r=-0.015$ ,  $P=.910$ ). Only the OG group achieved a significant correlation between distance-dose and distance change ( $r=0.607$ ,  $P=0.016$ ) and speed change ( $r=0.621$ ,  $P=0.013$ ).

**Conclusions :** For all treadmill-based interventions, dose was not related to the change in speed and distance. However, in the OG group alone, larger doses were associated with greater increases in distance walked in 2 minutes and 10-meter walking speed.

**Clinical Relevance :** The size of the training dose administered in the OG group had a positive relationship with outcomes of distance and speed change. This is likely due to task specificity of the training and greater physiologic demand on the participants. Thus, a greater dose administered with OG training could potentially yield improved outcomes with patients that have motor-incomplete SCI.

**TITLE:** Effect of rTMS and sensorimotor retraining in focal dystonia

**AUTHORS/INSTITUTIONS:** R.L. Schmidt, M. Chen, T.J. Kimberley, in Physical Therapy and Rehabilitation Science, University of Minnesota, Shakopee, Minnesota, UNITED STATES|C.M. Buetefisch, Department of Neurology, Emory University, Atlanta, Georgia, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Though the pathophysiology of dystonia remains uncertain, two primary factors implicated in the development of dystonic symptoms are excessive cortical excitability and impaired sensorimotor processing. The aim of this study was to determine the functional efficacy of a sensorimotor intervention combining rTMS and sensorimotor retraining. Our hypothesis was: participants receiving the sensorimotor intervention will (1) display significantly improved handwriting measures; (2) report significant functional improvement; (3) experience decreased hand cramping; and (4) display a significant decrease in corticospinal excitability compared to rTMS followed by stretching and massage.

**Number of Subjects :** 9

**Materials/Methods :** This study implemented a randomized, single-subject, multiple baseline design with crossover to examine subjects with focal hand dystonia (FHD). Intervention: 5 days rTMS + sensorimotor retraining (DSM) vs. 5 days rTMS + traditional therapy (DTT) (which included stretching and massage). The rTMS was applied to the premotor cortex at 1 Hz at 80% resting motor threshold for 1200 pulses (20 min). For sensorimotor retraining, a subset of the Learning-based Sensorimotor Training program was followed. Each session consisted of rTMS followed immediately by 30 minutes sensorimotor retraining or stretching/massage.

**Results :** Group analyses revealed a lack of washout effect between interventions, therefore; group data were analyzed without crossover. Subjective symptom rating improved in both groups. There was a significant group x time interaction ( $p < 0.0001$ ), with increasing inhibition in the DSM group and decreasing inhibition in DTT. No other differences were detected between groups. Single subject analyses were used to evaluate individual responses. Six subjects reported improvement of primary tasks impacted in life by FHD using the Global Rating of Change Scale, two of which were clinically meaningful improvements in the DSM group. One subject in the DTT group experienced a clinically meaningful worsening of symptoms. All subjects displayed changes in at least one outcome measure but changes were not consistent and did not follow hypothesis.

**Conclusions :** Group analyses did not reveal a clear difference between interventions as subjects experienced variable responses to both interventions. Although the majority of patients reported some improvement in function, two subjects experienced no change and one subjects reported worsening of symptoms. There was no clear advantage of pairing sensorimotor retraining with rTMS.

**Clinical Relevance :** These results suggest rTMS interventions may not be effective in all patients with FHD, but highlight the potential for moderate improvement in some. Factors that predict a patients' response to rTMS should be further evaluated. The duration of the training may have been inadequate to discern differences.

**TITLE:** Reliability and Precision of Video Head Impulse Test (vHIT) for Children

**AUTHORS/INSTITUTIONS:** L. Ross, College of Health Sciences, Northwestern University, Downers Grove, Illinois, UNITED STATES|J.O. Helminski, Physical Therapy Program, Northwestern University, Downers Grove, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The vHIT provides valid, reliable measurements of vestibulo-ocular reflex (VOR) gain for adults. Reliability for children is unknown. Brief, transient head rotations (impulses) are used to quantify the human VOR, a slow phase eye movement that matches amplitude and direction of head movement to maintain fixation. When slow-phase responses are inadequate, other mechanisms are triggered to help stabilize images on fovea after the head begins to move such as saccades, cervico-ocular reflex, and preprogramming of slow phases. The vHIT may be quantified using Otometrics ICS Impulse goggles to record eye position by high-speed video and head velocity by gyroscope. Detection of saccades and quantification of VOR gain (area under eye velocity (de-saccaded) versus area under head velocity) and peak head velocity are calculated using the OTOsuite Vestibular software. The purpose of the study was to evaluate test-retest and interrater reliability of mean VOR gain for 6 semicircular canals (SCCs) during the vHIT using ICS Impulse goggles, for children with typical development aged 4 to 17 years. The impulse quality was evaluated.

**Number of Subjects :** 31

**Materials/Methods :** VOR gain stability was estimated. Repeated measurement of VOR gain between 2 independent raters and within 1 rater within 1 session was conducted. Reliability of mean VOR gain (5 trials) for each SCC was estimated using a two-way random effects model, absolute agreement, average measures intraclass correlation coefficient (ICC 2,5; 95% CI). Mean peak impulse velocity was determined.

**Results :** Twenty-eight participants completed testing. Three participants were not tested due to goggle slippage. VOR gain measurements were stable over time; paired t test was not significant ( $p > .05$ ). Test-retest ( $ICC \geq .821 \leq .945$ ) and interrater ( $ICC \geq .800 \leq .971$ ) reliability were good for all SCCs. No data could be obtained on .5% of lateral and 10.5% of vertical SCCs. Raters performed 30% (lateral SCCs) and 105% (vertical SCCs) more trials to obtain acceptable data. The impulses delivered at peak velocities  $\geq 100^\circ/s$  on average were 38% for lateral and 6% for vertical SCCs.

**Conclusions :** The vHIT, using Otometrics ICS Impulse goggles, provides reliable VOR gain measurements in children aged 5 to 17. Measurements were difficult to obtain for the vertical SCCs. Trials were rejected due to too large of amplitude or too slow of head impulse. This may be due to cervical hypermobility of the immature spine in children  $< 12$  years. Too slow of head impulse would limit isolation of SCC function.

**Clinical Relevance :** The vHIT provides reliable VOR gain measurements that are difficult to obtain in children. To prevent large amplitude head movements the examiner reduced the head impulse velocity to accommodate for cervical hypermobility of the children's spines. When vestibular responses are inadequate, reduced head velocities would enable other mechanisms to compensate by helping to stabilize the image on the fovea resulting in false negative findings of vHIT.

**TITLE:** Does Playing Xbox Kinect and Treadmill Walking Improve Cognition, Balance, and Gait in Parkinson's Disease? A Case Study

**AUTHORS/INSTITUTIONS:** A.K. McMillion, S. Vallabhajosula, S.N. Witherspoon, J. Freund, Department of Physical Therapy Education, Elon University, Elon, North Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Treadmill walking may improve gait and decrease falls in persons with Parkinson's disease (PD). Recently, the use of virtual reality games to increase motor and cognitive abilities in persons with PD is growing. There is minimal research on the effects of a dual intervention of treadmill walking and virtual reality games in persons with PD. We investigated the effect of such an intervention on cognition, balance and gait in a person with PD.

**Case Description :** The participant was a 69 year old male with 7 year history of PD. The AB design included a 4-week pre-intervention period with weekly testing followed by 8 weeks of intervention with biweekly testing. Intervention consisted of 1 supervised and 2 unsupervised sessions per week. Sessions included 30 minutes each of playing Xbox Kinect games and treadmill walking. Testing included: Stroop test, Falls Efficacy Scale-I, Mini BesTest, Parkinsons Disease Questionnaire-39, 2-Minute Walk Test (2MWT) with and without dual task, gait using GaitRite, static balance using center of pressure (CoP) based measures of standing with eyes open and closed on a force plate for 30s , and dynamic balance using spatio-temporal measures of gait initiation (5 trials). The week 8 test (POST) scores were compared with the average of the 4-week pre-intervention period (PRE) with a  $\geq 2*SD$  change considered meaningful.

**Outcomes :** Clinical measures that improved with a  $\geq 2*SD$  change: Mini BesTest (PRE: 21.6, POST: 24), 2MWT Distance with dual task (PRE: 147m, POST: 153m). CoP-based measures of standing with eyes open that improved with a  $\geq 2*SD$  change: anteroposterior (AP) range in cm (PRE: 3.2, POST: 1.7), sway area in sq.cm (PRE: 11.8, POST: 5.6). CoP-based measures of standing with eyes closed that improved with a  $\geq 2*SD$  change: mediolateral (ML) range in cm (PRE: 4.9, POST: 3.9), AP range in cm (PRE: 3.9, POST: 2.1), Total path length in cm (PRE: 234, POST: 210), ML mean velocity in cm/s (PRE: 5.2, POST: 4.6), AP mean velocity in cm/s (PRE: 4.7, POST: 4.3). Measures of gait initiation that improved with a  $\geq 2*SD$  change: step length of 1st step in cm (PRE: 46, POST: 52), step velocity of 1st step in cm/s (PRE: 93, POST: 108), step velocity of 2nd step in cm/s (PRE: 151, POST: 168), coefficient of variation (CV) of step length of 1st step (PRE: 9%, POST: 2%), CV of step velocity of 1st step (PRE: 11%, POST: 2%).

**Discussion :** A dual intervention of virtual reality game playing and treadmill walking improved balance and gait measures in a person with PD. Although changes in 2MWT with dual task and Mini BesTest were not greater than minimal detectable change, the  $\geq 2*SD$  changes may reflect improved dual task performance and balance respectively. Improvements in instrumented measures of static and dynamic balance, and gait may indicate decreased fall risk and increased stepping control. The lack of improvement in other measures may be due to the short duration (weeks) and intensity (minutes per week) of the intervention and/or sensitivity of the outcome measures.

**TITLE:** Effects of Exertional Therapy on Concussion Management: A Systematic Review

**AUTHORS/INSTITUTIONS:** S. Lesh, C. Veerman, B. Schoeneberg, Physical Therapy, Southwest Baptist University, Bolivar, Missouri, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Concussions are the most common type of mild traumatic brain injury yet the pathophysiology is poorly understood. The onset, severity and duration of symptoms vary dramatically and it is not clear why such variance exists. Variation in presentation makes decision making difficult on how to effectively manage patients suffering from a concussion. Current guidelines require a concussed patient to fully rest until symptoms have resolved. After symptom resolution, protocols of graded exertional activities are introduced prior to the safe return to full activity level. The optimal duration of complete rest for a patient is unknown and it has been theorized that excessive rest may lead to greater co-morbidities. Some members of the rehabilitation community have suggested that graded exertional therapies prior to the complete resolution of symptoms may be of benefit for the concussed patients. Exertional exercise may help to restore normal physiologic function. The purpose of this systematic review is to evaluate the current evidence related to the impact that exertional therapy has on patients suffering from concussion symptoms.

**Number of Subjects :** NA

**Materials/Methods :** Study design was a systematic review of recent literature to identify relevant evidence related to the clinical question. The search was completed by utilizing EBSCOhost search engine. A PRISMA search strategy utilizing key words identified 4420 articles. After applying screening criteria 4 articles were included for data extraction and analysis. Two reviewers assessed quality of evidence using the quality checklist developed by Downs & Black. A neutral third reviewer was utilized to resolve disagreements leading to a consensus quality rating of good, fair, or poor.

**Results :** Assessed quality of included articles revealed 2 good and 2 fair quality articles. Data extraction is presented in a summary of findings table. 103 total subjects were included in the 4 reports. Exertional exercise protocols were described and were performed until symptoms were exacerbated. The 2 good quality articles produced significant results associating beneficial outcomes of exertional exercise and symptom management for concussed patients. The 2 fair quality articles also associated beneficial outcomes between controlled exercise and symptom reduction, however, only 1 demonstrated significance.

**Conclusions :** A graded exertional exercise program may aid recovery for concussed patients. Studies evaluated in this systematic review were limited by low number of subjects, lack of controls and inconsistent utilization ranging from acute to more chronic conditions. This search did not reveal any high quality RCT on this subject matter. Due to the limited scope of research on this topic, findings should be cautiously interpreted. More research is warranted to examine the impact of exertional therapy on concussion management.

**Clinical Relevance :** Concussions are a growing poorly understood epidemic. Based upon this systematic review the authors cautiously recommend that graded exertional therapy may be useful for improving concussion related symptoms.

