

# Abstracts



**Neurology Section Poster Presentations**

## Found 155 Abstracts

**TITLE:** Relationships between fall risk classifications and fall history in community dwelling older adults

**AUTHORS/INSTITUTIONS:** K.K. Cleary, , Eastern Washington University, Spokane, WA; C. Henderson, , Aegis Therapies, Spokane, WA;

### **ABSTRACT BODY:**

**Purpose/Hypothesis :** Falls in older adults and the resultant injuries and subsequent decline in function are a significant area of concern. Among older adults, falls are the leading cause of injury related to death and hospitalization. The purpose of this presentation is to describe relationships between fall risk classification and fall history in well elderly, and consider the usefulness of two established measures in classifying fall risk.

**Number of Subjects :** Forty-six subjects aged 65 and older ( $x=83$  years) who lived independently in a senior living community in the northwest region of the United States participated in this study. To participate, individuals had to be able to walk within their home, with or without an assistive device, but without help from another person.

**Materials/Methods :** Subjects completed established performance measures including the Tinetti Assessment Tool and the Timed Up and Go (TUG). Both instruments are well established as valid measures of balance and functional mobility in older adults, and classify risk for falls based on threshold scores. The Tinetti threshold score of 18 or less indicates high risk of falls. Scores of 15 seconds or more on the TUG indicate high risk of falls. Subjects provided information about their fall history and demographics. A fall was defined as an unintentional movement resulting in coming to rest on a lower surface like the floor or ground. Descriptive statistics, measures of association and t-tests were calculated using SPSS v. 18.0.

**Results :** Most subjects were female (69%), had completed at least grade 12 (96%), and had health insurance (98%). More than one-third of subjects (36%) reported a fall in the previous year ("fallers"). The mean Tinetti score was 23, with nine (20%) subjects classified at high risk of falls. The mean TUG score was 14.6, and its risk classification indicated that more than one-third (37%) of subjects were at high risk of falls. Fall risk classification using the TUG was significantly correlated with fall history ( $r=0.254$ ,  $p=0.045$ ), but Tinetti risk classifications were not related to fall history. There were no significant differences in mean scores on either instrument between fallers and non-fallers.

**Conclusions :** Fall history was correlated with TUG fall risk classification. Despite the fact that the Tinetti was designed as a fall risk screening measure for older adults, its risk classifications were unrelated to fall history in this study. Perhaps using three risk classifications (low, medium, high) diminishes its sensitivity for determining fall risk.

**Clinical Relevance :** The results of this study will benefit the physical therapy community by describing balance and functional mobility, and corresponding fall risk, among older adults well enough to live independently. Further, physical therapists may consider using the TUG instead of the Tinetti fall risk classification due to their respective relationships to fall history.

**TITLE:** Is Virtual Reality gaming an effective adjunct to traditional therapy in children and adolescents with traumatic brain injury?

**AUTHORS/INSTITUTIONS:** P.D. Palma, E. McFarling, T. Romero, E. Van Den Eynde, M. Sholas, , Children's Healthcare of Atlanta, Atlanta, GA; S. Flynn, , Blue Marble Rehabilitation, Inc, Altadena, CA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To compare the use of a commercially-available video game with traditional therapy as a treatment intervention to improve functional mobility in the pediatric population with traumatic brain injury (TBI).

**Number of Subjects :** 13 inpatients from Children's Healthcare of Atlanta Comprehensive Inpatient Rehabilitation Unit, aged 8-18 years (five females/ eight males) with TBI and a Rancho Los Amigos rating of V or VI.

**Materials/Methods :** The participants were randomly assigned to the virtual reality (VR) group or the traditional therapy (TT) group. Each group received 20-30 minutes of their respective intervention for a minimum of 6 sessions while inpatient. The VR group practiced balance exercises using the PlayStation II Sony TM Eye Toy® Play 2 while the TT group participated in conventional dynamic balance activities. Outcome measures included, Pediatric Berg Balance Scale (PBBS), Multi-Directional Reach Test (MDRT), Wee-FIM II<sup>SM</sup> and Intrinsic Motivational Inventory (IMI).

**Results :** There are no significant differences in outcomes between the VR group and the TT group. Both groups showed trends of improvement in the PBBS, MDRT, Wee-FIM II<sup>SM</sup> and IMI.

**Conclusions :** Video games are equally effective to traditional balance training as an adjunct to traditional therapy for children and adolescents with TBI on an inpatient pediatric rehabilitation setting.

**Clinical Relevance :** Clinically, video games can be a motivating tool. Video games engage the player in a variety of motivating, fun, competitive and interactive balance activities. Other benefits of video game play are social engagement, challenges to executive function through problem solving exercises, practice of real-time task requiring normal speed of movement and real world practice in a safer environment. Lastly, today's millennial children and adolescents have been exposed to video games making this an inexpensive and familiar tool to address a variety of functional deficits in motor, cognitive and visual skills.

**TITLE:** The Effect of a Safe Patient Handling Program on Rehabilitation Outcomes for Patients with Stroke

**AUTHORS/INSTITUTIONS:** M. Campo, School of Health and Natural Sciences, Mercy College, Dobbs Ferry, NY;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to determine the effect of a comprehensive safe patient handling and movement (SPHM) program on rehabilitation outcomes for patients with a primary diagnosis of Cerebrovascular Accident (CVA).

**Number of Subjects :** Subjects were patients treated on a rehabilitation unit at a hospital in Central Michigan. Subjects underwent inpatient rehabilitation in one of two periods: Group 1 (n=47) underwent rehabilitation between June 2005 to May 2006 and group 2 (n=47) underwent rehabilitation between January 2008 to December 2008. A comprehensive safe patient handling program was implemented between those two periods. This program included the use of a variety of advanced patient handling technologies including ceiling mounted lifts, floor based lifts, adjustable hospital beds, ambulation aids and sit to stand devices.

**Materials/Methods :** This was a retrospective cohort study with data gathered via consecutive chart review. Patients with a primary diagnosis of CVA were selected by ICD-9 code. The primary predictor was group (before or after SPHM implementation). Covariates included age and length of stay. The primary outcome was the mobility portion of the Functional Independence Measure (FIM). Descriptive statistics were used to summarize study variables and outcomes. The difference between the mean changes in FIM scores in each group was analyzed with an independent samples t test. An analysis of covariance was used to compare discharge mobility FIM scores while controlling for baseline mobility FIM scores, age and length of stay.

**Results :** The group who underwent rehabilitation after SPHM implementation had significantly better outcomes. Both the mean gain in mobility FIM and the mean discharge mobility FIM scores (adjusted for age, length of stay, and admission mobility FIM) were significantly higher in group 2.

**Conclusions :** A comprehensive SPHM program may improve rehabilitation outcomes. Additional studies are needed to confirm or refute these findings.

**Clinical Relevance :** This study was the first study to examine the effect of a SPHM program on rehabilitation outcomes. These programs can be met with resistance by physical therapists because it is feared they may slow recovery and promote dependence. Proponents claim however, that they allow for earlier and more aggressive patient mobilization. This study suggests that at the very least, these programs may not inhibit recovery and may possibly improve it.

**TITLE:** The Mobility Scale for Acute Stroke (MSAS) Predicts Discharge Destination from the Acute Care Setting

**AUTHORS/INSTITUTIONS:** M.L. Tinl, M. Kale, S. Doshi, Department of Rehabilitation Services, Brigham and Women's Hospital, Boston, MA; M. Beninato, Department of Physical Therapy School of Health and Rehabilitation Sciences, MGH Institute of Health Professions, Boston, MA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** In acute care (AC), early and accurate prediction of discharge destination (DD) is essential for optimal patient management and discharge planning. While factors related to DD prediction from rehabilitation are well studied, there is a need to identify measures predictive of DD after stroke from AC. The MSAS has been shown to be a useful predictor of length of stay after stroke in the Australian healthcare system; however, its usefulness in the US healthcare system, particularly in the AC setting, has yet to be examined. We hypothesized that MSAS scores on initial evaluation in patients with acute stroke will accurately predict DD (home vs. not home).

**Number of Subjects :** 265

**Materials/Methods :** Data was collected on patients admitted to the neuroscience service of an AC teaching hospital over a 1-year period, January 2009-2010, with a diagnosis of ischemic or hemorrhagic stroke, unrelated to trauma. The 6 item MSAS was used to assess functional mobility. The MSAS assesses bridging, transfers from supine to sit, transfers from sit to stand, walking ability and sitting and standing balance, using a 6 point ordinal scale for each item with a total score ranging from 6 to 36. Data collected included MSAS scores on initial physical therapy evaluation, DD, demographic data, and length of stay. Exclusion criteria were: status prior to admit was physically dependent, non-ambulatory, and/or lived in a skilled nursing facility, suffered a secondary major trauma at the time of the stroke, or underwent surgical intervention for stroke management. For data analysis, cutoff (CO) scores with associated sensitivity (Sn) and specificity (Sp) for predicting DD were derived from Receiver Operating Characteristic (ROC) curves for the entire sample and various subgroups. Positive and negative likelihood ratios (+LR and -LR) were also calculated.

**Results :** Patients were  $68 \pm 15$  years old, 48.3% were females, 43.0% had R hemisphere involvement, 74.7% had ischemic stroke and 16.2% had intracerebral hemorrhage (ICH). Median length of stay was 5 days. 107 (40.4%) patients were discharged home and 158 (59.6%) patients were discharged to a rehabilitation facility. Median initial MSAS score was 24 (range 6-36). CO score most accurate in determining DD (home vs. not home) with best balance between Sn and Sp and associated +LR and -LR (Sn/Sp; +LR/-LR) was for the whole sample CO=26 (.94/.86; 6.7/.07); right hemisphere CO=26 (.94/.90; 9.4/.07); left hemisphere CO=30 (.84/.94; 14.0/.17); ischemic stroke CO=26 (.95/.84; 5.9/.06); ICH CO=26 (.91/.94; 5.6/.10); females CO=26 (.89/.89; 8.1/.12); males CO=30 (.88/.93; 12.6/.13).

**Conclusions :** The MSAS is a highly accurate, sensitive and specific tool for predicting DD from AC after stroke.

**Clinical Relevance :** The MSAS can be used to assess mobility. It is efficient to administer, requires no special training or equipment and can be used to standardize information commonly assessed in AC. MSAS initial scores can be used to predict DD, thereby expediting discharge planning and facilitating optimal utilization of healthcare resources.

**TITLE:** Reliability and Validity of the Vestibular Activities and Participation (VAP) Measure

**AUTHORS/INSTITUTIONS:** A.A. Alghwiri, Physical Therapy, The University of Jordan, Amman, JORDAN; S.L. Whitney, P.J. Sparto, Physical Therapy, University of Pittsburgh, Pittsburgh, PA; J.C. Rogers, Occupational Therapy, University of Pittsburgh, Pittsburgh, PA; J.M. Furman, Otolaryngology, University of Pittsburgh, Pittsburgh, PA; G. Marchetti, Physical Therapy, Duquesne university, Pittsburgh, PA; C.E. Baker, Education, University of Pittsburgh, Pittsburgh, PA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To establish the test-retest reliability, minimal detectable change (MDC), concurrent validity, convergent validity, and discriminant validity of the Vestibular Activities and Participation (VAP) measure in people with vestibular disorders.

**Number of Subjects :** A consecutive sample of 58 participants between the ages of 18 and 85 years who had dizziness, imbalance, or a combination of these impairments participated in the study.

**Materials/Methods :** The test-retest reliability of the VAP total score was estimated using the Intra Class Correlation coefficient (ICC), model (3,1), and the 95% confidence interval (CI). Agreement per-item for the VAP was estimated using Cohen's kappa statistics (weighted and unweighted). The minimum detectable change at 95% confidence level for the VAP measure (MDC95) was estimated. The concurrent validity of the VAP with the World Health Organization Disability Assessment Schedule II (WHODAS II) and the convergent validity of the VAP with the Dizziness Handicap Inventory (DHI) were examined using Spearman rank order correlation coefficient ( $\rho$ ). The discriminant validity of the VAP was estimated using Mann-Whitney test and Spearman rank order correlation coefficient ( $\rho$ ).

**Results :** The VAP total score had excellent test-retest reliability (ICC=.95), (CI=.91-.97) and good to excellent agreement per-item indicated by the un-weighted kappa (.41-.80) and weighted kappa (.58-.94). The MDC95 of the VAP score was .58. The VAP had strong correlation ( $\rho$ =.7,  $p$ <.05) with the WHODAS II and moderate to strong correlations ( $\rho$ =.54-.74) with the DHI dimension and total scores. After adjustment for age, we found gender and self-reported imbalance to be independent predictors of the transformed VAP total score.

**Conclusions :** The VAP demonstrates excellent reliability and was validated with external instruments on people with vestibular disorders.

**Clinical Relevance :** The VAP can be used clinically as an outcome measure to assess activity limitations and participation restrictions in people with vestibular disorders.

**TITLE:** Are Balance and Gait Associated with Physical Activity in Community-Dwelling Stroke Survivors?

**AUTHORS/INSTITUTIONS:** J.E. Sullivan, L. Dunn, K. Korsch, S. Roeder, V. Warner, Department of Physical Therapy and Human Movement Sciences, Northwestern University, Chicago, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Increasing stroke incidence and declining mortality rate has resulted in an increased number of community-dwelling stroke survivors. Physical activity has been identified as important for maximizing functional recovery and preventing subsequent stroke. Little is known about the role of balance and gait on physical activity in chronic stroke. The purpose of this study was to investigate the association between balance, gait, and physical activity in community-dwelling stroke survivors. We hypothesized that physical activity was associated with: 1) clinical measures of balance, 2) balance self-efficacy, 3) gait speed and 4) gait distance.

**Number of Subjects :** Thirty-four community-dwelling chronic stroke survivors completed the study. Subjects included 20 males, 14 females. Mean age was 57 (29-88) years. Mean time since onset was 5.9 (0.5-24) years.

**Materials/Methods :** The following measures were administered in a single session: Rapid Assessment of Physical Activity (RAPA), Activities-Specific Balance Confidence (ABC) Scale, Berg Balance Scale (BBS), 6-minute walk test (6MWT) and 10-meter walk test (10MWT). Non-parametric correlational statistics were used to analyze the relationships between measures.

**Results :** There were no significant correlations between physical activity and the other measures. Excellent correlations were found between measures of gait and balance including: ABC with BBS ( $r=0.768$ ), 6MWT ( $r=0.708$ ), 10MWT ( $r=0.747$ ); BBS with 6MWT ( $r=0.853$ ), 10MWT ( $r=0.891$ ); 6MWT with 10MWT ( $r=0.967$ ).

**Conclusions :** 1) Self-reported physical activity as examined by the RAPA was not associated with gait and balance measures. 2) Strong associations exist between the other measures of gait and balance.

**Clinical Relevance :** Following stroke, balance self-efficacy is highly correlated with clinical performance measures of gait and balance. A more sensitive outcome measure of physical activity may be required to examine the association between physical activity and gait and balance.

**TITLE:** Is botulinum toxin effective in improving gait parameters in patients with hemiplegia and spasticity? A systematic review

**AUTHORS/INSTITUTIONS:** K.H. McCullough, G.L. McRae, A.E. Fountain, P. Stegall, University Rehabilitation Center, Department of Physical Therapy, University of Mississippi Medical Center, Jackson, MS; L.J. Barnes, K. Curbow Wilcox, School of Health Related Professions, Department of Physical Therapy, University of Mississippi Medical Center, Jackson, MS;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Spasticity, a common problem associated with upper motor neuron disorders, can impair functional mobility secondary to decreased range of motion, poor posture, or pain (Reiter, 1998). Spasticity treatment options include pharmacological, surgical, and physiotherapeutic interventions. Although there are many different treatment approaches for the management of spasticity, limited research exists to determine the most efficacious. Botulinum toxin (Botox), a neurotoxin causing temporary inhibition of muscles at the presynaptic neuromuscular junction, is a common pharmacologic treatment in the management of spasticity (Childers, 1996). The purpose of this systematic review was to determine the efficacy of Botox in improving gait characteristics in adult patients with hemiplegia and spasticity.

**Number of Subjects :** Design: systematic review

**Materials/Methods :** The PubMed database was searched from January 1995 through December 2010 using terms related to botox, hemiplegia, and spasticity combined using the “or” and “and” operators. Inclusion criteria were: English language, human subjects, randomized controlled trial (RCT), hemiplegia, adults ( $\geq 19$  years). Exclusion criteria were: children and cerebral palsy. A title screen, abstract screen, and the inclusion/exclusion criteria were applied in sequence to narrow the results to ten articles that met the purpose of the systematic review. Articles were evaluated using the Physiotherapy Evidence Database (PEDro) and the Center of Evidence Based Medicine (CEBM) levels of evidence.

**Results :** The initial PubMed search returned 45 articles. Ten studies met the systematic review criteria following the title and abstract screens and after applying inclusion/exclusion criteria. PEDro scores ranged from four to eight, with an average score of six. Using CEBM, the ten studies were rated at Levels I and II.

**Conclusions :** Based on the results of the systematic review, the evidence grade was an “A” secondary to CEBM Level I and II studies with PEDro scores ranging from four to eight. The results of the systematic review regarding the use of Botox for the treatment of spasticity to improve gait characteristics indicated that Botox is an effective treatment for patients with lower extremity hemiparesis and spasticity, although it is not shown to be more effective than other treatment options.

**Clinical Relevance :** Based on the results of the systematic review, Botox in combination with other therapeutic treatment options was found to be an effective treatment approach for improving spasticity and gait characteristics in patients with hemiplegia. Further research is needed in this area as well as additional study on the use of Botox in comparison to more traditional treatment options to provide evidence on the most effective interventions.

**TITLE:** Dancing For Balance and Gait: A Systematic Review of the Efficacy of Dance for Patients with Parkinson's Disease

**AUTHORS/INSTITUTIONS:** K. Curbow Wilcox, A.H. Banahan, R.C. Boyd, J.L. Hill, N.P. Johnson, S.D. Kitchens, M.T. Prewitt, T.R. Skrmetti, School of Health Related Professions, Department of Physical Therapy, University of Mississippi Medical Center, Jackson, MS;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Parkinson's Disease, which affects approximately one million people in the United States, is a disease of the nervous system that results in tremors, rigidity, bradykinesia, impaired balance, and gait deviations among other symptoms. In addition to pharmacological and surgical interventions, physical therapy is a viable treatment option to address the clinical manifestations of Parkinson's Disease. Among the various physical therapy treatments for Parkinson's Disease, dance therapy (or therapeutic dance) may be utilized and incorporated into the patient's plan of care. The purpose of this systematic review was to determine if therapeutic dance is an effective intervention to improve balance and gait characteristics in patients with Parkinson's Disease.