**TITLE:** Preliminary Evidence for the Use of Aggressive Mobilization Protocols in Disorders of Consciousness during Acute Rehabilitation

**AUTHORS/INSTITUTIONS:** J.J. Fernandez, C. Beaulieu, J. Walworth, K. Ngo, Brain Injury Program, Brooks Rehabilitation, Jacksonville, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Investigative research into treatments for DOC has largely been focused on the effectiveness of medications on improving awareness and consciousness and eventual emergence from the minimally conscious state (MCS). Far less research has focused on the behavioral rehabilitation interventions that may contribute to improvements in the clinical presentations of patients with DOC during acute rehabilitation. Generalized weakness, debility, and learned disuse are conditions identified as consequences resulting from extended critical care stays, especially following neurological disorders. The benefits of early mobilization protocols are well documented as methods for attenuating or reversing the negative impact of immobility on recovery and for reducing secondary complications. The benefits of aggressive mobilization for patients with DOC, however, have yet to be investigated. Furthermore, all aspects of DOC diagnosis are dependent upon the observation of patient behaviors (i.e., motor output), particularly to accurately demarcate the transition from MCS to emergence from MCS. Enhancing motor output and reducing the negative impact of the consequences of long-term immobility would be advantageous for patients with DOC. Thus, we are sharing preliminary evidence for the potential benefit of implementing aggressive mobilization protocols (AMP) for patients with DOC.

**Number of Subjects :** 25

**Materials/Methods :** A total of 25 records were retrospectively identified with patients diagnosed with a DOC following acute rehabilitation admission. Variables collected during record review included: Admission Date, Discharge Date, Interrupted Stays and Re-admission date(s), DOB, Sex, DOC diagnosis following admission assessment, Emergence from DOC prior to discharge, Etiology of diagnosis, type of facilitated mobilization, duration and frequency of mobilization, and level of engagement. Calculated variables included: Admission Age, Total Length of Stay (LOS).

**Results :** Of the 25 patients admitted, 11 received one of four types of facilitated mobilization. Of the 11 patients who received facilitated mobilization, 7 patients emerged either prior to discharge (N=4) or shortly after discharge to home (N=3) and were subsequently readmitted for acute rehabilitation. Of the 14 patients who did not receive any form of facilitated mobilization only 3 emerged prior to discharge.

**Conclusions :** This preliminary evidence suggests AMP should be formally investigated as a potential valuable addition to care plans for patients with DOC. AMP may assist patients with DOC to overcome severe weakness, debility, or learned disuse that may be negatively impacting their ability to respond to external stimuli. AMP may also facilitate recovery of arousal and awareness in low-level clinical profiles.

**Clinical Relevance :** Physical therapists as practitioners of choice for mobilization have the potential opportunity to influence assessment and treatment in the DOC population.

**TITLE:** How is perturbation-induced step landing different in stroke and controls?

**AUTHORS/INSTITUTIONS:** R. López-Rosado, C. Binder, A. Montanaro, K.N. Stupica, M. Reinke, E. Mueller, K. Martinez, Northwestern University, Chicago, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to investigate perturbation-induced stepping in chronic stroke survivors and controls. We hypothesized that stroke survivors would take a greater number of steps, initiate step with the non-paretic leg, and exhibit decreased landing impulse compared to controls.

**Number of Subjects :** 13 subjects, 8 chronic stroke survivors (7 male, 1 female) mean age  $54.5 \pm 10.84$  and 5 controls (3 male, 2 female) mean age  $54.0 \pm 13.66$ . Mean years post stroke was  $10.22 \text{ years} \pm 10.22 \text{ yrs}$ .

**Materials/Methods :** Subjects were screened by phone to verify eligibility and were tested without their AFO's and/or assistive devices. Recovery steps were induced by an anterior waist pull perturbation at 10% of body weight (BW). 10 trials at equal weight-bearing, and 6 catch trials at 2% BW were randomly applied. Reflective markers were used to track stepping leg, number of steps, and ankle angle at landing. Landing impulse forces of the first step was collected from heel strike to toe off of the trailing leg. Data was collected using Qualysis motion analysis system. Subjects were instructed to stand with feet shoulder width apart and respond naturally to the perturbation. Visual feedback was used to enable subject to maintain equal weight bearing for 250-1000 ms to initiate the weight drop perturbation. A one-way MANOVA was used to determine difference in landing between controls, and stroke stepping with paretic and non-paretic legs with Bonferroni post-hoc ( $p \leq 0.05$ ).

**Results :** There was a trend towards a significant difference between the number of steps taken by controls compared to steps taken with the paretic leg in chronic stroke survivors ( $p=0.059$ ). Participants post-stroke stepped 81% of the time with their non-paretic leg; only 3 subjects post-stroke stepped with their paretic leg. There was no difference in the first step impulse magnitude between controls and the paretic or non paretic leg in chronic stroke survivors.

**Conclusions :** Stroke survivors show a preference for initiating perturbation-induced protective steps with their non-paretic leg. The lack of difference in the landing impulse may be related to the number of steps taken across subjects.

**Clinical Relevance :** Training stroke survivors to initiate perturbation-induced protective steps with their paretic leg may increase the likelihood of initiating a change of support strategy with either leg when responding to dynamic reactive balance challenge.

**TITLE:** Low force contractions induce fatigue consistent with muscle mRNA expression in people with spinal cord injury

**AUTHORS/INSTITUTIONS:** M.A. Petrie, E. Faidley, R. Shields, Physical Therapy and Rehabilitation Science, The University of Iowa, Iowa City, Iowa, UNITED STATES|M. Suneja, Department of Internal Medicine, The University of Iowa, Iowa City, Iowa, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Spinal cord injury (SCI) is associated with muscle atrophy, transformation of muscle fibers to a fast fatigable phenotype, metabolic inflexibility (diabetes), and neurogenic osteoporosis. Electrical stimulation of paralyzed muscle may mitigate muscle metabolic abnormalities after SCI, but there is a risk for a fracture to the osteoporotic skeletal system. Purpose: The goal of this study was to determine if low force stimulation (3Hz) causes fatigue of chronically paralyzed muscle consistent with selected muscle gene expression profiles.

**Number of Subjects :** We tested 29 subjects, 9 with a SCI and 20 without and SCI, during low force fatigue protocol. 3 SCI and 3 non-SCI subjects were muscle biopsied for gene and protein expression analysis.

**Materials/Methods :** Subjects were positioned in a chair with the knee flexed to 90° with the ankle firmly secured to a force transducer. Surface electrodes were on the skin over the quadriceps muscles. Single stimulus pulses were delivered at progressively increasing intensities up to ensure supra maximal muscle stimulation. Stimulus pulses were spaced 10 seconds apart to minimize muscle fatigue before testing. Subjects then performed 2 bouts of electrical stimulation at a frequency of 3Hz containing 1000 and 200 pulses respectively. A 5 minute recovery period followed the first bout of 1000 stimulation pulses.

**Results :** The fatigue index (FI) was  $0.21 \pm 0.27$  and  $0.91 \pm 0.01$  for the SCI and non-SCI groups, respectively, supporting that the low force protocol physiologically fatigued the chronically paralyzed muscle. The post fatigue potentiation index (PI) for the SCI group was increased to  $1.60 \pm 0.06$  ( $p < 0.001$ ), while the non-SCI group was  $1.26 \pm 0.02$  supporting that calcium handling was compromised with the low force stimulation. The mRNA expression from genes that regulate atrophy and fast properties (MSTN, ANKRD1, MYH8, and MYCBP2) was up regulated, while genes that regulate oxidative and slow muscle properties (MYL3, SDHB, PDK2, and RyR1) were repressed in the chronic SCI muscle. MSTN, ANKRD1, MYH8, MYCBP2 gene expression was also repressed three hours after the low force stimulation protocol.

**Conclusions :** We discovered that 1000 stimulus pulses, delivered at a 3Hz stimulation frequency, caused fatigue of the paralyzed quadriceps muscle in people with long term paralysis but did not fatigue the quadriceps of people without paralysis. The fatigability responses were consistent with each group's gene expression signatures. Taken together, these findings support that a low force single twitch activation protocol induces paralyzed muscle fatigue and subsequent gene regulation.

**Clinical Relevance :** These findings suggest that training with a low force protocol may elicit skeletal muscle adaptations in people with SCI. Since individuals with SCI develop 1) severe osteoporosis, 2) have limited muscle activity, 3) impaired muscle glucose utilization, and 4) diabetes, this low force activation protocol may present a novel strategy to mitigate the incidence of metabolic disease in a convenient and safe manner.

**TITLE:** The Relationship between Pedometer Feedback and Gait Speed Improvements in Acute Stroke Rehabilitation- Preliminary Results

**AUTHORS/INSTITUTIONS:** S. Keller, M. Burns, D. Zielke, E. Cohee, E. Hanson, K. Ruroede, Marianjoy Rehabilitation Hospital, Wheaton, Illinois, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The goals of this study are to measure the total number of steps taken per day by a patient in acute stroke rehabilitation, to determine if a relationship exists between the number of steps taken daily and gait speed improvements, and to evaluate the feasibility to utilize pedometers to provide feedback to the patient. The authors hypothesis is that the use of low-cost pedometers will provide increased monitoring and external cues for increasing steps per day in the acute stroke rehabilitation population.

**Number of Subjects :** These preliminary results cover the first eight patients in the study with a goal of monitoring at least 100 participants. All patients to date are male with a mean age of 71 years (SD=13.9 years).

**Materials/Methods :** All patients admitted to the stroke unit of an acute inpatient rehabilitation hospital are evaluated for appropriateness and only patients admitted following a stroke per medical record were included in the study. Once a patient reaches the ability to ambulate 50 feet at minimal assistance or better in physical therapy, the patient's gait speed is assessed with the 10 meter gait speed test and they are issued a pedometer to wear throughout the day. Total steps per day are recorded via the pedometer each day until discharge while continuing to participate in the traditional rehabilitation program. The patient's gait speed is assessed within 72 hours of discharge with the 10 meter gait speed test.

**Results :** The patients ambulated an average of 1321 steps per day (range of 270-3034 steps per day, SD= 901 steps) during the monitoring period. The patient's gait speed improved an average of .3 m/s via the 10 meter gait speed test (range of .01-.6 m/s, SD=.2 m/s; t=-4.115, p=.004).

**Conclusions :** The preliminary results of this study revealed an increased focus on daily ambulation in both therapy sessions and on the nursing unit improving carryover of gait training from therapy. There was a statistically significant improvement in gait speed noted during the monitoring period. One limitation of the study is the knowledge that the pedometer readings have fluctuated day to day with some fluctuations being greater than patient presentation in therapy sessions. However, while the readings may not be the most accurate due to the low-cost technology, patients and other members of the inter-disciplinary team have been utilizing the pedometer number of steps per day to encourage increased ambulation outside of therapy sessions.

**Clinical Relevance :** Patients following stroke need increased stepping practice throughout the day. A pedometer worn throughout the day to encourage increased ambulation in the therapy gym and on the nursing unit could be a low-cost, effective method of monitoring and feedback. The low cost nature of this technology could also allow patients to utilize a pedometer following discharge to further encourage increased steps per day and mobility following rehabilitation.

**TITLE:** Gait Speed Reserve is Associated with Balance Measures following Chronic Stroke

**AUTHORS/INSTITUTIONS:** M. Lewek, UNC-Chapel Hill, Chapel Hill, North Carolina, UNITED STATES|C. Husted, UNC Health Care, Chapel Hill, North Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The ability to increase gait speed to walk at a faster than comfortable self-selected speed is important for everyday functioning. Individuals who walk at speeds close to their maximum gait speed capacity may not be able to go any faster, in part, due to poor balance and balance confidence. The purpose of this study is to determine the relationship between the ability of an individual to increase gait speed above a comfortable self-selected speed (gait speed reserve) and their balance following chronic stroke. It was hypothesized that individuals that have little increase from the comfortable to fast gait speed would display poorer balance.

**Number of Subjects :** 27 subjects with chronic stroke and comfortable gait speed (CGS) < 1.0 m/s (17M/10F, 60 ± 11 years old, 44 ± 34 months post stroke) that were part of a larger ongoing trial.

**Materials/Methods :** Following a familiarization session for gait speed testing, subject were assessed with the use of a GaitRite to determine both comfortable (CGS) and fast gait speeds (FGS). Subjects were instructed to first ambulate at their comfortable, everyday speed and then as fast as they felt safe. Assistive devices and orthotics were permitted, but no physical assistance was provided. The difference between the CGS and FGS was calculated as the gait speed reserve. A battery of balance measures including the Berg Balance Scale (BBS), Four Square Step Test (4STT), and Functional Gait Assessment (FGA) was then performed. A Pearson correlation was used to determine the relationship between gait speed reserve and the 4SST. Spearman rank correlations were used to assess the relationship between gait speed reserve and the BBS and FGA.