**Number of Subjects :** Design: systematic review

**Materials/Methods :** A systematic review of the literature was conducted using the CINAHL database with search years of January 1998 to March 2011. Search strategies included using terms related to Parkinson's Disease, dance, and balance. Terms were combined using "AND" and "OR" operators. Electronic limitations included abstract available, peer-reviewed, human subjects, English language, and adult age (19 and older). Inclusion criteria included balance, treatment/intervention, and gait. Exclusion criteria included dancers. Using the electronic screening strategy, 21 articles were gathered. Following the title screen, abstract screen, and article screen, 5 articles remained. The 5 articles were then evaluated using the PEDro scale and the 2011 Center for Evidence-Based Medicine (CEBM) levels. The PEDro scale is used for rating the methodological quality of randomized controlled trials by looking at external (one criterion) and internal (nine criteria) validity of studies using a ten point scale. CEBM levels are based on the type of study that was scored using a I to V scale with I representing studies with the highest level of evidence.

**Results :** Five studies met the purpose of the study. PEDro scores ranged from 2-5 with an average score of 3.8. CEBM Levels included two level III and three level V studies.

**Conclusions :** Dance therapy shows promise as an effective intervention for patients with Parkinson's Disease, in that therapeutic dance has shown to significantly improve at least one balance or gait outcome measure per study used for this systematic review. However, the overall evidence for this systematic review is graded as a C. This grade was due in part to the weakened internal validity of the 5 studies reviewed. As implied by the grade of C, more supportive evidence is needed before therapeutic dance can be effectively utilized as a physical therapy intervention in a clinical setting.

**Clinical Relevance :** Because some beneficial improvements in balance and gait characteristics have been reported, a physical therapist may recommend a group dance class to a patient with Parkinson's Disease. However, this recommendation should be suggested as an optional addition to existing clinically proven treatments for Parkinson's Disease.

**TITLE:** Reliability and Validity of Resting State Functional Connectivity in the Motor Cortex as Revealed by Near Infrared Spectroscopy.

**AUTHORS/INSTITUTIONS:** A. Butler, H. Atwood, K. Cleveland, D.C. Fennerty, E.D. Wigfall, J.L. Wallace, J. Rajendra, Rehabilitation Medicine, Emory University, Atlanta, GA; G. James, Psychiatric Research Institute, University of Arkansas, Little Rock, AR;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The primary objective of this study was to investigate the test-retest reliability of fNIRS-based resting state functional connectivity (RSFC) maps for the primary motor cortex (M1), premotor cortex (PM), and supplementary motor cortex (SMA) in able-bodied people. Secondly, the validity of motor RSFC maps generated with fNIRS was investigated through comparison to RSFC maps generated with fMRI in the same able-bodied people.

**Number of Subjects :** Seventeen able-bodied adults completed two fNIRS recording sessions seven days apart while performing rest and motor tasks. Five subjects underwent a single resting state functional magnetic resonance image (fMRI).

**Materials/Methods :** Three regions of interest (ROI), M1, PM, and SMA, were defined anatomically and corresponding fNIRS channels were selected based on the international 10-20 system. Correlations between time courses in ROIs were calculated for oxy hemoglobin (HbO), deoxy hemoglobin (HbR), and total hemoglobin (HbT) for both sessions. Intraclass correlation coefficient (ICC) values were calculated for each region of interest between sessions. Additionally, differences between fMRI and fNIRS correlations were investigated using paired t-tests.

**Results :** RSFC maps were generated for both resting and motor states using mean HbO values for session 1 and 2. Pathweights for HbO timecourses were strong between all three ROIs, sessions, and tasks, and stronger between M1 and PM and in the resting state paradigm. ICC's revealed strong reliability (0.50 – 0.91) of RSFC maps in HbO and HbR in both the resting and motor task. Strongest repeatability was found in HbO in the motor task. Comparison of fNIRS-based RSFC maps with those generated by fMRI indicated comparable RSFC for the M1 and SMA ( $p = 0.104$ ), while the means of PM-M1 ( $p = 0.002$ ) and PM-SMA ( $p = 0.004$ ) revealed a statistically significant difference.

**Conclusions :** Results from the test-retest analysis showed that the fNIRS RSFC maps in the motor network are reliable over time, consistent with previous findings. However, the validity investigation of fNIRS and fMRI RSFC maps did not demonstrate consistent results. Further examination of the use of fMRI RSFC maps for comparison with fNIRS is required.

**Clinical Relevance :** fNIRS may be useful for monitoring and studying functional reorganization of the cortical networks responsible for motor control that may contribute to adaptation leading to functional recovery of poststroke hemiparesis.

**TITLE:** Falling and Fear of Falling After Stroke: a Qualitative Study

**AUTHORS/INSTITUTIONS:** C.P. Kelley, M. Carlegis, K. Suchma, School of Physical Therapy, Texas Woman's University, Houston, TX; S.K. Ostwald, School of Nursing, University of Texas Health Science Center at Houston, Houston, TX;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Up to 66% of survivors of stroke (SSs) have experienced falls, with up to 37% sustaining an injury. Fear of falling (FoF) has been reported in 54% of SSs. The purpose of this study was to gain an in-depth understanding of the issues expressed by SSs and their spousal caregivers related to falling and FoF. The research question was, "What are the lived experiences of SSs and spouses about falling and FoF?"

**Number of Subjects :** 6 SSs and their spouses

**Materials/Methods :** The phenomenological qualitative research tradition was used to conduct follow-up in-depth semi-structured interviews of six couples from an original study of 133 couples. The Activities-specific Balance Confidence (ABC) Scale was embedded within the interview. Each interview was audio recorded and transcribed verbatim. Member checking was used to ensure accuracy of what they intended to express. Each researcher performed independent open coding, followed by triangulation of the data by the first three researchers. All coded data was transferred onto index cards for sorting and reorganizing into categories and themes.

**Results :** Two female and four male SSs and their spouses were interviewed. SSs were an average of 69.5 years old, 7.2 years post stroke, and 5/6 had residual left hemiparesis. Their ambulatory abilities ranged from physiological walking to least limited community walking. Five SSs reported receiving education in fall prevention, one regarding FoF, and three in how to get up from the floor. All SSs reported at least one fall since hospital discharge, and 50% reported sustaining an injurious fall. Two SSs reported FoF when directly asked, but 83% of them scored less than 79% on the ABC. The overarching theme of adjustment emerged, with subthemes of 1) physical and 2) emotional/cognitive adjustment. Under physical adjustment, the categories were environment, including barriers, modifications, and obstacles; equipment usage; and physical self, including activity limitations, impairments, and injuries. Under emotional/cognitive adjustment, responses to loss and safety concerns fell within the negative category, and acceptance, awareness, determination, self-confidence, strategies, and support fell within the positive category.

**Conclusions :** The SS fall history was unknown to the researchers as they recruited couples from the original study. The SSs' reported fall incidence, injuries, and FoF exceeded that found in existing literature. Those with concerns about these issues may have been more likely to agree to participate, although they represented a wide variety of SS ambulatory ability. The SSs and their spouses expressed significant issues related to physical and emotional/cognitive adjustment, most of which physical therapists can impact.

**Clinical Relevance :** Education and training regarding falling, fall prevention, FoF, and getting up from the floor appear to be inconsistent. Heightened awareness of issues expressed by SSs and their spouses may improve care provided in hospital and post-hospital/community settings. Reduction of falling and FoF can help SSs and spouses to adjust as they resume life activities.

**TITLE:** The EXCITE Trial: Analysis of “Non-completed” Wolf Motor Function Test Items

**AUTHORS/INSTITUTIONS:** S.L. Wolf, T. Lonergan, N. Richardson, Division of Physical Therapy, Emory University School of Medicine, Atlanta, GA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** This is the first study to examine Wolf Motor Function Test (WMFT) tasks among EXCITE Trial participants that could not be completed at baseline or 2 weeks later at post-test.

**Number of Subjects :** Data were collected from participants who received Constraint Induced Movement Therapy (CIMT) immediately at the time of randomization (CIMT-I, N = 106) and those who were delayed in receiving this intervention one year later (CIMT-D, N = 116)

**Materials/Methods :** Generalized estimating equation (GEE) analyses were used to examine repeated binary data and count values. Condition and visit interactions were assessed, adjusting for functional level, affected side, dominant side, age, and gender covariates.

**Results :** CIMT-I participants increased the proportion of completed tasks at post-test compared to CIMT-D, particularly for tasks 10-12 and Total Incompletes ( $p < .0033$ , Bonferroni correction). One hundred and twenty tasks for CIMT-I and 58 for CIMT-D could be completed after two weeks compared to baseline. Common movement components that may have contributed to incomplete tasks include: shoulder stabilization and flexion, as well as elbow flexion and extension.

**Conclusions :** CIMT should increase emphasis on reeducating proximally specific movement components to improve functional gains from CIMT intervention.

**Clinical Relevance :** If CIMT can be more effective, patients will obtain a greater amount of function during their stroke recovery.

**TITLE:** Blue Prescription: facilitating self-directed increases in physical activity for people with multiple sclerosis

**AUTHORS/INSTITUTIONS:** L.A. Hale, H. Mulligan, C. Smith, School of Physiotherapy, University of Otago, Dunedin, NEW ZEALAND; G.J. Treharne, Psychology, University of Otago, Dunedin, NEW ZEALAND;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Participation in physical activity is important for health but long term engagement in physical activity is challenging for people with multiple sclerosis (MS). We developed a novel approach to enhancing physical activity adherence (called "Blue Prescription" (BP)) based on three evidence-based factors: 1) choice of activity, (2) control over level of engagement, and (3) support in choice of activity with advice and encouragement over time from a physical therapist (PT). The purpose of our exploratory phase II study was to investigate the short term benefits of BP among people with MS with a range of disability levels.

**Number of Subjects :** Twenty-six individuals with a definite diagnosis of MS, of any type, duration or level of disability.

**Materials/Methods :** Using a mixed-methods non-controlled before-after design, participants were assessed at baseline and three months later by trained research assistants blinded to the nature of the intervention. Measures included the Multiple Sclerosis Impact Scale (MSIS-29), European Quality of Life Scale (EQ-5D) and MS Self Efficacy Scale (MSES), activity diaries and qualitative in-depth interviews. PTs, blinded to results, met with participants in their homes 3 times. Using motivational interviewing, goals around physical activity levels were set, the desired physical activity chosen by the participant and a problem-solving process used to discuss how the desired physical activity could be achieved. Participants could choose any physical activity but the activity had to be something the participant felt they could realistically continue with in the long term on their own or with the support of family/friends. At the final visit PTs used volitional help sheets to assist participants with maintaining their level of engagement long term. Data were analysed with Wilcoxon signed ranks test. Qualitative data were analyzed using the General Inductive Approach. All participants provided informed consent; the study had University of Otago Human Ethics Committee approval.

**Results :** The MSIS-29 significantly improved, both statistically ( $p=0.018$ ) and clinically ( $>7$ points) (effect size: 0.3). There were no significant changes in the EQ-5D or MSES. Qualitative analysis identified 'Support' as a key theme with the sub-themes signifying the importance of 'The relationship', 'The approach', and 'Supporting myself'. Two additional themes were 'Motivation to participate' and 'Tweaking the approach'.

**Conclusions :** BP had a favourable impact on the lives of our participants; they felt supported and motivated to engage in physical activity, and enhanced self-efficacy enabled them to support themselves. Participants valued PT expertise and advice. Progression to an international randomized controlled trial with long term follow-up is warranted.

**Clinical Relevance :** The cost of professional health care is high. Enabling people with chronic disorders to participate in physical activity using the BP approach requires only minimal PT input but appears to have the potential for long term health benefits.

**TITLE:** Patterns in Manual and Power Wheelchair Training: Findings from the SCI Rehab Project

**AUTHORS/INSTITUTIONS:** S. Taylor Schroeder, Allied Health, Rehabilitation Institute of Chicago/University of Michigan, Chicago, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Describe the variation in manual and power wheelchair training for patients with traumatic spinal cord injury (SCI).

**Number of Subjects :** 600 patients in a practice based evidence, observational, cohort design

**Materials/Methods :** Physical therapists and occupational therapists (OT) providing regular care to patients with SCI documented the content of each physical therapy (PT) sessions using a portable electronic device featuring customized software. Session type (group vs. individual), session activities, and time spent on each activity were documented. Patient and injury characteristics were obtained via chart review. Level and completeness of SCI were determined using the International Standards of Neurological Classification of SCI. Total minutes of treatment per week was calculated and compared among groups using Chi-square tests and ANOVA.

**Results :** The majority of SCIRehab patients (95%) participated in PT sessions involving wheelchair (WC) mobility during inpatient rehabilitation; a large subset (67%) also participated in OT WC mobility training. OT information is included here to ensure that all time spent on WC mobility is accounted for. 76% of patients with cervical injuries and 21% with thoracic injuries practiced power WC mobility skills. 81% of patients with cervical injuries, 76% with thoracic injuries, and 63% with lumbar injuries practiced manual WC mobility skills. Only 5% received no WC mobility training. Together, OT and PT provided 5013 manual WC mobility sessions (49 minutes per week (mean)) and 2988 power WC sessions (36 minutes per week). Significant differences in time spent were seen among neurologic injury groups for both manual and power WC training.

Therapists provided training on 10 skills for manual WC mobility using 9 types of adaptive equipment. Propulsion was the manual WC skill practiced most frequently (2925 sessions with 445 patients) followed by wheelies (1348 sessions with 260 patients). Eight skills (5 types of adaptive equipment and 6 drive types) were included in power WC training: again, propulsion/driving was the most frequent power WC skill practiced (1428 sessions with 265 patients) followed by positioning in chair (564 sessions with 173 patients).

**Conclusions :** Wide variation in type of training, time spent, adaptive equipment, and drive types demonstrates the absence of a common standard of care and the need to determine the best type of wheeled mobility training to prepare a patient with varying levels of SCI to return to the community and be as independent as possible.

**Clinical Relevance :** Manual and power WC mobility are essential skills that are practiced with patients with SCI. These findings form a foundation for determining skills that are essential for enabling mobility independence for patients with various levels of injury.

**TITLE:** Movement System Diagnosis and Management of a Patient with an Incomplete Spinal Cord Injury

**AUTHORS/INSTITUTIONS:** L. Horan, S.L. Cornbleet, Program in Physical Therapy, Washington University School of Medicine, St. Louis, MO;

**ABSTRACT BODY:**

**Background & Purpose :** More than 8,000 people suffer a traumatic spinal cord injury (SCI) each year in the US. Of these, more than 50% have motor incomplete lesions. Recent literature supports the use of a movement system diagnosis to classify a patient based on deficits at the impairment level, and treatment (tx) is directed by the movement system diagnosis. Use of the movement system diagnosis in the neurologic population has only been demonstrated in patient's post-stroke. The purpose of this case report is to describe the use of a movement system diagnosis to guide the management of a patient with an incomplete SCI.

**Case Description :** The patient was a 54 year old male with an incomplete C3-4 SCI following a traumatic fall. Three days post-injury the patient was admitted to inpatient rehab. Following the initial physical therapy (PT) exam, the patient was given the movement system diagnosis of Movement Pattern Coordination Deficit (MPCD), indicating a primary movement dysfunction in the inability to coordinate intersegmental tasks due to a deficit in timing and sequencing. The primary lower extremity (LE) movement dysfunction is observed during postural control tasks with improvement noted in practice and instruction. Key findings for the patient in this case report include: 1) altered sequence of movement components during sit-to-stand with inadequate forward translation of tibias over feet and posterior sway at termination, 2) increased sway, knee hyperextension, and repeated stepping to maintain balance in quiet standing, 3) variable foot placement during gait, and 4) impaired ability to perform non-equilibrium tasks, such as heel-to-shin and toe tapping. The patient's performance improved with practice in all tasks. LE strength was 3/5 or better and not a limiting factor to his progress. The focus of tx was to correct the patient's movement patterns by coordinating LE segments during functional mobility tasks.

**Outcomes :** The patient received PT for a total of 30 sessions over 3 weeks. The patient's Functional Independence Measure- Locomotion subscale increased from 1/14 to 11/14; Berg Balance Scale improved from a 32/56 to 41/56; and 10-Meter Walk Test improved from 3.3-4.0 km/h. Marked visual improvements were noted in his ability to coordinate movement during functional tasks with little change in LE strength.

**Discussion :** Using a movement system diagnosis for a neuromuscular condition can more appropriately guide the selection of interventions. Commonly, patients with a SCI have major strength deficits and would be given a movement system diagnosis of Force Production Deficit with tx directed at strengthening and/or compensatory strategies to accomplish functional tasks. Tx for the patient in this case focused on improvement of postural control activities and practice of essential components of mobility tasks, instead of strength or compensation. Performing a detailed neuromuscular examination to determine the appropriate movement system diagnosis may aid physical therapists in developing more appropriate and efficient tx programs.

**TITLE:** The Experience of Implementing Standardized Stroke Outcome Measures Across the Continuum of Post-Acute Care

**AUTHORS/INSTITUTIONS:** M. Danzl, Rehabilitation Sciences, University of Kentucky, Lexington, KY; E.G. Hunter, , Cardinal Hill Rehabilitation Hospital, Lexington, KY;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To describe the experiences of clinicians and administrators in implementing stroke outcome measures at a rehabilitation hospital.

**Number of Subjects :** Twenty-five.

**Materials/Methods :** Qualitative case study methodology was utilized. Participants were recruited through purposeful maximal sampling. Data collection involved individual interviews, focus groups, participant observations, photographs and documentation review. Interviews were coded and categories and themes emerged. To establish trustworthiness and credibility, data analysis included triangulation, peer debriefing, member checks, an audit trail, and a reflection journal.

**Results :** Participants concur that using standardized outcome measures represents best practice. Clinicians, initially resistant to altering practice, conceded that implementing the tools improved clinical practice. Additional benefits include holistic conceptualization of care, equipment justification, reimbursement support, and client motivation and education. Systems, therapist, and continuum barriers were identified. Systems barriers include inadequate time and space and data management for research. Therapist barriers include low self-efficacy in using the tools, effective standardization training, changing clinical habits, and frustration at the lack of follow-through in using the data for research. Continuum barriers include identifying appropriate tools and enabling data transfer across settings. Therapists expressed that only the Timed Up and Go and the Berg Balance Scale could pragmatically be used across all settings and be most clinically meaningful. Most therapists reported difficulty with the Fugl-Meyer Assessment of Motor Performance. Clinicians desire tools that are functional, enhance goal writing, and are easily interpreted by clients.

**Conclusions :** Outcome measures improve clinical practice. An “outcomes toolbox” in which clinicians can choose outcome measures may be more beneficial than mandating specific tools by enabling clinical decision-making. The APTA StrokEDGE task force provides a thorough assessment of outcome measures to guide practice. The findings could standardize toolboxes for the continua of post-acute care. Study design limitations include the fact that the primary investigator works with the participants in the hospital studied. Secondly, this study took place in one facility which limits data transferability, however, the issues raised allow for the development of questions for future study such as enhancing clinician’s ability to choose appropriate tools. For instance, as the Fugl-Meyer findings demonstrate, clinical extrapolation of a research gold standard measure can be tenuous.