**Results :** Overall, subjects had a gait speed reserve of 0.13 ± 0.13 m/s. All three balance measures demonstrated strong correlations with gait speed reserve. Gait speed reserve was positively associated with the BBS ( $r_s=0.787$ ;  $p<0.001$ ) and the FGA ( $r_s=0.796$ ;  $p<0.001$ ). The 4STT had a negative association with gait speed reserve ( $r=-0.559$ ;  $p=0.002$ ).

**Conclusions :** Individuals that demonstrated a smaller gait speed reserve had worse balance.

**Clinical Relevance :** Following chronic stroke, those that had more impaired balance demonstrated less capacity to change gait speed to ambulate at a faster speed than their comfortable, self-selected speed. This indicates that they are already ambulating near their maximum speed, in part, due to their impaired balance, gait instability, and likely fear of falling. Addressing balance deficits during training may help to increase gait speed reserve in individuals with chronic stroke.

**TITLE:** Vestibular Rehabilitation Protocol following Surgical Repair for Superior Canal Dehiscence Syndrome

**AUTHORS/INSTITUTIONS:** W. Carender, M. Grzesiak, Dept of Otolaryngology, University of Michigan Health System, Ann Arbor, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose :** Superior Canal Dehiscence Syndrome (SCDS) is a disorder that causes both auditory and vestibular symptoms. Following surgical repair of SCDS, patients often experience symptoms of dizziness and imbalance. At the University of Michigan Health System, we have developed and implemented a post-operative vestibular exercise program that focuses on the principles of central compensation and habituation. The purpose of this case report is to describe the specific post-operative exercise protocol and how it was modified for a patient with slow progress secondary to visual vertigo, suspected to be related to his previous history of strabismus.

**Description :** A 63 year old male with head CT positive for right superior semicircular canal dehiscence and right encephalocele in the posterior epitympanum presented with right side hearing loss, aural fullness, and sensitivity to loud sounds. Pre-operatively, he was evaluated and educated in the SCDS protocol which consisted of adaptation exercises including VOR x 1 in the horizontal and more importantly in the vertical plane; habituation head movements in horizontal, vertical and diagonal planes; and balance and gait exercises. He was instructed to perform the exercises three times per day while limiting the intensity of the dizziness to a level of 2-3 on a 5 point scale. He was seen for a total of six visits over the course of nine months. Additional vision/vestibular exercises including Near/Far Targets, VORc and VOR x1 with complex background were added to address his additional symptoms of visual vertigo.

**Summary of Use :** Outcomes: Patient initially presented to pre-op Vestibular PT evaluation with no report of dizziness or imbalance. His Dizziness Handicap Inventory Score (DHI) was 0/100, balance on compliant foam surface was 30 seconds eyes open and closed, Timed Up & Go (TUG) Score was 8.78 seconds, Dynamic Gait Index Score was 24/24 and there was a 2 line difference in Dynamic Vision at 2 Hz. Two weeks post-operatively, he returned to Vestibular PT. Outcome measures at that time were as follows: DHI 38/100, balance on foam with eyes open was 30 seconds but was limited to 6 seconds with eyes closed, TUG Score was 9.92 seconds, DGI was 16/24, there was a 3 line difference in DVA, and he reported motion sensitivity rated 2/5 with head movements in the yaw plane and 3/5 with head movements in the pitch plane. At discharge, DHI had improved significantly to 18/100, balance on compliant foam surface was 30 seconds eyes open or closed, TUG improved to 6.87, DGI improved to 23/24 (rail used on stairs for safety) and there was only a 1 line difference in DVA. He was able to return to work, driving and all of his recreational activities.

**Importance to Members:** Vestibular exercises focusing on adaptation, habituation, balance, and walking can be both functionally and symptomatically beneficial following surgical repair for SCDS and should be implemented into post-op vestibular exercise programs.

**TITLE:** An Observational Analysis of the Amount of Practice Performed by Individuals with Traumatic Brain Injury during Intensive Mobility Training

**AUTHORS/INSTITUTIONS:** S. Callahan, D.M. Liuzzo, D.M. Peters, A. Middleton, S.L. Fritz, Exercise Science, University of South Carolina, Columbia, South Carolina, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to determine if Intensive Mobility Training (IMT) resulted in higher amounts of practice compared to traditional physical therapy (PT) for individuals with TBI.

**Number of Subjects :** Seven participants with chronic TBI (mean time since TBI: 11.3±9.2 year; mean age: 37±15.3 years) participated in the study.

**Materials/Methods :** During the intervention phase, participants completed a total of 20 days of IMT. Each IMT session included approximately 150 minutes of therapy split equally among three primary areas: 1) gait training on a body weight supported treadmill, 2) balance, and 3) strength/ ROM/ coordination. Interventions were patient specific addressing the functional limitations experienced by the participants. Video recordings were taken of day 1, 11, and 20. Repetitions were counted and sorted into nine categories: passive exercise, active exercise, functional activity, sensory, gait, transfers, balance, stairs, and other.

**Results :** IMT protocol resulted in an average total number of repetitions per session of 7283.5 ± 2176.43, with an average total number of repetitions per minute of 42.45 ± 14.08. The gait category had the highest number of repetitions per session (5200 ± 1458) and per minute (34.33 ± 12.18) opposed to 13.13 repetitions per minute with traditional physical therapy. Upper extremity categories were under-represented from the nature of the interventions provided; however, these interventions were more likely to be included in the functional activity category.

**Conclusions :** IMT resulted in higher repetitions per minute than traditional PT treatment in upper extremity functional movements, total lower extremity repetitions, and gait. As a result, IMT may prove to be a valuable treatment modality to increase practice in individuals with TBI.

**Clinical Relevance :** When performing an intensive rehabilitation program, such as IMT, individuals with TBI can perform higher numbers of repetitions compared to traditional physical therapy.

**TITLE:** Decreasing reliance on harness support in a reactive balance training protocol.

**AUTHORS/INSTITUTIONS:** D.D. Espy, A. Reinthal, S.M. Grosel, R. Lightfoot, Physical Therapy, Cleveland State University, Cleveland, Ohio, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** There is evidence for the transfer of reactive balance training (in the form of repeated slips) to improved responses to slipping in the 'real world' and greater fall resistance among older adults. In fact, reactive balance training may be more effective at fall prevention long term than proactive balance training. Clinically feasible reactive-balance training programs require much more complex equipment in order to provide standardized, well controlled perturbations, as well as additional safety and patient reassurance measures. In particular, reactive balance training programs often require harness support for patient safety or confidence. The harness can provide a sense of confidence, but it can also provide real external assist and support that the individual may rely upon in learning the balance recovery task. This support would not be available in a real world slip, therefore adaptation to and learning of the balance recovery task must include decreasing reliance on the harness in order to transfer to greater fall resistance in general. The purpose of this study was to investigate the degree to which adaptation to and accomplishment of the balance recovery task in a repeated slip protocol includes reliance on the harness for support.

**Number of Subjects :** Eleven

**Materials/Methods :** Subjects underwent 5 repeated slips induced by a posterior (relative to the subject) surface translation, standardized to each subject's body weight and leg length. All wore a support harness throughout. The distance a subject could descend in the harness was standardized and the force exerted by the subject through the harness was measured by a load cell in series with it. Subjects were unable to come to rest on the surface with any body part except their feet (i.e., they were unable to truly fall). Thus, the force through the harness (threshold = 30% of body weight) was used to determine a fall.

**Results :** Five subjects did not fall on any slip. Their harness forces remained consistent across trials (range of no more than 8%). Six subjects fell on the first slip: 3 adapted to recover, with a pattern of decreasing harness forces over the 5 trials (22, 27, and 34% decrease); 2 continued to fall over all 5 trials, but with decreasing harness forces (22 and 19% decreases). One subject maintained high harness forces across all 5 trials.

**Conclusions :** Our study demonstrated decreasing reliance on the harness for support through the adaptation and learning of the fall resisting task for those subjects who fell initially. Those subjects who did not fall initially, demonstrated consistent and low forces through the harness throughout.

**Clinical Relevance :** Reactive balance training protocols can be clinically important in training for fall resistance, but they often require harness support throughout. Our study demonstrated decreasing reliance on the harness for support through adaptation and learning of the fall resisting task, which is important for the transfer of the balance training to real world fall prevention in which no harness is available.

**TITLE:** Sympathetic activation through whole body heat stress: Impact on muscle force and spinal cord excitability  
**AUTHORS/INSTITUTIONS:** C. Yen, R. Shields, Physical Therapy & Rehabilitation Science, University of Iowa, Iowa City, Iowa, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** We previously reported that whole body heat stress increases sympathetic nerve activity (Heart Rate) and increases the release of catecholamines (norepinephrine) into the blood. Enhanced sympathetic activity is thought to augment muscle force through an adrenergic to calcium release pathway in skeletal muscle. We sought to determine if passive heat stress “primes” skeletal muscle by enhancing the force generating properties. In addition, we explored the extent to which passive whole body heat stress modulates spinal cord excitability. A secondary interest was to ascertain if males and females respond similarly to passive heat stress, given known variants in adrenergic-estrogen signaling. Specifically, we determined the effects of whole body heat stress on muscle twitch potentiation and H-reflex suppression in both males and females. We hypothesized that 1) adrenergic activation by prior heat stress would increase the muscle force and spinal excitability, and 2) prior heat stress would increase muscle force in females compared to males.

**Number of Subjects :** 16 (8 females)

**Materials/Methods :** Healthy young adults participated in the control (Control) and whole body heat (Heat) sessions on two different days, separated by one week. In each session, subjects underwent motor function and spinal excitability measurements before and immediately after either 30-min Control (22 °C) or Heat (82 °C) session. Motor function and spinal excitability measurements included maximal voluntary quadriceps contractions (MVC), quadriceps twitch torque, and paired pulse H-reflexes. A two-way repeated measures ANOVA was used to compare differences across two sessions and two time points. The independent t test was used to compare the differences between groups who received high and low stress (Heart Rate), and between males and females.

**Results :** MVC, twitch torque and H reflex suppression did not differ between Control and Heat sessions ( $P > 0.41$ ,  $0.11$ ,  $0.15$ , respectively). The magnitude of the stress, as measured by heart rate, did not explain the lack of change between Control and Heat ( $P > 0.41$ ,  $0.11$ ,  $0.24$ , respectively). There was a significant effect on SEX as females showed a higher normalized twitch torque after heat stress compared to the males ( $P = 0.04$ ).

**Conclusions :** Whole body heat stress modulates the quadriceps twitch torque in females, but does not regulate spinal cord excitability or the ability to perform a MVC in males or females.

**Clinical Relevance :** Whole body heat stress “primes” the CNS to enhance motor learning (Littmann and Shields, 2013). In this study we show that whole body heat stress minimally modulates spinal cord excitability and skeletal muscle force enhancement. Taken together, whole body heat stress may assist female patients who are not able to exercise due to immobility induced by neurological or orthopedic complications.

**TITLE:** Sitting balance measures in non-ambulating individuals diagnosed with multiple sclerosis: determining the existence of a correlation between the Function in Sitting Test and SMART Equi Test®.

**AUTHORS/INSTITUTIONS:** B. Baker, M. Casterline, J. Decker, M. Vanden Berg, physical therapy, grand valley state university, Grand Rapids, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Determine existence of a correlation between the FIST and SMART EquiTest® in non-ambulating individuals with MS.

**Number of Subjects :** : 9 subjects

**Materials/Methods :** : 9 subjects were recruited and passed inclusion and exclusion criteria pertaining to level of function with MS. FIST and SMART EquiTest testing were performed per documented protocols in random order for each subject. Data was collected and analyzed using SPSS 18 statistical software.

**Results :** Results: This study found a good to excellent correlation (0.892,  $p=0.003$ ) between FIST and SMART EquiTest® across 8 subjects, after removal of one subject who was a qualitative outlier. Across all subjects this study found a moderate to good correlation (0.591,  $p=0.094$ ). Dynamic sitting tasks and scooting tasks on the FIST were found to have a stronger correlation with the SMART EquiTest® than static and reactive sitting items on the FIST.

**Conclusions :** Conclusions: There is a good to excellent correlation between the FIST and SMART EquiTest® when measuring dynamic sitting in the non-ambulating population with MS. Therefore, either test can be effectively used to assess sitting balance in this specific population.

**Clinical Relevance :** : Multiple Sclerosis (MS) is a progressive demyelinating disease affecting over 2.1 million Americans. One-third of these individuals will require future wheeled mobility, which requires sitting balance for postural maintenance. There is currently a dearth of evidence on objective sitting balance measurement tools for persons diagnosed with MS.

**TITLE:** The Influence of Computerized Cognitive Training on Gait Speed in Older Adults

**AUTHORS/INSTITUTIONS:** J. Blackwood, T. Houston, University of Michigan-Flint, Flint, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** In older adults, cognition is one significant component in the multifactorial approach to fall risk and prevention, and older adults with cognitive impairments fall more frequently than those who are cognitively intact. Prior researchers have identified a strong association between Executive Function (EF) and mobility impairments in older adults. Specifically, changes in gait speed (GS), a clinically-relevant functional mobility assessment, have been reported in older adults with deficits in EF. Non-pharmacological approaches to address cognitive deficits have included computerized cognitive training (CCT) and researchers have reported a transfer effect of training into functional activities including ADLs and GS. However research investigating the effects of CCT in those who walk slower (GS <1.0m/sec) is lacking. The purpose of this study was to compare the effects of six weeks of CCT, focused on the EF domains of set shifting, attention, and visual spatial ability, on GS in a group of community dwelling older adults.

**Number of Subjects :** 20

**Materials/Methods :** Twenty community dwelling older adults (slow gait speed group: N=10; fast gait speed group N=10) participated in six weeks of CCT at 3x/wk (15-20 minutes/session) with measurements at pre/post intervention. Older adult subjects age 65 or older were recruited from senior centers who met inclusion/exclusion criteria. Pre and post-test measures included GS, EF via the Trail-Making Test Part B (TMT-B), and mild cognitive impairment via the Montreal Cognitive Assessment Tool (MoCA). CCT was performed using 4 games emphasizing the EF domains of set-shifting, attention, and visual spatial ability. In the analyses, participants were divided into two groups based on pretest walking speeds: slower walkers (<1.0 m/s) and faster walkers ( $\geq 1.0$  m/s). Descriptive statistics and post-test group wise comparisons of GS and the cognitive measures were performed using Mann Whitney U.

**Results :** At pre-test, the groups did not differ in age, education level, or in the performance on the cognition assessments. At post-test, subjects in the slow gait speed group demonstrated a statistically significant improvement in gait speed after CCT (Mdn=.65,  $z = -3.1$ ,  $p = .002$ ). Posttest measures of cognitive function were not significantly different for the TMT-B ( $p = .151$ ) nor the MoCA ( $p = .939$ ).

**Conclusions :** Results of this study expand our understanding of how cognitive interventions influence function as slower walkers who participating in a six week CCT program had a statistically significant improvement in gait speed. Future studies are needed to examine how other frequencies of CCT affects physical function and potentially, fall risk including examinations of the association between gait speed and early cognitive loss.

**Clinical Relevance :** Non-pharmacological approaches to cognitive deficits which are associated with GS may result in improved mobility, however but further study is warranted.

**TITLE:** The effects of exercise on physical, psychosocial, and cardiovascular functioning in individuals with mild to moderate intellectual disabilities.

**AUTHORS/INSTITUTIONS:** A. Donato, K. Grande, N. Greene, B. Mooney, M.D. Ross, Department of Physical Therapy, University of Scranton, Scranton, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Some authors have advocated that for adults with intellectual disability, participation in exercise programs has positively impacted physical performance and psychosocial functioning. The purpose of this systematic review was to examine the effects that exercise has on the physical, psychosocial, and cardiovascular functioning of individuals with mild to moderate intellectual disabilities.

**Number of Subjects :** N/A

**Materials/Methods :** Articles were selected following a comprehensive search of 4 databases (PubMed, CINAHL, ProQuest and Google Scholar) for randomized control trials (RCTs) published from January 1990 to January 2014. Inclusion criteria involved individuals with Down Syndrome or mild to moderate intellectual disabilities, men or women 18 years of age and older, and RCTs examining the effects that exercise has on the physical, psychosocial, and cardiovascular functioning. Exclusion criteria involved individuals with intellectual disabilities less than 18 years of age. Three independent reviewers used the validated Physiotherapy Evidence Database (PEDro) scale to evaluate the methodological quality of the included studies.

**Results :** Sixteen studies met the inclusion criteria of this systematic review. The mean PEDro quality score was 6.3 with a standard deviation of 1.5 and range from 5 to 8. Of the 453 individuals included in these studies, 293 individuals received an exercise intervention and 160 individuals served as controls. The age range of these individuals was 18-65 years of age with a mean age of 37.9. Intervention studies included a variety of different types of physical activities, including walking, bicycle ergometry, dancing, resistance training of the upper and/or lower body, balance activities, and plyometric activities. The most commonly assessed outcomes included muscle strength, endurance, balance, anxiety, and quality of life. Notable evidence revealed that physical activity positively affected physical fitness, psychosocial attributes, and cardiovascular health. While several studies demonstrated significant improvements in muscle strength and balance with a variety of different training activities, the two studies that examined cardiovascular functioning following aerobic training demonstrated significant improvements in heart rate and peak VO<sub>2</sub> rates. In general, significantly greater improvements in anxiety and overall quality of life were seen for individuals who participated in exercise interventions compared to controls. There were no adverse effects on the participants in any of the studies.

**Conclusions :** Based on the finding of this systematic review, there is evidence to support the physical, psychosocial, and cardiovascular benefits of exercise on individuals with mild to moderate intellectual disabilities.

**Clinical Relevance :** Health maintenance through regular physical activity is vital for adult individuals with intellectual disabilities. Further research is needed to determine optimal exercise programming and dosages for individuals with intellectual disabilities.

**TITLE:** Identifying the brain region responsible for acute hypertonicity in patients diagnosed with a cerebrovascular accident

**AUTHORS/INSTITUTIONS:** K. Perry, S.D. Purdy, Physical Therapy, University of Tennessee at Chattanooga, Chattanooga, Tennessee, UNITED STATES|S. Barlow, Siskin Hospital for Physical Rehabilitation, Chattanooga, Tennessee, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Increased muscle hypertonicity (MH) is a common impairment found in patients that have been diagnosed with a cerebrovascular accident (CVA). Very little is known about the mechanism(s) responsible for causing this problem at the level of the brain. Interestingly, the onset time of MH varies considerably in this patient population. There is a small population of patients that have increased tone within two weeks following their CVA. Other patients may take three to six months before they experience the onset of MH. No information is available in the literature regarding the difference between these two patient populations. The purpose of my research is to determine the location of neurological insult in the brain of patients that have onset of MH within two week following their CVA. My hypothesis is that there will be an overlapping area of damage discernible on the MRIs of patients that have increased tone acutely post CVA.

**Number of Subjects :** Inclusion criteria: 1) the patient was less than 14 days post their first CVA, 2) the CVA was ischemic but not hemorrhagic 3) an MRI was performed to diagnose the CVA and 4) the patient had no past medical history of a neurological diagnosis. Patients (45) that had increased tone acutely following a CVA comprised the experimental group and patients (45) that did not have increased tone acutely constituted the control group.

**Materials/Methods :** This was a retrospective study. Rehabilitation Admission Assessments previously recorded by licensed physical and occupational therapists at Siskin Hospital for Physical Rehabilitation were examined for patients that had a primary diagnosis of a CVA. Any increase in tone designated by  $> 1$  on the Modified Ashworth scale was also recorded. Radiologist's impressions of MRIs that were taken to diagnose the CVA were analyzed for areas of neurological damage. All areas of damage noted by the radiologist were recorded. The data were grouped into discrete areas of the brain and the frequency of appearance of each area was determined. A chi-square analysis was used to determine if the frequency of appearance of a particular brain region correlated with increased MH acutely after CVA.

**Results :** Of the 449 Rehabilitation Admission Assessments examined, only 45 of these (10%) met the inclusion criteria and had acute MH. Interestingly two areas of the brain are consistently affected in patients that demonstrate MH acutely after CVA, the basal ganglia (47%) and the pons (24%). A chi-square test was performed to examine the relation between lesion location and presentation of acute MH. The relation between these variables was significant,  $X^2(2, N = 90) = 25.938, p < .01$ .

**Conclusions :** The results of this study suggest that the basal ganglia and pons are consistently affected in patients that have increased MH acutely following ischemic infarct.

**Clinical Relevance :** These results will provide researchers with novel areas that could be targeted for future pharmacological therapy.

**TITLE:** Bimanual coordination for functional tasks in patients with stroke: Kinematic analyses and role of sensory-motor impairments

**AUTHORS/INSTITUTIONS:** S. Katak, N. Zahedi, R.L. McGrath, Neuroplasticity and Motor Behavior Laboratory, Moss Rehabilitation Research Institute, Elkins Park, Pennsylvania, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The aim of the study was to compare bimanual coordination patterns in patients with stroke as they performed a symmetric and asymmetric functional activity with those in age-matched controls. We hypothesized that patients with stroke will demonstrate significant deficits in asymmetric, but not symmetric functional bimanual tasks compared to age-matched controls.

**Number of Subjects :** 12 patients with mild- to- moderate impairments (Fugl-Meyer 30-55) after unilateral stroke and 8 control participants participated in the study.

**Materials/Methods :** Participants performed 20-trial block of each of the three tasks: (1) unimanual goal-directed reaching task (UNI), (2) symmetrical bimanual task (BISYM) which comprised of picking a box using both hands, and (3) asymmetrical bimanual task (ASYM) which comprised of opening a drawer with their non-paretic hand and pressing a button with their paretic hand. Trajectories of each hand were recorded using a 3-D motion recording system with 2 electromagnetic sensors placed on the dorsum of each hand. Kinematic measures included: movement time (MT), maximal velocity (Vmax), directness of trajectory (DT) measured as trajectory/distance ratio. To quantify spatiotemporal coordination in bimanual tasks, cross-correlation analyses (CCA) between velocity profiles of each hand yielded a correlation coefficient (r- spatial coordination) and time-lag (temporal coordination).

**Results :** Both healthy controls and patients with stroke demonstrated strong spatial and temporal coordination for BISYM task. In contrast, for the ASYM task, controls demonstrated greater temporal and spatial coordination compared to the patients, who demonstrated a significantly greater time-lag between the paretic and non-paretic hand ( $p < 0.05$ ). Importantly, time-lag between the two hands in patients with stroke strongly correlated with Vmax for the UNI task and Fugl-Meyer score of the paretic arm. More severe patients demonstrated fragmented pattern of execution: they opened the drawer completely before even beginning to reach to press the button, leading to longer time lags.

**Conclusions :** Our results demonstrate a task-based dissociation in bimanual coordination in patients post-stroke. Patients post-stroke demonstrate deficits in coordination of two arms during execution of an asymmetric, but not symmetric bimanual task. This deficient coordination is in part, explained by the degree of motor impairment and deficits in unimanual control.

**Clinical Relevance :** Most, if not all activities of daily living, require some degree of collaboration between two hands. With many rehabilitation interventions focusing on bilateral symmetric (e.g. BATRAC) or unilateral (CIMT) training, little is known about control and coordination of bimanual asymmetric functional activities. Rehabilitation interventions and outcome measures should incorporate bimanual asymmetric activities. Quantitative kinematic analyses may offer greater insights in to the control and coordination of bimanual activities

**TITLE:** Physical Therapy Intervention for Surfer's Myelopathy: A Case Report

**AUTHORS/INSTITUTIONS:** J. Mathew, L. Chowansky, Physical Therapy, Rusk Institute of Rehabilitation, New York, New York, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Surfer's Myelopathy is a rare, non-traumatic spinal cord injury that affects first time surfers. It is triggered by prolonged hyperextension of the back, causing ischemic injury to the spinal cord; there are only 10 reported cases since first described in 2004.<sup>1,2</sup> Symptoms may be severely disabling to the individual, resulting in back discomfort, variable motor-sensory involvement, and urinary incontinence with recovery ranging from complete return of function to persistent paraplegia.<sup>3,4</sup> Currently there is a lack of literature on physical therapy management and rehabilitation to improve clinical outcomes. This single case report follows a patient with Surfer's Myelopathy from admission in an acute inpatient rehab to discharge from outpatient physical therapy. The purpose of this case study report is to describe the benefits of early and intensive rehabilitation in an individual with Surfer's Myelopathy.

**Case Description :** This is the case of a 15 year old male diagnosed with Surfer's Myelopathy less than one year ago. The patient was admitted to an acute care hospital following subjective report of pain in the lower back and report of lower extremity weakness while receiving a surfing lesson. Symptoms progressed to difficulty walking and being unable to stand. Upon examination in acute care, thoracic MRI showed abnormal signal within the central cord from T8-T11 and a small central disc protrusion at C-C6 without mass effect on the spinal cord. Following a one-week acute care hospitalization the patient was transferred to pediatric acute inpatient rehabilitation for 11 weeks, receiving 1.5-2 hours of physical therapy sessions a minimum of five out of seven days per week. Physical therapy sessions focused on transfer training, seated and standing static and dynamic balance, lower extremity stretching and strengthening, core strengthening through functional mobility, RT300 FES lower extremity cycle and extensive gait training including treadmill training using body weight support (BWSTT) and robotic assisted gait training on the Lokomat. The patient continued physical therapy in the outpatient setting with an emphasis on robotic assisted gait training utilizing the Lokomat for a total of 18 sessions for 35-40 minutes.