**Clinical Relevance :** Current research focuses on surveys and systematic reviews to identify benefits and barriers to using outcome tools. This is the first qualitative investigation of a hospital’s attempt to address barriers to using outcome measures and the subsequent effects on practice. The findings can assist hospitals with post-acute care continua who wish to implement the use of outcome measures.

**TITLE:** Informing Locomotor Training Prescription Post-Stroke

**AUTHORS/INSTITUTIONS:** D.K. Rose, A.L. Behrman, X. Lin, D. Martin, R. Schofield, S.S. Wu, , University of Florida, Gainesville, FL; K.J. Sullivan, J.K. Tilson, , University of Southern California, Los Angeles, CA; P. Duncan, , Duke University, Durham, NC;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Pre-morbid physical inactivity is a risk factor for stroke. Hemiparesis with mobility limitations further contributes to cardiovascular deconditioning. Training on a treadmill (TM), even with body-weight support (BWS), places a certain cardiovascular demand on patients. Exercise Tolerance Testing (ETT) is not routine prior to initiation of rehabilitation, but may provide important information regarding readiness for a locomotor training program (LTP). The purpose of this study was to determine the relationship of ETT performance to LTP readiness, defined as number of sessions needed to attain stepping duration of 20 minutes.

**Number of Subjects :** Participants (n=282;age:65±13 yrs;56±9 days post-stroke) in the Locomotor Experience Applied Post-Stroke trial were randomized to a LTP which included TM training w/BWS, either early at 2-months (e-LTP) or late at 6-months post-stroke (l-LTP). They were stratified according to walking velocity as severe (< 0.4 m/s) or moderate(>0.4 m/s < 0.8 m/s) stroke.

**Materials/Methods :** To ensure adequate cardiovascular functional capacity and exercise tolerance during LTP participants completed a cycle-ergometer based ETT. Screening via chart review excluded those with serious cardiac conditions. Participants pedaled with workload increased 10 W/minute. ETT was terminated (and cycling duration recorded) according to a prescribed list of cardiac criteria or fatigue. Baseline assessments included the Six-Minute Walk Test (6MWT) and Lower Extremity Fugl-Meyer Motor Score (LEFM). LTP consisted of 36 sessions with the goal of 20 minutes of stepping per session. Cox regression model tested the hypothesis that individuals with better ETT performance (longer cycling duration) would need fewer training sessions to attain 20 minutes of TM stepping. Training group (e-LTP vs. l-LTP), the interaction of ETT performance by training group, age, baseline severity, LEFM and 6MWT distance served as covariates.

**Results :** There was no difference in ETT performance (6.1±2.4 vs. 5.8±2.1 min), 6MWT (124±78 vs. 126±82 meters) or LE-FM (23.7±6.7 vs. 24.8±6.4) for those randomized to e-LTP (n=139) or l-LTP (n=143). ETT performance was negatively associated with number of sessions to first attain 20 minutes of stepping: Spearman's rank correlation -0.24 (p<0.0001) and unadjusted hazard ratio 1.13 (p < 0.0001). However, results from Cox regression showed that the effect of ETT performance (Hazard Ratio (HR) = 1.05; p=0.24) or intervention group (HR=1.18; p=0.66) were not significant for the number of sessions to first attain 20 min stepping, after adjusting for participant's age (HR = 0.98; p = 0.001) and 6MWT distance (HR = 1.01; p < 0.0001).

**Conclusions :** ETT cycling duration was not correlated to LTP readiness (20 minutes of stepping) when controlled for 6MWT distance and age. These latter factors contribute to LTP performance and can inform clinicians regarding treatment planning and goal-setting when initiating a LTP post-stroke.

**Clinical Relevance :** Simple demographic and clinical gait performance measures provide tools to design appropriate locomotor training programs for patients post-stroke.

**TITLE:** Participants' perspectives on the benefits associated with an intensive, task-specific intervention for gait, balance and mobility in individuals with chronic stroke: A qualitative analysis

**AUTHORS/INSTITUTIONS:** A.R. Merlo, Physical Therapy, Franklin Pierce University, Goodyear, AZ; A. Goodman, Health, Leisure and Exercise Science, Appalachian State University, Boone, NC; B.K. McClenaghan, S.L. Fritz, Exercise Science, University of South Carolina, Columbia, SC;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The physical therapy profession has emphasized the importance of incorporating patient preferences and priorities throughout the rehabilitation process (Ozer, Payton et al. 2000). Evidenced based practice (EBP), an influential model in the physical therapy community, includes the incorporation of clinical expertise, current and relevant research and patient priorities and preferences. Although patient priorities and preferences are taken into account during direct patient care, there appears to be a lack of patient input at the level of research.

The observation and intense analysis of personal perspectives of those who participate may lend supportive evidence to the quantitative findings, give valuable insight pertaining to the benefits and/or drawbacks of rehabilitative techniques, as well as highlight new questions or problems that may be addressed in future research studies. Therefore, the purpose of this study was to identify and describe what participants perceive to be the benefits of participating in a larger randomized controlled trial of an intensive, task-specific intervention for individuals with chronic stroke.

**Number of Subjects :** 8

**Materials/Methods :** A purposive sample of eight participants voluntarily participating in an intensive, task-specific therapy was interviewed on three separate occasions: during the therapy, at the conclusion of therapy and one-month post therapy. In addition, a focus group was held with seven individuals. Data was collected via in-depth, semi-structured interviews. Interviews were transcribed verbatim and analyzed using Nvivo 8 software to identify common themes. Peer review, member checking and reflexivity were used to establish trustworthiness.

**Results :** Six major themes arose during the data analysis, including: improvements in walking ability, ability to do daily activities, increased confidence in ability, improvements in balance, improvements in endurance, and improvements in lower extremity strength.

**Conclusions :** These findings support the purpose of the larger trial, identifying improvements in gait, balance and mobility. Improvements outside the scope of the larger trial were also identified, such as psychosocial benefits, endurance and strength.

**Clinical Relevance :** Further research should incorporate a mixed methods design to provide a more comprehensive evaluation of rehabilitation research.

**TITLE:** Incidence and Impact of DVT and /or PE Following Brain Injury during Inpatient Rehabilitation

**AUTHORS/INSTITUTIONS:** C.M. McQuillan, T.L. Fetter, Physical Therapy, Marianjoy Rehabilitation Hospital, Wheaton, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to examine the incidence and risk factors associated with developing a deep vein thrombosis (DVT) and/or pulmonary embolism (PE) for patients following a traumatic brain injury (TBI) and its impact while participating at inpatient rehabilitation (IPR).

**Number of Subjects :** A total of 766 patients were identified using pre-admission impairment codes.

**Materials/Methods :** This retrospective study included all patients who were admitted to a freestanding rehabilitation hospital over 24 months with a diagnosis of a TBI. The medical chart reviews were conducted by two physical therapists. Information abstracted during the medical chart reviews included the following: gender, age, weight / BMI, admit FIM score, presence of paralysis of lower limb, history of DVT or PE at the acute care, history of surgery at the acute care, presence of a DVT or PE during IPR, length of stay for IPR, discharge FIM score, and discharge destination from IPR. For data integrity, at random 25% of the chart reviews were re-evaluated by different reviewer.

**Results :** An overall incidence rate of 5.7% (44/766) was found for presenting with either a DVT and/or PE either at the time of admission or during IPR. Of those 44 patients, only 9 patients (1.17%; 9/766) actually developed the DVT and/or PE while at IPR. With those 9 patients, all (9) had a cerebral bleed, 5 underwent a craniotomy at the acute care, 5 had an IVC filter already placed, and only 1 was receiving anticoagulation therapy. The study sample was divided into two cohorts. Group 1, n=44, consisted of consecutive admissions to the brain injury program who presented with a DVT and/or PE either at the time of admission or develop one during IPR. Group 2, n=44, consisted of case-matched consecutive admissions for age, gender, injury type/diagnosis, and admission FIM scores who did not present with a DVT and/or PE during IPR. The significant variables associated with the development of a DVT/PE during IPR were the presence of a DVT and/or PE at the acute care (Group 1=79.55%; Group 2 = 0%, p=0.001) and the presence of paralysis in the lower extremity (Group 1=45.5%; Group 2=20%, p=0.001). Differences in BMI (Group 1=27.45; Group 2=25.55, p=0.197) and for a history of undergoing surgery at the acute care (Group 1=61.4%; Group 2= 50%) were not significant. Rehabilitation outcomes for overall FIM gain (Group 1=17.4, Group 2=18.6), FIM gain per day (Group 1=1.19, Group 2 =0.997), and length of stay (Group 1=18.48 days, Group 2=18.5 days) were not statistically significant.

**Conclusions :** This study identified an overall 5.7% incidence rate of presenting with either a DVT and/or PE during IPR. Presence of lower limb paralysis was associated with developing this complication. Rehabilitation outcomes were similar between the two groups.

**Clinical Relevance :** Patients who present with a DVT and/or PE during IPR are still able to make rehabilitation gains comparable to patients who did not present with this complication.

**TITLE:** Inter-rater reliability and Consistency of the Dynamic Gait Index Among Vestibular Physical Therapists at the Cleveland Clinic.

**AUTHORS/INSTITUTIONS:** K.E. Cherian, A. Cassady, V.K. Ranganathan, , Cleveland Clinic, Cleveland, OH;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Currently the use of outcome measures are being emphasized in clinical physical therapy practice. Advanced vestibular training suggests using the Dynamic Gait Index (DGI) as an outcome measure of fall risk. The purpose of this study was to examine inter-rater reliability and consistency in DGI scoring among trained vestibular therapists (1 to 10 years of training) as compared to an expert therapist (>20 years of training).