**Outcomes :** At discharge, the patient demonstrated significant improvements in all functional mobility including standing, walking, and ability to negotiate stairs. Gait endurance and functional exercise capacity improved from 278.71 meters to 446.95 meters on the 6 Minute Walk Test (6MWT). Gait speed improved from 0.83 m/sec to 1.3 m/sec at discharge.

**Discussion :** Current evidence of physical therapy management and treatment of individuals with Surfer's Myelopathy is limited due to the rarity of diagnosis. This case study report demonstrates the effectiveness of early mobilization and intensive physical therapy in addition to a range of interventions utilized to maximize this patient's functional outcomes.

**TITLE:** Emphasis of cognitive stimulation as an adjunct to traditional vestibular rehabilitation to facilitate recovery from concussion.

**AUTHORS/INSTITUTIONS:** M. Hippler Brant, P. Lanter, St. John Medical Center, Westlake, Ohio, UNITED STATES|J.G. Keehan, Cleveland State University, Cleveland, Ohio, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** A concussion is a form of a mild traumatic brain injury. An estimated 1.6 to 3.8 million athletes are diagnosed with a concussion each year. Most concussions occur without a loss of consciousness and result in time off from a sport prior to receiving medical clearance to return to play. A graded exercise protocol and vestibular rehabilitation are common in the return to play process based on the athlete's symptoms. The purpose of this case study is to examine the potential role of cognitive stimulation to facilitate concussion recovery.

**Case Description :** The patient was a 16 year old female athlete who sustained a concussion while playing volleyball. The patient was referred to the Concussion Clinic by the High School Athletic Trainer for further evaluation and subsequent medical clearance. The initial physical therapy evaluation consisted of the administration of the Sport Concussion Assessment Tool 3 including a symptom, balance and cognitive assessment. The patient's initial symptom score was 14/22 with a severity score of 41/132. A comprehensive vestibular and oculomotor assessment was also performed. The patient was seen for 7 follow up visits where she was prescribed a home exercise program including smooth pursuit, gaze stabilization, saccades, tandem stance with eyes closed, single leg stance with eyes closed and cognitive stimulation through an online game. The patient was progressed through a graded exercise return comprised of 6 steps incorporating light to moderate aerobic activity with vestibular challenges, sport specific activities, standardized balance and cognitive assessments.

**Outcomes :** The Sensory Organization Test on the Neurocom Computerized Dynamic Posturography machine and the ImPact Neurocognitive Test were utilized along with the SCAT 3 to determine the athlete's readiness to return to play. The SOT demonstrated an improvement from a composite score of 67 initially to 85. The cognitive efficiency index of the ImPact test was 0.34 at baseline and 0.54 post injury. The test was readministered after cognitive stimulation was introduced and the score improved to 0.33.

**Discussion :** The patient had progressed through the return to play protocol without adverse reaction. The patient was instructed on vestibular exercises throughout to facilitate recovery and cognitive stimulation was introduced when the patient's SOT scores were below the composite score of her peers. After performing cognitive stimulation in conjunction with vestibular exercises, the patient's scores improved in all the assessment measures. Cognitive stimulation appears to play a vital role in concussion recovery particularly when the athlete struggles to return testing scores to baseline.

**TITLE:** Prediction in the VOR is not as useful in chronic vestibular hypofunction

**AUTHORS/INSTITUTIONS:** M.C. Schubert, Y. Agrawal, Otolaryngology Head and Neck Surgery, Johns Hopkins University, Baltimore, Maryland, UNITED STATES|G. Mantokoudis, Department of Neurology, Johns Hopkins University, Baltimore, Maryland, UNITED STATES|S. Lee, Department of Neurology, Chonnam National University Medical School, Chonnam National University Medical School, Gwangju, KOREA, DEMOCRATIC PEOPLE'S REPUBLIC OF

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To describe differences in prediction as measured during inward vs. outward head impulses (HIT). We hypothesized that inward HIT would show a vestibular and saccadic oculomotor advantage for ipsilesional head impulses compared with outward directed impulses in both the immediate postoperative and chronic recovery stages after unilateral vestibular deafferentation (UVD) from vestibular schwannoma resection.

**Number of Subjects :** Seven subjects with acute UVD, five subjects with chronic UVD, and 3 healthy controls.

**Materials/Methods :** We recruited patients with unilateral vestibular schwannoma who were scheduled to undergo tumor resection via retrosigmoid approach. Eye and head rotations for the patients in the acute stage (pre, POD 2-5 and POD 30) of the study were measured with a portable video-oculography goggle system (EyeSeeCam, Munich, Germany) with a high speed infrared camera (250 Hz) and built-in accelerometer. Eye and head rotations for the patients in the chronic stage (> 3 months) were measured using the scleral search coil system. For both stages, we measured the horizontal vestibulo-ocular reflex (VOR) gain and various compensatory saccade metrics during passive ipsilesional head impulses that were either directed towards or away from center.

**Results :** There was no functional differences in VOR gain for inward or outward ipsilesional head impulses in patients with acute or chronic UVD. In acute UVD, overt saccades appeared first, followed by covert saccades. For outward HIT, the mean compensatory saccade latency (overt and covert) initially was  $196.94 \pm 8.6\text{ms}$ ,  $p < 0.0001$ ), and continued to decline on average about  $13.46 \pm 2.0\text{ms}$  ( $p < 0.0001$ ) per day after surgery. Inward directed HIT included saccade latencies that were on average  $13.25 \pm 4.5\text{ms}$  shorter than those during outward HIT ( $p = 0.0033$ ). By POD 30, there was no difference in saccade latencies for outward vs inward HIT ( $7.6 \pm 4.3\text{ms}$  latency difference,  $p = 0.077$ ). In chronic UVH, compensatory saccade latencies were longer for inward vs outward ipsilesional head rotation ( $p < 0.03$ ).

**Conclusions :** For acute and chronic UVD, the direction of the HIT has no relevance on VOR. In acute UVH, compensatory saccades reduce in latency over the 1st post-operative week. This appears to transition with recovery such that inwardly directed ipsilesional HIT have compensatory saccade latencies (overt and covert) that are longer than those during outward HIT. For chronic UVD, inward applied HIT are more likely to include an overt compensatory saccade based on their lengthened latency, contrary to what one might presume to be a 'predictable' direction. Inward directed HIT may therefore improve sensitivity of the clinical HIT in chronic unilateral vestibular loss.

**Clinical Relevance :** Clinicians treating inpatients with UVD may examine the VOR with inward or outward directed HIT. An inward applied HIT may 1. be more sensitive to identify a VOR deficit based on the lengthened latency of the compensatory saccade; 2. reduce the impact of nystagmus on HIT interpretation and 3. reduce the risk of cervical complaints.

**TITLE:** The association between subjective fatigue measured by the MFIS and objective measures of cognitive and physical fatigue and subjective sleep quality in individuals with multiple sclerosis

**AUTHORS/INSTITUTIONS:** M. Aldughmi, P. Dowling, S. Billinger, C.F. Siengsukon, KU Physical Therapy and Rehabilitation Sciences, The University of Kansas Medical Center, Kansas City, Kansas, UNITED STATES|J. Bruce, Psychology Department, University of Missouri Kansas City, Kansas City, Missouri, UNITED STATES|S.G. Lynch, Neurology Department, University of Kansas Medical Center, Kansas City, Kansas, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Fatigue is the most frequent symptom experienced by 90% of individuals with MS and is often difficult to assess and treat. Physical and cognitive fatigue are two distinct components of fatigue that need to be assessed in people with MS. Sleep disturbances are also very common and are associated with increased fatigue among individuals with MS. The purpose of this study was to examine the relationship between objective measures of cognitive and physical fatigue and subjective sleep quality with subjective fatigue assessed using the Modified Fatigue Impact Scale (MFIS), which is considered the gold standard instrument to assess subjective fatigue in people with MS.

**Number of Subjects :** Twenty-two individuals with relapsing-remitting or secondary-progressive MS ( $48.91 \pm 7.73$  years of age) participated in this study.

**Materials/Methods :** Participants completed questionnaires to assess subjective fatigue (MFIS) and sleep quality [Pittsburgh Sleep Quality Index, (PSQI)]. Cognitive fatigue was assessed objectively using the Paced Serial Addition Test (PASAT) and the Symbol Digit Modalities Test (SDMT), and physical fatigue was assessed objectively using the six minute walk test (6MWT). Pearson's correlations were utilized to examine the associations between the outcome measures of interest.

**Results :** There was a strong negative correlation between the PASAT and the MFIS total score ( $r = -.466$ ,  $p = .052$ ) and a moderate negative correlation between the SDMT and the MFIS total score ( $r = -.395$ ,  $p = .104$ ). The PASAT and the SDMT also showed moderate negative correlations with the cognitive component of the MFIS ( $r = -.366$ ,  $p = .135$  and  $r = -.356$ ,  $p = .147$  respectively). There was a negligible negative correlation between the 6MWT and the MFIS total score ( $r = -.174$ ,  $p = .491$ ), but the 6MWT had a moderate negative correlation with the physical component of the MFIS ( $r = -.332$ ,  $p = .178$ ). There was a weak positive correlation between the PSQI and the total score of the MFIS ( $r = .212$ ,  $p = .413$ ).

**Conclusions :** This study demonstrates that the total MFIS score adequately captures cognitive fatigue but does not adequately capture physical fatigue or the sleep component of fatigue in people with MS. However, the components of the MFIS adequately capture the cognitive and physical components of fatigue, respectively. The lack of statements assessing how sleep issues contribute to subjective fatigue in the MFIS likely contributes to the weak association between sleep quality and the MFIS. However, to capture the multidimensional nature of fatigue in people with MS, cognitive fatigue, physical fatigue, and the contribution of sleep to fatigue all must be assessed. A larger study is needed to verify the findings of this study.

**Clinical Relevance :** The MFIS may be limited in the ability to assess the multidimensional fatigue that is experienced by people with MS. Also, the contribution of sleep to fatigue must be considered in people with MS.

**TITLE:** Locked-in syndrome, implications for outpatient physical therapy: a case study.

**AUTHORS/INSTITUTIONS:** C.E. Maqueda, R.M. Patel, School of Physical Therapy, Texas Woman's University, Houston, Texas, UNITED STATES|S. Denton, Physical Therapy, University of Washington Medical Center, Seattle, Washington, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Locked-in Syndrome (LIS) is a very rare neurological condition, thus physical therapists have limited opportunities to work with this population. Evidence has supported early rehabilitation, but rehabilitation in chronic stages of LIS is less known. Also, there is limited evidence to support rehabilitation in an outpatient physical therapy (OPT) setting. This case study will illustrate interventions for an individual with chronic LIS as well as one discuss progress and challenges encountered.

**Case Description :** 31-year-old healthy and independent male diagnosed with LIS in April 2012 following surgical clipping of a vertebral artery aneurysm (VAA) secondary to subarachnoid hemorrhage (SAH) and VAA rupture. He presented to OPT 20-months post-injury completely dependent for all ADLS; portrayed 1-2/5 in cervical motor function; no motor function below C2; and independent communication via vertical eye movements. Long term goals (LTGs) established were to gain caregiver independence in home exercise program, improve head on neck stability in an upright position, and increase strength in cervical musculature and right upper extremity (RUE) for future independent wheelchair mobility. Over 12 weeks, 12/15 OPT sessions were attended for 60-70 minutes each. Interventions included neuromuscular electrical stimulation (NMES), head on neck stability training, relaxation training, and patient/caregiver training.

**Outcomes :** After 12 weeks, 3/7 LTGs were met. Active head control improved from maximum assist to contact guard assist; cervical motor function increased by one muscle grade; and caregiver independence in home exercise program was achieved. Based on caregiver report, there was an increase in independent mindfulness practice, proving independent participation in home program. Use of NMES did not produce anticipated functional change; and goals to hold head upright in neutral with standby assist and increase functional independence in wheelchair locomotion were not met.

**Discussion :** This case study reveals that OPT is beneficial in chronic stages of LIS, to improve motor function and quality of life (QOL), yet progress is slow and may require longer time to demonstrate functional gains. Consistent and active participation by all is crucial. Follow-up studies with a larger sample are needed to determine proper frequency, intensity and duration of OPT. Research to establish valid and reliable outcome measures to assess QOL and function for individuals with chronic LIS is also necessary. Outcome measures used in stroke rehabilitation may produce floor-effects in the LIS population. A measure used in previous studies, the McGill Quality of Life Questionnaire (MQOL), could be modified and validated to account for communication capabilities. Further literature review of mindfulness may yield an objective measure that may be valuable for this population. Finally, PTs should recognize functional potential in persons with LIS and advocate for strong support networks.

**TITLE:** Comparing EEG and TMS-derived motor cortex locations in a typically developing child and a child with hemiparesis

**AUTHORS/INSTITUTIONS:** B. Gillick, K. Lorschach, S. Mathiowetz, C. McQuillan, J. Meuwissen, Program in Physical Therapy, University of Minnesota, Minneapolis, Minnesota, UNITED STATES|J.S. Menk, Biostatistical Design and Analysis Center, University of Minnesota, Minneapolis, Minnesota, UNITED STATES|G. Meekins, Department of Neurology, University of Minnesota, Minneapolis, Minnesota, UNITED STATES|T. Feyma, Department of Neurology, Gillette Children's Specialty Healthcare, St. Paul, Minnesota, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Cerebral palsy (CP) is the most common motor disability in children(1). Twenty-five percent of children with CP are affected by hemiparesis(2). Transcranial direct current stimulation (tDCS), a form of noninvasive brain stimulation (NIBS), has been shown to improve hand function in adults with hemiparesis(3). A previous study established the safety of using tDCS as a possible intervention in children with hemiparesis, but raised questions about the optimal placement of the tDCS electrodes. (Gillick et al, in Preparation) The International 10-20 System for EEG placement uses surface landmarks to identify specific brain regions such as C3 and C4 for motor cortex in the left and right hemispheres respectively(4). Transcranial Magnetic Stimulation (TMS) uses electromagnetic currents to evoke motor evoked potentials(5). Employed individually, both methods are used as reference for the motor cortex localization. Currently it is unclear which method provides the optimal localization of motor cortex for hand representation. This case study compares EEG measurement system and TMS-derived motor cortex locations in a typically developing child and a child with hemiparesis. The study was approved by the University of Minnesota IRB.

**Case Description :** Biological siblings, one typically developing and one with congenital hemiparesis, were evaluated. Subject 1 was a right-hand dominant 13-year-old typically developing female. Dominant and non-dominant average grip strength by hand dynamometry was 59.0 and 49.7 lbs respectively. Subject 2 was a 14-year-old female with right-sided congenital hemiparesis, with unaffected and affected average grip strength of 32.7 lbs, 44.7 lbs respectively. Motor cortex, identified by International 10-20 C3 and C4 EEG measurement, was determined by a Pediatric Neurodiagnostic Technician. Single-pulse TMS was used to determine the motor hotspots on the left and right hemispheres. The distance between the hotspot and the corresponding hemisphere EEG location was measured using BrainSight ® stereotactic neuronavigation.

**Outcomes :** Results for Subject 1 revealed a 2.53 cm difference between the EEG location of C3 and left hemisphere motor hotspot and a 2.07 cm difference between C4 and the right hemisphere motor hotspot. Results for Subject 2 demonstrated a 2.42 cm difference between the EEG location of C3 and left hemisphere motor hotspot and a 1.23 cm difference between C4 and the right hemisphere motor hotspot.

**Discussion :** The C3 and C4 coordinates were found to differ from the TMS-derived location of motor hotspot in each hemisphere of both children. Future studies may incorporate this knowledge in order to investigate the most effective means of identification of motor cortex location for optimal tDCS electrode placement and evaluation of intervention efficacy at either site.

**TITLE:** Learning and Inter-Limb Transfer of Foot Trajectory Tracking during Treadmill Walking

**AUTHORS/INSTITUTIONS:** C. Krishnan, Physical Medicine & Rehabilitation, University of Michigan, Ann Arbor, Michigan, UNITED STATES|M. Tatarbe, Biomedical Engineering, University of Michigan, Ann Arbor, Michigan, UNITED STATES|R. Ranganathan, Department of Kinesiology, Michigan State University, East Lansing, Michigan, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Several lines of research indicate that motor learning is a key component of recovery after neurological injuries such as, stroke or spinal cord injury. There is also evidence to suggest that learning in one limb transfers to the other limb, which is termed as inter-limb transfer. We have recently developed a novel functional motor learning paradigm for gait rehabilitation; however, less is known on the retention and inter-limb transfer effect of our paradigm. Therefore, the purpose of this study is to evaluate the consolidation and inter-limb transfer effects of a leg motor skill learning task in a group of neurologically intact adults. A secondary purpose was to evaluate whether the inter-limb transfer effects are side-specific as evidence from upper-extremity literature indicates that spatial accuracy tasks are learned better when participants initially practiced the task with their non-dominant hand. We hypothesized that learning in one leg would transfer to the other leg, and it would be side-specific.

**Number of Subjects :** Twenty-two young adults (11 dominant group, 11 non-dominant group) were tested on two consecutive days.

**Materials/Methods :** Participants performed a foot target-tracking task that necessitated modifications in their hip and knee flexion while walking on a treadmill. On Day 1, the dominant group performed testing with their dominant leg (i.e., preferred leg for kicking). On Day 2, they were tested for their dominant leg retention and non-dominant leg transfer effects using the same paradigm. The non-dominant group performed the same sequence beginning with their non-dominant leg instead. The changes in tracking error were computed to study the learning effects.

**Results :** The results indicate that repeated practice of the leg motor learning task resulted in significant reduction in target-tracking error in both the groups ( $P < 0.05$ ). For the dominant group, the error in target-tracking during the first block of Day 2 was similar to those observed on block 10 of Day 1, indicating that subjects retained their performance improvements. In contrast, the error in target-tracking during the first block of Day 2 was slightly lower to those observed on block 10 of Day 1 in the non-dominant group ( $P < 0.05$ ), indicating that there was some offline learning. Similarly, inter-limb transfer effects were better for the non-dominant group in comparison to the dominant group, although both groups showed transfer effects ( $P < 0.05$ ).

**Conclusions :** These results indicate that inter-limb transfer effects are present for our leg motor skill learning task and appear to be side-specific.

**Clinical Relevance :** The inter-limb transfer effects of learning observed in our target-tracking paradigm provide an opportunity to facilitate recovery of the impaired limb via training of the less impaired limb. The results have meaningful implications for gait rehabilitation in individuals with stroke or other neurological disorders.

**TITLE:** Decreased gait variability following an intense backward walking program in an individual with chronic incomplete spinal cord injury

**AUTHORS/INSTITUTIONS:** H. Foster, L. Demark, Physical Therapy, Brooks Rehabilitation, Jacksonville, Florida, UNITED STATES|C. K. Balasubramanian, Physical Therapy, University of North Florida, Jacksonville, Florida, UNITED STATES|D.K. Rose, Physical Therapy, University of Florida, Gainesville, Florida, UNITED STATES|E.J. Fox, Physical Therapy, Brooks Rehabilitation & Univ. of FL, Gainesville, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Individuals with incomplete spinal cord injuries (ISCI) demonstrate increased gait variability which is associated with impairments in walking and balance function. Gait variability is an established outcome measure in clinical populations such as stroke and older adults, and is used to assess walking function, balance, and the effectiveness of targeted rehabilitation approaches. Gait variability, however, is not a typical outcome measure for the assessment of individuals with ISCI and the responsiveness of gait variability to changes in walking function and balance has not been established. The purpose of this case report is to describe the effects of an intense backward walking program on gait variability in an individual with chronic ISCI. Backward walking training has recently emerged as a rehabilitation strategy to promote walking recovery and improve balance in individuals with ISCI.

**Case Description :** A 28 year old female, 11-years post ISCI (C4, AIS D) participated in an intense backward walking program. She walked with Lofstrand crutches at home and used a power wheelchair for mobility in the community. Eighteen backward walking sessions were completed across 6 weeks (3times/week; 1-hour each). Backward walking was practiced on a treadmill with partial body weight support and overground. Principles of locomotor training were applied to guide the training and progression. Intense, repetitive practice was emphasized by increasing backward walking training speeds and counting steps. Pre- and post-gait variability as well as gait speed was captured using a 12-foot instrumented walkway. Gait variability was quantified as the standard deviation of the spatial and temporal step parameters. The Berg Balance Scale was used to assess changes in balance.

**Outcomes :** Following 18-sessions of intense backward walking training, average gait variability decreased across several step parameters as follows: stride length, 6.44 to 4.56 cm; stride width, 2.15 to 1.51cm; stance time, 0.14 to 0.16 s and; swing time, 0.15 to 0.11 s. Concurrent with these improvements, gait speed increased from 0.20 m/s to 0.27 m/s and balance improved as evidenced by an increase in the Berg Balance Scale scores from 20 to 37/56.

**Discussion :** Individuals with ISCI demonstrate increased gait variability which is associated with walking and balance impairments and may be due to altered neuromuscular control following injury. In this clinical case, gait variability was sensitive to the improvements in walking and balance function after an intense backward walking program in an individual with ISCI. Gait variability may be a useful outcome measure to demonstrate the effectiveness of targeted walking rehabilitation approaches, such as intense backward walking training. To establish the clinical utility of gait variability as an outcome measure, future studies should validate the responsiveness of gait variability in the ISCI population and establish the minimal clinically important difference in the ISCI population.

**TITLE:** Physical therapy rehabilitation of an individual with concussion utilizing vestibular rehabilitation and orthopaedic neck treatment

**AUTHORS/INSTITUTIONS:** C.D. DiSanto, A. Russman, S.M. Linder, J. Alberts, Physical Therapy, Cleveland Clinic, Cleveland, Ohio, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Concussion is a complex injury with individualized symptoms. Many of these symptoms can persist and have significant consequence on a person's quality of life. Emerging evidence demonstrates the effectiveness of vestibular rehabilitation in assisting individuals recovering from concussion. There is also growing evidence in regard to the role of the neck as a contributor to persistent concussion symptoms. There is little research, however, that addresses the combination of these two areas. This single case study demonstrates the practical combination of orthopaedic physical therapy in conjunction with vestibular rehabilitation to create a comprehensive concussion rehabilitation program.

**Case Description :** A 56 year old male sustained a work related concussion during a motor vehicle accident. He was referred to physical therapy 38 days after injury with persistent and non-resolving symptoms that included headache, dizziness, neck pain, as well as, difficulty sleeping. Self-reported questionnaires were utilized and a disability of moderate to severe was reported. A detailed physical therapy evaluation was performed which included musculoskeletal analysis, balance testing by means of the Balance Error Scoring System (BESS), concussion assessment tools, and reaction time. The individual demonstrated decreased postural control and balance, neck range of motion limitations, neck pain and dizziness provoked by head movements. A combination of balance, gaze stabilization, cervical rom and strengthening exercises, as well as postural re-education, manual therapy to the neck, and self-care education were all utilized as treatment interventions. This individual was treated in physical therapy at a frequency of 1-2 times a week for 30 minute sessions over a 13 week period of time for a total of 16 visits. The goal of treatment was for this person to return to work and performance of his daily routines at his prior level of function.

**Outcomes :** Upon discharge from physical therapy, this patient's self-reported functional questionnaires scores were improved from 66 to 34 on the Dizziness Handicap Inventory, 42 to 10 on the Headache Disability Index, 13 to 0 on the Neck Disability Index, and 43 to 5 on the graded Symptom Severity Score. BESS test score was reduced from 17 to 12 errors. The concussion assessment tool, SCAT-3, was utilized and the score improved from 37 to 12.

**Discussion :** The role of the cervical spine as a mediator of dizziness and headache is well established. This case study demonstrates the outcome of including assessment and treatment of the cervical spine in concussion care. Identification of associated impairments and the application of specific physical therapy interventions to create a comprehensive approach to concussion care may facilitate better individual outcomes versus vestibular therapy or rest alone.

**TITLE:** Patient-Centered Task-Oriented Training in Stroke Rehabilitation

**AUTHORS/INSTITUTIONS:** J. Choi, Department of Physical Therapy, Daegu University, Gyeongsan, KOREA, REPUBLIC OF|S. Kang, Department of Physical Therapy, Korea National University of Transportation, Jeungpyeong, KOREA, REPUBLIC OF|S. Kim, School of Physical Therapy & Rehabilitation Sciences, University of South Florida, Tampa, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Task-oriented training has been used to improve motor functions in people with stroke. This training method primarily relies on the therapist's assessment of the patient's impairments and functional limitations. The literature shows that the patient's participation in developing interventions plays an important role in reducing chronic disabilities. This suggests that task-oriented training using a patient-centered approach may facilitate the improvement of motor functions. However, to our knowledge, few studies have focused on patient-centered task-oriented training (PCTOT) in stroke rehabilitation. Thus, the purpose of this study was to investigate the effects of a PCTOT program on balance, activities of daily living, and self-efficacy in individuals with chronic stroke.