**Number of Subjects :** Seventeen physical therapists who attended the Vestibular Rehabilitation Competency Based Course presented by Dr. Susan Herdman et. al, and one faculty member from this course were involved in our study.

**Materials/Methods :** Informed consent was obtained from a current vestibular patient. A video recording was made while he performed two trials of the DGI. The video was edited and then viewed by the seventeen vestibular therapists at the Cleveland Clinic as well as by an expert vestibular therapist. Scores were obtained on each of the eight categories as well as the total score for the DGI.

**Results :** The total DGI score by the trained PT's varied from 14/24 to 20/24, while the expert therapist scored the DGI at 21/24. The greatest variance in scoring was in the categories: gait and pivot turn, change in gait speed, gait level surface and gait with horizontal head turns. The average score of DGI by Cleveland Clinic Therapists was 18/24 which places the patient at risk for falling, while the expert therapist score was 21/24 which indicates that he is not at risk for falling.

**Conclusions :** The scores from the trained vestibular therapists were not reliable when compared to one another or to the expert score. At this time, it is unclear whether this is an artifact of the quality of the video recording, the use of the video instead of a live patient, or of the limitation of the DGI itself. A study limitation of only one expert therapist versus a panel of experts may also improve inter-rater reliability. However, if the DGI is to be used as a reliable tool in the vestibular population it appears that additional clarification on the three areas of discrepancy (as noted above) would be of benefit.

**Clinical Relevance :** The DGI is an outcome measure for assessing fall risk. Even though the therapists involved in this study had specialized training on grading this gait measure, several areas of weakness and subjectivity were identified. Further research and training is needed to assist in standardizing scoring, equipment, and set up of this commonly used gait assessment to improve inter-rater reliability.

**TITLE:** Factors related to walking economy in people with Parkinson's disease

**AUTHORS/INSTITUTIONS:** C.L. Christiansen, M. Schenkman, Physical Medicine & Rehabilitation, University of Colorado, Aurora, CO; W.M. Kohrt, Geriatric Medicine, University of Colorado, Aurora, CO; B.S. Davidson, Mechanical and Materials Engineering, University of Denver, Denver, CO;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** This study examined factors related to poor walking economy in people with Parkinson's disease (PD). We hypothesized that specific measures related to age, gait function, motor impairment, pulmonary function, and fatigue would be associated with walking economy for people with PD.

**Number of Subjects :** Eleven women and men classified at Hoehn and Yahr (HY) stages 2 to 3 participated (age: 66.6 ± 8.1 years, BMI: 25.2 ± 3.4 kg/m<sup>2</sup>).

**Materials/Methods :** Walking economy was determined by measuring net rate of oxygen consumption (VO<sub>2</sub>; gross minus resting) during treadmill walking at 2.5 mph. Gait function measures during walking at 2.5 mph were lower extremity muscle co-activation index (CI), stride rate (SR), and SR variability. Motor impairment and rigidity were measured using the Unified Parkinson's Disease Rating Scale (UPDRS) motor score and rigidity rating criteria. Pulmonary function was measured as forced expiratory volume in one second (FEV<sub>1</sub>) divided by forced vital capacity (FVC). Fatigue was measured using the self-report Parkinson's Fatigue Scale (PFS).

**Results :** Pearson product-moment correlations of VO<sub>2</sub> with FEV<sub>1</sub>/FVC ( $r = -0.67$ ), lower extremity CI ( $r = 0.63$ ), lower extremity rigidity rating ( $r = 0.45$ ), SR ( $r = 0.30$ ), UPDRS motor score ( $r = 0.30$ ), and PFS ( $r = 0.27$ ) were fair to moderately strong. There was no apparent relation of VO<sub>2</sub> with age ( $r = 0.04$ ), SR variability ( $r = -0.03$ ), or upper extremity rigidity ( $r = 0.09$ ).

**Conclusions :** It has been suggested that typical disease severity measures of PD (i.e., HY and UPDRS total scores) do not adequately capture the factors related to poor walking economy in people with PD. This study identified gait function, motor impairment, and fatigue measures having direct relations with walking economy in people with PD. Pulmonary function, as measured by normalized forced expiratory volume (FEV<sub>1</sub>/FVC), was inversely related to walking economy.

**Clinical Relevance :** Identifying mechanisms underlying poor walking economy in people with PD is important to develop interventions addressing this PD-related phenomenon. Additionally, it is clinically relevant to understand the association between walking economy and fatigue, a common problem reported by people with PD. This exploratory study supports further examination of gait-related muscle co-activation, stride rate, disease-specific motor impairments, lower extremity rigidity, and pulmonary function as factors linked to walking economy in people with PD.

**TITLE:** Tolerance to a Tilt Table Standing Protocol In an Acute Stroke-Unit Setting: A Pilot Study.

**AUTHORS/INSTITUTIONS:** H. Lietz, I. Sausser, M. Baltz, Physical Therapy, University of Michigan Hospital, Ann Arbor, MI; C. Kalpakjian, PM&R, University of Michigan, Ann Arbor, MI; D. Brown, Neurology, University of Michigan, Ann Arbor, MI;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To describe and examine physiological and self-reported indices of tolerance of a standing tilt table protocol (STTP) among patients following an acute cerebral vascular accident.

**Number of Subjects :** Participants: 36 (22 females, 14 males) aged 24 to 87 years (62 + 16 years) and admitted to an acute stroke unit, diagnosed with either ischemic or hemorrhagic CVA.

**Materials/Methods :** Methods: A clinical protocol for the use of the tilt table was developed and applied to subjects in the acute phase following a CVA. A step-wise process to gradually raise the subject into a standing position for bilateral LE weight bearing on the tilt table platform, at 10 deg. intervals from 60 to 90 degrees. Following demonstrated tolerance for 5 minutes at each deg., angle of inclination was progressed until one or more tolerance indices were failed. Tolerance was operationally defined as predetermined variance from baseline on multiple physiological measures: vital sign parameters (BP, HR, SpO<sub>2</sub>), subjective report (RPE, pain, angina, nausea, and disequilibrium) and clinical presentation (pallor, diaphoresis, and dyspnea). Data was reported using descriptive analysis. Specifically, frequencies of the highest angle achieved, the central tendency for duration of standing time tolerated, and physiologic response.

**Results :** 53% of subjects (N = 19) attained 60 degrees or higher (minimum of 87% total weight bearing) on the standing tilt table. Ten subjects were unable to achieve 45 degrees or greater. Subjects tolerated a mean total standing time, at or above 60 degrees, of 8.9 + 7.2 minutes. Physiologic indices of tolerance indicated 100% tolerance for dyspnea, pain, pallor, perceived effort, and nausea at 60 degrees or higher. For heart rate, 96% of subjects tolerated 60 degrees; for 70, 80 and 90 degrees 100% of subjects tolerated each degree. For diastolic blood pressure, tolerance ranged from 89.5% (70 degrees) to 72.2% (80 degrees). For systolic blood pressure, tolerance ranged from 100% (90 degrees) to 84.2% (70 degrees). Oxygen saturation tolerance was achieved in 100% of subjects at each angle.

**Conclusions :** The results of this pilot study suggest that a STTP is a viable option to safely assist patients into prolonged standing when otherwise immobilized.

**Clinical Relevance :** Given that this was a pilot study, and the use of strict, conservative operational criteria for physiological and self-report indices of tolerance, using less stringent criteria, given that intolerance was quite low and largely related to blood pressure changes, in the future and including additional parameters in future research is worthwhile. These may include mean arterial pressure (MAP), motor, sensory and cognitive function. The next step in this line of research is to test the STTP protocol in a larger sample across various conditions such as polytrauma, burn, oncology, cardiac, spinal cord injury and other medically fragile patient populations and to refine and/or expand parameters of tolerance.

**TITLE:** Reorganization of Spinal Neural Circuits after Locomotor Training in Human Spinal Cord Injury

**AUTHORS/INSTITUTIONS:** A.C. Smith, C.K. Mummisetty, Z.W. Rymer, , Rehabilitation Institute of Chicago, Chicago, IL; N. Hajela, , Department of Physical Medicine and Rehabilitation, Northwestern University, Chicago, IL; M. Knikou, , The Graduate Center, City University of New York, New York, NY;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The main objective of this study was to assess changes in the soleus H-reflex modulation pattern and leg muscle activity during assisted stepping in people with a chronic spinal cord injury (SCI) after 60 sessions of locomotor training (LT) while utilizing a robotic exoskeleton system (Lokomat®). We have previously shown that the phase-dependent modulation pattern of the soleus H-reflex is preserved during stepping with the Lokomat in control subjects (Knikou et al. 2011). Thus, the soleus H-reflex can be utilized as a probe to study the reorganization of spinal reflex circuits when the Lokomat is utilized for training or testing purposes.

**Number of Subjects :** This is an ongoing multi-year project. Findings are presented here for two individuals with a chronic motor complete (ASIA A) and sensory incomplete (ASIA B) SCI.

**Materials/Methods :** The experimental protocol was approved by the Institutional Review Board (IRB) of the Northwestern University and College of Staten Island IRB committees and was conducted according to the 1965 Declaration of Helsinki. All subjects signed a signed consent form before participation to the study. The soleus H-reflex was elicited following monopolar direct current stimulation of the posterior tibial nerve with a 1 ms single pulse by a custom-made stimulator. During stepping, the soleus H-reflex was elicited based on the signal from the ipsilateral foot switch and was evoked randomly across the step cycle which was divided into 16 equal bins. A supra-maximal stimulus was delivered to the posterior tibial nerve 80 ms after the test H-reflex, and this maximal M-wave was utilized to normalize the M-wave and H-reflex, all elicited at the same bin. During testing, electromyographic (EMG) activity of major hip, knee, and ankle flexors and extensors was recorded.