**Number of Subjects :** Twenty subjects ( $64.0 \pm 8.5$  years old) with chronic stroke.

**Materials/Methods :** Subjects were randomly divided into two groups: experimental ( $n=10$ ) and control groups ( $n=10$ ). The experimental and control groups underwent a PCTOT program and a traditional physical therapy program, respectively, over 4 weeks (5 sessions per week, 30 minutes each). Five primary tasks (i.e., indoor walking, outdoor walking, climbing stairs, dressing, and grasping objects) were developed for the PCTOT program based on the subjects' response on the Canadian Occupational Performance Measure. The four levels of difficulty in each task were applied depending on the subjects' progress. Subjects' balance, activities of daily living, and self-efficacy were assessed using the Berg Balance Scale (BBS), Modified Barthel Index (MBI), and Self-Efficacy Scale (SES), respectively. Changes in BBS, MBI, and SES following training were analyzed using the Wilcoxon signed rank test, and group differences were examined using the Mann-Whitney U test, with a significance level of 0.05.

**Results :** BBS, MBI, and SES scores significantly improved in both the experimental ( $p < 0.01$ ) and control groups ( $p < 0.05$ ). Improvements in BBS, MBI, and SES scores were significantly greater in the experimental group compared with the control group ( $p < 0.05$ ).

**Conclusions :** This study shows that PCTOT is more effective to improve balance, activities of daily living, and self-efficacy following stroke than traditional physical therapy. The outcomes suggest that when physical therapists apply task-oriented training for stroke rehabilitation, they may need to focus more on a patient-centered approach.

**Clinical Relevance :** Task-oriented training using a patient-centered approach can be an effective intervention in stroke rehabilitation.

**TITLE:** Progressive Reactive Balance Training in Parkinson's Disease: A Pilot Study

**AUTHORS/INSTITUTIONS:** M.B. Smith, A.E. Littmann, P.G. Ho, E.L. Hoelzel, H.J. Hultine, S. McCarthy, P. Scott, P. Sheets, A. Weingartner, School of Physical Therapy, Regis University, Denver, Colorado, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Despite medications, anticipatory and reactive postural instability (PI) remain a major problem in individuals with Parkinson's Disease (PD). Factors contributing to PI include rigidity, bradykinesia, and cognition. Research has focused primarily on the effect of interventions at the structure and function (impairment) level. This purpose of this study was to examine the effect of reactive balance training on structure and function, as well as on activity, and participation in individuals with mild to moderate PD.

**Number of Subjects :** 10 subjects (2 men, 8 women) ages 50-70 with confirmed PD, Hoehn &Yahr stages I-III.

**Materials/Methods :** Subjects completed two 15-minute training trials separated by a 5 minute rest. An algorithm was developed and applied for use with a computer controlled, multi-directional platform (Proprio 5000™) to randomly alter platform perturbation by tilt (2°-25°), direction (360°), and speed (12.6 °/s -126°/s) within and across sessions that were scheduled twice weekly for 4 weeks. Assessment of outcomes at the structure and function level used a clinical balance measure, the Mini-BESTest; spatial and temporal gait parameters at comfortable and fast speeds using the GaitRite™ System; and reactive dynamic motion analysis (DMA) score and time on task from the Proprio machine. Self-reported measures were used to assess function (Patient-specific Functional Scale; PSFS); activity (Activity-specific Balance Confidence Fear of Falling Scale; ABC); and participation (SF-36). Outcomes were recorded: at baseline, intervention completion, and 1 month post-intervention (retention).

**Results :** SPSS (version 19) was used to analyze data. Significant improvements occurred in comfortable gait velocity that could be attributed to improved cadence and stride. Neither fast velocity, nor its spatiotemporal parameters differed. While minor improvements occurred in the Mini-BESTest, only the DMA score and total time significantly improved at intervention completion and retention. Although scores for the ABC scale and total SF-36 score improved, neither significantly differed. When the SF-36 was divided by sub-scales, physical function and vitality subcomponents met clinical minimal detectable change.

**Conclusions :** High level functioning subjects with PD require assessment tools that can measure a range of activities in order to demonstrate improvement. While most subjects scored the ABC scale at 90% or 100%, leaving little room for statistical improvement, when each subject identified important activities related to balance on the PSFS, subjects perceived improvement. The Proprio 5000 is a tool that permits not only application of a challenging reactive balance intervention, but also a measurement tool to assess postural control and response time.

**Clinical Relevance :** Results of this study encourage practitioners to include challenging reactive balance interventions similar to random environmental stimuli to improve function, activity, and participation in patients with mild to moderate PD.

**TITLE:** Clinical vestibular and balance findings in Multiple Sclerosis

**AUTHORS/INSTITUTIONS:** H. Garg, L. Dibble, E. Gappmaier, University of Utah, Salt Lake City, Utah, UNITED STATES|M.C. Schubert, Johns Hopkins University, Baltimore, Maryland, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** A bedside clinical oculomotor exam comprising of Head Impulse test (HIT), Nystagmus and Test of Skew (HINTS) is a diagnostic predictor in acute vestibular syndromes. It demonstrates high sensitivity and specificity in differentiating central nervous system (CNS) vestibular structural impairments from peripheral disorders in an acute setting, thereby assisting treatment decisions for emergency department clinicians. To date, HINTS has not been utilized in individuals with progressive diseases such as Multiple Sclerosis (MS) to identify CNS impairments (i.e., brainstem and cerebellar lesions) that may result in clinical vestibular findings and fall risk. This study aimed to describe HINTS findings in people with MS with confirmed dizziness and fall risk in an outpatient setting. In addition, we examined differences in balance, balance confidence and walking mobility in people with MS who had impairments (as identified from HINTS) versus people with MS who did not.

**Number of Subjects :** 14 individuals with clinically definite MS, complaints of dizziness and fall risk (indicated by the Dizziness Handicap Inventory [DHI] and retrospective fall history), no recent relapses (<3 months), EDSS  $\leq$ 6.5 and no peripheral vestibular pathology were recruited.

**Materials/Methods :** Participants with normal HIT, direction changing nystagmus and skew deviation were considered HINTS positive (Group1), and considered to have CNS vestibular structural impairment. Those who did not meet the HINTS criteria were considered HINTS negative (Group2). Separate independent t-tests were conducted to determine between group differences in Berg Balance Test (BBT), Activities-specific Balance Confidence scale (ABC), 12-item MS Walking Scale (MSWS).

**Results :** 14 individuals (2M/12F) with a mean (range) age=58.29 yrs (42-73), diagnosis duration=12 yrs (1-43), DHI score=45.14 (6-82) and 3.57 (0-8) falls reported in the past year. Of 6 individuals in Group1, 4 demonstrated direction changing nystagmus, 2 lateral skew deviation and 6 normal HIT. Group2 (n=8) exhibited a normal HIT, no skew deviation and either no nystagmus with gaze holding (n=4), unidirectional lateral nystagmus (n=2) or pendular nystagmus (n=2). No significant group differences were noted in BBS, ABC and MSWS ( $p>0.05$ ).

**Conclusions :** Our results suggest that HINTS may play a role in identifying central causes for oculomotor/ vestibular signs in outpatient setting, as 6 out of 14 individuals were HINTS positive. However, functionally no differences in balance and walking mobility were found. These results indicate that, in individuals with MS with potential vestibular complaints (i.e., dizziness, fall risk), the HINTS exam by itself is insufficient to identify CNS vestibular structural impairments that may affect gaze and postural stability, balance and walking mobility. Future research should examine the validity of HINTS in conjunction with laboratory and clinical vestibular function measures to identify CNS vestibular impairments.

**Clinical Relevance :** Utility of a clinical tool in identifying central vestibular impairments in MS.

**TITLE:** High Intensity Backward Walking Treadmill Training for Individuals with Parkinson's Disease

**AUTHORS/INSTITUTIONS:** C.L. Barnes, B.A. Tschoepe, M.B. Smith, A.E. Littmann, R. Brossart, J. Brown, S.K. Ellefson, J. Fred, R.D. McFadden, J.A. Tschoepe, School of Physical Therapy, Regis University, Denver, Colorado, UNITED STATES|

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Parkinson's disease (PD) is a neurodegenerative disorder affecting 17 per 100,000 individuals each year, with peak incidence in the 7th decade. As this disease progresses, individuals typically experience gait impairments and balance challenges. Interventions that provide external pacing for gait may compensate for basal ganglia deficiencies believed to be responsible for internally cueing. High-intensity forward walking treadmill training (TmT) has led to gait and functional improvements regardless of practice schedules in mild to moderate stages of PD. Principles of neuroplasticity suggest that interventions are more effective if they are active, repetitive, attended to, and novel. The purpose of this study was to determine if a novel high-intensity backward walking treadmill training program (BWTmT) would improve gait, balance and functional outcomes in people with mild to moderate PD.

**Number of Subjects :** Thirteen individuals (8 women, 5 men) with PD (Hoehn & Yahr I-III) met inclusion criteria.

**Materials/Methods :** Subjects trained twice weekly for 6 weeks during this study. Target training speed was 80% of individuals' fast backward walking speed, determined by the GAITRite™ system. Subjects walked backward for a total of 20 minutes on a treadmill using a distributed practice schedule over a 50 minute session. The distributed practice schedule consisted of two 7-minute TmT periods and a final 6-minute TmT period, with 10-minute rest periods. Outcome measures included Unified Parkinson's Disease Rating Scale Motor Scale (UPDRS); temporal and spatial gait parameters; Six-Minute Walk Test (6MWT); Timed 10 Meter Walk Test (10MT), Timed Up and Go (TUG); Functional Gait Assessment (FGA); and static balance measures. Assessments were completed at baseline, post-intervention, and 4 week post-intervention retention.

**Results :** Statistical analysis was performed using SPSS (version 19.0). Significance was set a priori at  $P \leq 0.05$ . Significant differences across time were identified in functional outcome measures: 6MWT, 10MT, and TUG. No significant differences were noted for spatial or temporal gait parameters, static balance tests, FGA, and UPDRS-motor scale. Mean TUG scores decreased over time, moving subjects from a PD fall risk to below fall risk category ( $\leq 7.95$  seconds). Although changes in FGA scores were not significant, they met clinical significance (MDC=0.61).

**Conclusions :** This study agrees with other studies that indicate that novel tasks facilitate learning. Although we anticipated an improvement in FGA, 70% of our subjects obtained near maximal scores at baseline resulting in what we believe to be a ceiling effect. The FGA did exceed the MDC value.

**Clinical Relevance :** Our results suggest that high intensity BWTmT generalize to improvements in function as opposed to merely improving only task specific gait parameters. A combined intervention of high intensity forward and backward treadmill training, and balance training over a duration greater than 6 weeks may be needed to improve overall gait, balance and function for individuals with mild to moderate PD.

**TITLE:** Rehabilitation to promote respiratory recovery following complete cervical spinal cord injury and intramuscular diaphragm stimulation

**AUTHORS/INSTITUTIONS:** A. D'Alessandro, A.S. Thomas, Brooks Rehabilitation, Jacksonville, Florida, UNITED STATES|A.J. Kerwin, UF Health Jacksonville, Jacksonville, Florida, UNITED STATES|D. Fuller, K.A. Streeter, University of Florida, Gainesville, Florida, UNITED STATES|E.J. Fox, Physical Therapy, Brooks Rehabilitation & Univ. of FL, Gainesville, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Individuals with cervical spinal cord injuries (C-SCI) often have severe respiratory impairments and require mechanical ventilation. While this is a life-saving approach, mechanical ventilation causes secondary impairments such as profound diaphragm atrophy. Intramuscular diaphragm stimulation, known as diaphragm pacing (DP) is an emerging alternative to long term mechanical ventilation. Recent reports indicate that some individuals with SCI and a DP may recover independent respiration and wean from the DP. Rehabilitation strategies to promote respiratory recovery and weaning from the DP have not been reported but are critical to promote independent respiration. The purpose of this case series is to describe the application and effects of a DP weaning protocol applied to two individuals with C-SCI who received DPs after failure to wean from mechanical ventilation.

**Case Description :** DPs were implanted acutely in two individuals with complete C-SCI after failure to wean from mechanical ventilation. Both were transferred and evaluated in a rehabilitation hospital setting. Injuries were classified as C-3 and C-4, AIS A and both individuals were dependent on the DP for respiration; respiratory rate was pre-set at 16 and 18 breaths per minute. Rehabilitation focused on daily respiratory muscle training. Key criteria for initiating weaning from the DP were established as a) oxygen saturation >92% when breathing room air; b) gradual improvements associated with respiratory training; c) demonstration of inspiratory volume and respiratory rate above the level induced by the pacer, and ; d) incentive spirometry >250ml. The weaning protocol commenced with 20 - 30 min trials with the DP off. Oxygen saturation, respiratory rate, and patient tolerance were monitored. The duration of weaning trials gradually increased and respiratory training progressed with the DP off.

**Outcomes :** Weaning trials were initiated within 2-weeks after admission to inpatient rehabilitation. Both individuals demonstrated gradual gains in respiratory function as evidenced by increased duration of weaning trials and progression of respiratory muscle training. Within 12 days, both achieved independent respiration for >8 hours and progressed to full independence within 2 weeks. Within 3 weeks following the initiation of weaning, both individuals were discharged, and within 3-days post discharge, their DPs were removed.

**Discussion :** Following C-SCI, DP is emerging as an alternative to mechanical ventilation. Some individuals may recover independent respiration and wean from the DP. A weaning protocol was developed and successfully implemented for two individuals C-SCI. Close monitoring and a gradual progression of weaning and respiratory muscle training was effective for promoting weaning from DP and recovery of independent respiration. Additionally, use of the DP may have had a neuro-rehabilitative effect on respiratory motor control and contributed to the respiratory recovery in these two individuals with complete C-SCI.

**TITLE:** You Are Not Alone: Development of a Local Neurologic Private Practice Network-Strategies and Successes

**AUTHORS/INSTITUTIONS:** N.D. Matthews, InCourage Physical Therapy, Pasadena, California, UNITED

STATES|J.A. Hershberg, E.J. Caudill, re+active physical therapy & wellness, Los Angeles, California, UNITED

STATES|C.A. Martinez, University of Southern California, Los Angeles, California, UNITED STATES|

**ABSTRACT BODY:**

**Purpose :** With reduction in inpatient length of stays and emerging evidence for the role of exercise in the care of patients with neurologic diagnoses, there has been an increased need for experienced neurologic physical therapists working in the outpatient private practice setting. The Neurologic Physical Therapy Network (NPTN) was established to bring physical therapists that work in outpatient neurologic practices in the Los Angeles area together to allow exchange of ideas and develop a network of high-quality practitioners that covers a large geographic area.

**Description :** In the Los Angeles area over the last five years, several outpatient neurologic physical therapy private practices have started. These practices have grown in that time, but there was little to no communication or collaboration between them. In October 2012, the Neurologic Physical Therapy Network (NPTN) was established. Physical therapists who are board certified Neurologic Clinical Specialists (NCS) working at 9 different private practices in diverse areas of Los Angeles and Orange Counties were invited to participate in the network. The NPTN was developed to meet several goals including: 1) to learn about the work of other Neurologic Clinical Specialists in the area, 2) to provide education/information to physicians and patients about neurologic physical therapy as a specialty and as purveyors of high-quality patient care, 3) to provide a forum for discussion about complex patient cases, 4) promote standardization of outcome measurement and treatment approaches for distinct populations, and 5) to explore opportunities for participation in clinical research.

**Summary of Use :** Seven different private practices have regularly participated in NPTN meetings. With these practices dispersed over a large geographic area, it has allowed network members to refer patients and physicians to quality neurologic physical therapy providers throughout Los Angeles and Orange Counties. Specific gains identified by network participants include collaboration with neurologists who were invited to network meetings, referrals from physical therapists within the network, invitation to be involved in a clinical research trial, and communication on novel treatment philosophies and ideas to incorporate into practice.

**Importance to Members:** With a growing need for physical therapists to treat the neurologic patient population in the outpatient private practice setting, development of community to support the work of the physical therapists providing that treatment is key. Working in collaboration with other physical therapists in neighboring communities can help to advance treatment within these practices, as well as increase referrals. Tools to assist with meeting remotely should be considered as well as the development of common goals to identify how the group can benefit from one another in collaboration.

**TITLE:** Vision, cognition, and dual-task training in Parkinson's disease: the impact of a oculomotor training hierarchy on balance when coupled with cognitive demands

**AUTHORS/INSTITUTIONS:** G. Porter , Physical Therapy and Athletic Training, Northern Arizona University, Flagstaff, Arizona, UNITED STATES|V. Carter, Northern AZ University, Flagstaff, Arizona, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** People with Parkinson's disease (PWP) experience mobility impairments and an increased risk of falls secondary to deficits in balance, posture, and vision. PWP use visual feedback to maintain upright posture and control balance as a compensatory strategy for inaccurate processing of proprioception and sensory feedback. Common visual impairments associated with PD add to the challenge of PWP ability to effectively use vision in maintaining balance. Additionally, PWP are known to experience increased fall risk when completing simultaneous tasks. However, recent studies have shown potential for improved task performance in PWP under dual-task conditions. An important goal of dual-task training for PWP is an "automatization" of task components. Thus, the goals of this research are to: 1) develop a hierarchy of dual task training involving visual stimuli that require cognitive processing of progressive difficulty; 2) demonstrate improved performance in balance through an "automatization" of visual strategies in dual-task conditions involving cognitive demands; 3) develop a treatment protocol that includes various sequences of visual targets during gait and balance training that require cognitive skills with progressive difficulty.

**Case Description :** Pre and post-test data: The NeuroCom's® Sensory Organization Test and the 10M walk test with head-turning and identification of visual stimuli per the established hierarchy. Treatment: Consisted of four, one-hour long sessions emphasizing gait and balance training with visual targets to train visual processing speed and saccadic eye movement under cognitive sequences with progressive difficulty. Participants also completed a daily home program involving oculomotor and head-turning exercises. Outcome Measures: Pre- and post-test NeuroCom® and 10M walk test data were compared and evaluated for percent change. Treatment data was also analyzed for speed of processing and error rate in identifying/detecting visual stimuli.

**Outcomes :** Results: Data on 3 subjects have been collected and is being analyzed. A preliminary review of the NeuroCom® data indicates a 19% improvement in the use of visual information and a 62% improvement in the use of vestibular information to maintain balance. 10M walk test data revealed a 2% decrease in speed; however, subjectively, the quality of head-turning and ability to detect and process visual stimuli improved as seen in reduced errors with increased cognitive tasks.

**Discussion :** Clinical Relevance: PWP have deficits in balance, vision, and dual-tasking. The recommended hierarchy shows a meaningful improvement of in balance for PWP when they are required to process visual cues of increasingly difficult cognitive demands. Use of visual targets that require cognitive processing while promoting saccadic eye movement and head-turning during gait and balance training improves postural control. Positive results can be achieved with minimal intervention.

**TITLE:** Changes in pedaling power and symmetry in individuals with Parkinson's disease following a tandem cycling intervention: A case series

**AUTHORS/INSTITUTIONS:** S.K. MacDonald, M.D. Nelson, C. Robinson, L. Campbell, L. Richards, E.L. McGough, Rehabilitation Medicine, University of Washington, Seattle, Washington, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Slower and asymmetric lower extremity motor patterns are common in individuals with Parkinson's disease (PD), however, little is known about the effects of cycling interventions designed for individuals with PD on pedaling output. An indoor tandem cycling intervention, using standard and recumbent tandem bicycles mounted on trainers, is a method to mechanically augment pedaling at a high cadence and consistent pace in individuals with motor impairments. The purpose of this case series is to describe changes in solo pedaling characteristics of three individuals with PD before and after a 10-week tandem cycling intervention.

**Case Description :** Solo pedaling characteristics are described in three individuals with mild to moderate PD before and after they participated in a 10-week tandem cycling class. Subject A was a 64-year old male with 6 years PD on Levodopa (L-dopa) medication. Subject B was a 67-year old female with 4 years PD on L-dopa medication. Subject C was a 66-year old male with 2 years PD on monoamine oxidase (MOA) inhibitor medication. The tandem cycling intervention consisted of 60-minute classes, 3x/week for 10 weeks. Each class included 40 minutes of high cadence pedaling (80-90 RPMs) at moderate intensity (3-4 on the modified Borg scale and 60-75% estimated maximum heart rate) and 20 minutes of warm-up, cool-down and gentle stretching).

**Outcomes :** A custom research bicycle with a Computrainer (RacerMate Inc., Seattle, WA) was used to measure solo pedaling power (W/kg), power split (% power right versus left), and average torque angle (ATA). Power output changes during steady state cycling were as follows: Subject A improved from 1.13 to 1.47 W/kg (30.1% increase), Subject B improved from 0.64 to 0.88 W/kg (37.5% increase), and subject C improved from 1.07 to 1.44 W/kg (30.8% increase). The difference in right versus left power split during steady state cycling decreased as follows: Subject A changed minimally from 15.74% asymmetry to 15.58%, subject B decreased from 2.0% asymmetry to 0.64 %, and Subject C decreased from 4.0% asymmetry to 2.04 %. ATA side-to-side symmetry improved from a 14 degree difference to a 0.9 degree difference in subject C (13.07° improvement), but ATA became less symmetrical in subjects A (2.57° to 11.44°; 8.87° less symmetrical) and subject B (6.6° to 14.48°; 7.88° less symmetrical).

**Discussion :** Following the 10-week tandem cycling intervention, power output (W/kg) improved 30-37.5% in all three cases. Power split symmetry also improved in all cases, but subject A showed minimal change. ATA symmetry was more variable. Improved lower extremity power output in individuals with mild to moderate PD has the potential to improve lower extremity function. Larger studies are needed to better understand the training effects of cycling interventions on pedaling power and symmetry in individuals with PD.

**TITLE:** Y Balance Test to Assess Balance for a Patient with Stroke: A Case Report

**AUTHORS/INSTITUTIONS:** N. Dilworth, J. Canbek, Nova Southeastern University, Fort Lauderdale, Florida, UNITED STATES|

**ABSTRACT BODY:**

**Background & Purpose :** Ability to maintain the body's center of mass (COM) over the base of support (BOS) or limits of stability (LOS). Outcome measures which assess perceived LOS are available, but do not focus of movement of the COM over a narrowed BOS. The Y Balance Test (YBT) measures the ability to maintain balance in a narrowed base of support by standing on one leg while maximally reaching with the opposite leg in 3 directions: anterior, posteromedial and posterolateral. The YBT is used in young athletes to measure dynamic standing balance, but has not been described to measure balance in people with stroke. This case report describes the use of the YBT to measure dynamic standing balance in a patient post-stroke.

**Case Description :** 61 year old male, 8 weeks post-stroke with left sided hemiparesis, walking household distances with min/mod assist using a quad cane who received outpatient physical therapy for 12 weeks. Balance was assessed using the Berg Balance Scale (BBS), Dynamic Gait Index (DGI) and YBT at initial evaluation and then at 4 weeks, 8 weeks and 12 weeks. Composite scores of the YBT were calculated for each limb by averaging the distance reached in all directions and dividing by the 3 times the patient's limb length. Interventions included strengthening exercises, balance training and gait training.

**Outcomes :** Initial scores: BBS 54/56; DGI 18/24; YBT right 72.6%; YBT left 64.8%. Scores improved on all tests during the 12 week period. Scores were consistently high on the BBS (54/56, 56/56, 56/56). DGI scores were also high (22/24, 24/24, 24/24). Improvement was seen YBT scores of both legs (right: 86.3%, 103.1%, 99.3%; left: 83.5%, 94.1%, 83.8%). The greatest amount of change between initial evaluation scores and scores at 8 weeks was noted in the YBT scores of the right leg (30.5%) and YBT left leg (29.3%), when compared with the overall change in BBS (3.6%) and DGI (20.8%) scores.

**Discussion :** The YBT and the DGI were able to capture initial balance deficits not captured by the BBS and the YBT captured the greatest amount of change over time. There appeared to be a ceiling effect in the BBS and DGI tests that was not seen in the YBT scores, possibly attributed to continuous, ratio-level measurement on the YBT. The YBT also differs from the other tests in that it focuses on LOS testing in a narrowed base of support (single-limb stance). Interestingly, the patient scored the highest possible score on the functional reach item of the BBS at initial eval, but showed deficit in the YBT on both legs. The functional reach test is the traditional and widely accepted method for assessing LOS by reaching forward with an outstretched arm while standing in the patient's normal BOS. The YBT may test LOS in a more realistic and functional manner, mimicking skills that would be needed to adapt to the environment while walking, for example. The YBT may be a useful for assessing balance in persons with stroke. Further research is needed to evaluate the psychometric properties of the YBT to measure balance in people with stroke using larger samples.