**Results :** In the subject with ASIA A SCI, the phase-dependent modulation pattern of the soleus H-reflex changed drastically after LT. Specifically, from early to mid stance the soleus H-reflex was progressively increased, while a maintained reflex excitability from mid to late stance was found in contrast to pre-LT reflex values. During the swing phase, the soleus H-reflex was significantly depressed after LT. Further, EMG activation profiles changed significantly post LT, with excitation patterns resembling those observed in control subjects. In the subject with ASIA B SCI, both the soleus H-reflex modulation pattern and EMG profiles changed significantly.

**Conclusions :** These findings provide evidence towards reorganization of spinal neural circuits after repetitive locomotor training in people with a chronic SCI.

**Clinical Relevance :** Locomotor training with Lokomat promotes recovery of walking through activity-dependent plasticity of the injured human spinal cord.

**TITLE:** The Effect of an Aquatic Exercise Program on Balance in Individuals with Parkinson's Disease

**AUTHORS/INSTITUTIONS:** A. Dupre, B. Marcoux, M. Jacobs, J. Fasano, M. Seyboth, E. Johnson, Physical Therapy, University of Rhode Island, Kingston, RI;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Postural instability and compromised balance in individuals with Parkinson's disease can lead to falls, injury, and a decrease in quality of life. The scientific literature certainly supports the role of exercise in helping to improve balance and stability. And although aquatic exercise has been shown to significantly improve balance in age-related populations, it has not been adequately studied in the target population. The objective of this single-group pretest-posttest pilot study was to evaluate the effectiveness of an aquatics-based exercise protocol on improving balance in persons with Parkinson's disease.

**Number of Subjects :** Eight independently ambulating individuals with a primary neurological diagnosis of Parkinson's disease participated in a six-week aquatic exercise program.

**Materials/Methods :** Subjects participated in aquatic exercise for one hour, twice weekly, for six weeks. Protocols focused on flexibility, strength, aerobic endurance, with additional emphasis on gait and balance training, trunk extension and rotational range of motion, and postural awareness. A unique aspect of the program was having clients work at an intensity of 13-15 on the Borg scale of perceived exertion. Outcomes included the Berg Balance Scale, the Step Test, and the analysis of a sit-to-stand task utilizing the BalanceMaster©.

**Results :** Analysis of pretest to posttest scores using the Wilcoxon signed rank test revealed significant improvements in balance for the Berg Balance Scale ( $p=0.05$ ) and the Step Test ( $p=0.02$ ), with non-significant findings for the sit-to-stand task analysis using the BalanceMaster©. All of the participants reported positive psychosocial benefits associated with completing the aquatic exercise protocol.

**Conclusions :** The results of this study suggest that a 6-week intensive aquatic exercise program may have beneficial effects on improving the balance of individuals with early to mid-stage Parkinson's disease. These results support the existing body of literature regarding both the benefits of exercise for individuals with Parkinson's disease, as well as the benefits of aquatic therapy in related populations. Due to the small sample size and lack of control, these findings are not generalizable and require confirmation with a larger randomized controlled trial.

**Clinical Relevance :** Participation in aquatics programs may facilitate improved balance and reduce falls for individuals with stages I-III PD.

**TITLE:** The Head Shake Sensory Organization Test (HS-SOT): Normative Data and Correlation with Dynamic Visual Acuity Testing

**AUTHORS/INSTITUTIONS:** S.C. Livingston, D. Burch, T. Clapp, H. Gream, E. Puckett, A. Cripps, Rehabilitation Sciences, University of Kentucky, Lexington, KY;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** (1) to establish normative data for the Head Shake Sensory Organization Test (HS-SOT) in a sample of healthy young adults, and (2) to examine the relationship between the HS-SOT and static/dynamic visual acuity test.

**Number of Subjects :** Sixty asymptomatic volunteers (34 females, 26 males, age  $23.7 \pm 1.6$  years; height  $172.0 \pm 12.9$  cm; mass  $72.1 \pm 15.5$  kg) participated in the study.

**Materials/Methods :** Each subject completed the sensory organization test (SOT), HS-SOT, and visual acuity testing [including static visual acuity (SVA), perception time test (PTT), gaze stabilization test (GST), and dynamic visual acuity (DVA) test] on the NeuroCom SMART Balance System using the InVision program. Subjects performed three 20-second trials on each of the six conditions of the SOT (18 total SOT trials), and four to five 20-second trials on each of the two HS-SOT conditions (8-10 HS-SOT trials). Outcome measures included: (a) composite equilibrium score, sensory analysis ratio, strategy analysis, and center of gravity alignment from the SOT; (b) equilibrium score ratio (ESR) and movement axis velocity for the HS-SOT; (c) static visual acuity (Snellen fraction), (d) minimum perception time (on the PTT) , and (e) maximum gaze velocity, symmetry difference [right to left], visual acuity difference [between static and dynamic conditions, and head velocity for the GST and DVA tests.

**Results :** Equilibrium scores for the HS-SOT condition 2 [eyes closed, fixed surface] =  $93.23 \pm 1.99$ , 95% CI = 92.7-93.8; and condition 5 [eyes closed, sway-referenced surface] =  $66.69 \pm 1.13$ , 95% CI=64.4-70.0. ESR for condition 2 =  $1.01 \pm .003$  ( $\delta^2 = .001$ ), and condition 5 =  $.94 \pm .03$  ( $\delta^2 = .055$ ). ESR fixed surface was negatively correlated with DVA loss symmetry % [ $R = -.36$ ,  $p = .004$ ,  $R^2 = .13$ ] and with DVA errors (right) [ $R = -.30$ ,  $p = .02$ ,  $R^2 = .09$ ].

**Conclusions :** Normative data for the HS-SOT in a healthy, asymptomatic sample of young adults are reported. Measures on the HS-SOT were not significantly correlated with measures of DVA, indicating that the HS-SOT and DVA assess two different constructs: postural stability during head movements (HS-SOT) and visual acuity during head movements (DVA), respectively. Outcome measures on the HS-SOT are not related to those of DVA testing in a normal, healthy sample.

**Clinical Relevance :** Normative data on the HS-SOT can be compared to clinically-derived HS-SOT data to assist the clinician with accurate assessment of postural instability due to possible peripheral vestibular involvement.

**TITLE:** Family-Centered Care during Constraint Induced Movement Therapy

**AUTHORS/INSTITUTIONS:** S. Blanton, D. Cussen, C. Schwartz, A. Holmes, B. Regan, Department of Rehabilitation Medicine, Emory University, Atlanta, GA; P. Clark, D. Aycock, Byrdine F. Lewis School of Nursing, Georgia State University, Atlanta, GA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Carepartner (CP) management of stroke survivor (SS) care improves recovery after stroke; however, this role can negatively impact the CP and result in increased fatigue and depression. Other factors such as family conflict or SS characteristics can increase burden and negatively impact CP mental health. Constraint Induced Movement Therapy (CIMT) can improve SS upper extremity function and health related quality of life. However, this approach frequently requires intensive practice in the home where family members play a supportive role, potentially increasing CP stress and burden. Expanding the CIMT intervention to address CP needs in collaboration with therapy sessions may improve SS outcomes and decrease caregiver burden. The purpose of this study was to evaluate the feasibility and effect of a CP-centered intervention in combination with modified CIMT to improve family function and CP health related quality of life.

**Number of Subjects :** 7 carepartners of stroke survivors

**Materials/Methods :** This pilot, feasibility study was a one-group, quasi-experimental design with pre-post and 1-month follow-up evaluations. The Caregiver and Constraint Induced Movement Therapy Evaluation (CARE-CITE) used an interactive workbook in ten, 20 minute sessions for the CP to address family roles in CIMT, general stroke education, self-efficacy for CP and SS, and autonomy support of SS. Instruments included Center for Epidemiologic Studies Depression Scale (CES-D), Piper Fatigue Scale (PFS), the Family Caregiver Conflict Scale for Stroke (FCCS) and the Knowledge of Stroke scale. With the small sample, estimated effect sizes are reported and alpha set  $p < .10$ .

**Results :** All 7 dyads completed the intervention. At baseline (BL), 43% of CP reported depression scores  $\geq 16$  indicating possible clinical depression; and moderate fatigue levels.

Most caregivers (86%) reported some conflict surrounding stroke recovery with average FCCS scores of  $41.29 (\pm 19.77)$ . The intervention had medium to large effect sizes from BL to 1 month follow-up with lower depression (BL  $M = 16.42 \pm 12.75$ , to 1 month  $M = 10.14 \pm 11.05$ ,  $p = .20$ ,  $d = 0.52$ ); less fatigue (BL  $M = 3.62 \pm 2.70$  to 1 month  $M = 1.63 \pm 1.65$ ,  $p = .05$ ,  $d = .89$ ); and less family conflict (BL  $M = 41.43 \pm 19.92$ , to 1 month  $M = 30.00 \pm 17.42$ ,  $p = .07$ ,  $d = 0.61$ ). CP also demonstrated improved knowledge of stroke with BL knowledge scores ( $M = 65.71 \pm 10.58$  to 1 month  $M = 75.00 \pm 10.41$ ,  $p = .066$ ,  $d = 0.88$ ).

**Conclusions :** Involving CPs in CIMT appears to be helpful in reducing CP depression and fatigue, as well as family conflict surrounding stroke recovery and CP knowledge of stroke. Results suggest that provision of a CP-focused intervention alongside CIMT is potentially feasible and effective.

**Clinical Relevance :** Family-centered care, promoting self-advocacy through educational and training programs, may collectively improve outcomes of the SS family unit. The CARE-CITE intervention serves as a potential framework for fostering CP involvement in other therapeutic interventions.

**TITLE:** Using A "Reverse" Brandt-Daroff Exercise In The Treatment Of Anterior Canal Benign Paroxysmal Positional Vertigo

**AUTHORS/INSTITUTIONS:** B. Kinne, , Grand Valley State University, Allendale, MI;

**ABSTRACT BODY:**

**Background & Purpose :** Anterior canal benign paroxysmal positional vertigo (AC-BPPV) is characterized by downbeating nystagmus with or without a torsional component. Like posterior canal benign paroxysmal positional vertigo (PC-BPPV), it is most frequently elicited when an individual looks upward, bends over, or performs bed mobility activities; and it is most often reproduced by the Dix-Hallpike test. Although it is the least common type of BPPV, it can have a negative impact upon an individual's health-related quality of life. Although five particle repositioning maneuvers have been developed for the specific management of AC-BPPV, the efficacy of these proposed treatments has not yet been determined. Therefore, PC-BPPV techniques, such as the Brandt-Daroff exercise, have traditionally been used in the management of AC-BPPV. The purpose of this case report was to describe the treatment of AC-BPPV using a "reverse" Brandt-Daroff exercise.

**Case Description :** The patient was a 41-year-old female who complained of a "spinning" sensation whenever she rolled over onto her right side in bed. During her initial evaluation, she demonstrated upbeating right torsional nystagmus with the right Dix-Hallpike test. This type of nystagmus is indicative of right-sided PC-BPPV. Therefore, she was treated with the Parnes particle repositioning maneuver, a PC-BPPV technique. When she was reevaluated four days later, she no longer reported any significant vertigo; and she exhibited a negative Dix-Hallpike test bilaterally. Approximately two months later, though, she returned to physical therapy with complaints of a "spinning" sensation whenever she rolled over in bed. Although she demonstrated a negative Dix-Hallpike test bilaterally, she exhibited downbeating right torsional nystagmus when she rolled over onto her right side. This type of nystagmus is indicative of right-sided AC-BPPV. Because she opted against having a particle repositioning maneuver performed, she was instructed in the Brandt-Daroff exercise. Two weeks later, she continued to complain of a "spinning" sensation whenever she looked upward or bent over. Therefore, she was instructed in a "reverse" Brandt-Daroff exercise.

**Outcomes :** The patient was contacted by telephone after having performed the "reverse" Brandt-Daroff exercise for approximately two weeks. At that time, she reported no significant vertigo during her everyday life. A year later, this positive outcome remained.

**Discussion :** The Brandt-Daroff exercise is a proven technique used in the management of PC-BPPV. Although it has also been used in the treatment of AC-BPPV, it was not successful in this particular case. After carefully considering the anatomical features of the anterior semicircular canal as compared to those of the posterior semicircular canal, it was proposed that a "reverse" Brandt-Daroff exercise would be more effective. Based upon its successful use in this case report, a "reverse" Brandt-Daroff exercise should be considered another viable option in the management of AC-BPPV.

**TITLE:** Reliability and validity of using a robotic exoskeleton to assess lower limb static position sense in persons with spinal cord injury

**AUTHORS/INSTITUTIONS:** A. Domingo, T. Lam, Human Kinetics, University of British Columbia, Vancouver, British Columbia, CANADA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Measures of sensory function are essential for evaluating the efficacy of treatments and therapies after spinal cord injury (SCI). Proprioception is a sensory modality that provides information about static position and movement of the limbs in space and is a critical component to motor control. Current clinical methods used to test proprioception are limited to crude, manual tests. In order to better characterize sensory deficits after SCI and during locomotor recovery, it is imperative to use more precise and quantitative assessment tools, particularly those that test lower limb proprioception. The purpose of this study was to develop a quantitative assessment tool to measure static position sense in the legs. We hypothesized that the Lokomat could provide a valid and reliable means of assessing proprioception in the lower limbs in persons with incomplete SCI.

**Number of Subjects :** 9 able-bodied (AB) subjects and 4 persons with incomplete SCI (American Spinal Injury Association Impairment Scale level C or D).

**Materials/Methods :** We used the Lokomat, a robotic exoskeleton, and custom software to assess static position sense. Subjects were asked to memorize a target position at either the hip or knee. The Lokomat then moved the test joint to a distractor position. Subjects were then asked to bring the joint back to the target position with a joystick controller. All movements were passive. Two hip angles (-10° and 30°) and 2 knee angles (10° and 50°) were tested, resulting in 4 combinations, repeated 5 times each for a total of 20 trials at each joint. Differences between final and target angles was recorded as errors. Means and standard deviations of errors at each target were calculated. Construct validity was verified by the ability of the test to discriminate between AB and SCI subjects. To measure test-retest reliability, subjects were tested twice, at least one week apart, and the intra-class correlation coefficient (ICC) comparing errors from each session was calculated.

**Results :** Preliminary data show the test was reliable (ICC=0.839,  $P<0.001$ ). Hip and knee angle errors (mean±SEM, (°), repeated measures ANOVA) in subjects with SCI (hip: mean=11.41±3.68, SD=7.07±1.58; knee: mean=13.81±3.73, SD=12.75±4.08) were greater ( $P=0.001$ ) and more variable ( $P=0.001$ ) than in AB subjects (hip: mean=2.76±0.21, SD=1.97±0.19; knee: mean=3.18±0.30, SD=2.27±0.23).

**Conclusions :** This study shows that the Lokomat may potentially be used as a measurement tool for assessing static position sense in persons with incomplete SCI. More subjects should be tested, particularly those with SCI, to further establish this tool's reliability and validity.

**Clinical Relevance :** Using the Lokomat to test proprioception after neurological injury could be valuable for assessing the efficacy of treatments in clinical trials. Because of its strong influence on motor control, proprioceptive function must be more accurately measured after neurological injury in order to develop treatments to improve sensory function and ultimately maximize functional mobility.

**TITLE:** Utilizing Intensive-Amplitude Specific Therapeutic Approaches as an Effective Strategy for Improving Functional Mobility in Patients Diagnosed with Parkinson's Disease.

**AUTHORS/INSTITUTIONS:** R.L. Julius, M. Sandmann, J.A. Bajwa, P. Tatman, A. Fehrer, Capistrant Center for Movement Disorders, Bethesda Hospital, Saint Paul, MN;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Patients with Parkinson's disease (PD) have decreased movement efficiency that affects gait mechanics and basic mobility. We used an intensive-amplitude specific therapeutic (IAST) approach to target the components of functional mobility in order to yield the greatest effect on their activities of daily living. Our objective was to analyze the effects of IAST approaches on the functional mobility of patients with PD.

**Number of Subjects :** 44; 70% male, average age was 71.8.

**Materials/Methods :** Patients diagnosed with PD that started IAST between 9/1/08 and 8/31/09 were included. Chart review was completed to gather information regarding demographics, and initial and discharge scores for the Timed Up and Go (TUG) test, 30 second chair stand test (30SCST), gait speed test (GST), and the 2 min or 6 min walk test (2MWT or 6MWT).

**Results :** Patients averaged 13 sessions in 6.5 weeks. There were significant changes between the initial and discharge scores for all tests. The average decrease in TUG score was 3.1 seconds ( $p < 0.001$ ). The average increase in GST was 0.34 m/sec ( $p = 0.002$ ). The average increase in 30SCST score was 1.8 ( $p < 0.001$ ). The average increase in 6MWT score was 56.2m ( $p < 0.001$ ) and the average increase in the 2MWT score was 21.5m ( $p < 0.001$ ). Thirty-nine percent of patients had at least a 25% decrease in TUG score, 64% had at least 0.18 m/sec increase in the GST, 29% of patients could do at least 3 additional chair stands, 32% could walk at least 82m further in the 6MWT and 25% of patients could walk at least 27.4m further in the 2MWT.

**Conclusions :** PD patients who participated in IAST demonstrated significant improvements in all areas measured. This data warrants further research on the sustainability of these results post therapy with parameters surrounding frequency and duration to determine the most effective therapy.

**Clinical Relevance :** Vigorous, challenging exercise may slow the Parkinson's disease process. As physical therapists, we strive to continuously challenge our patients so that they may achieve their optimal movement potential. Treatment approaches such as IAST may serve as an effective therapeutic tool for obtaining this goal.

**TITLE:** The Effectiveness of FES Combined with Conventional Therapy vs. Conventional Therapy Alone in Post-Stroke Gait Training: A Systematic Review

**AUTHORS/INSTITUTIONS:** B. McNeal, K. Vance, H. Stockton, Physical Therapy, Southwest Baptist University, Bolivar, MO;

**ABSTRACT BODY:**

**Purpose :** The purpose of this systematic review was to investigate the effectiveness of using Functional Electrical Stimulation (FES) combined with conventional PT for post-stroke gait training compared to conventional PT without the use of FES. While there are a variety of techniques used to rehabilitate post-stroke patients to achieve maximal gait function, many therapists use FES. FES alone has been shown to improve certain aspects of gait. The objective of this review was to determine if FES combined with conventional PT has a more significant effect than conventional PT alone in improving the following outcomes: walking speed, balance, gait pattern, spasticity, muscle strength of dorsiflexors and plantarflexors, ankle ROM, and overall functional walking.

**Description :** A comprehensive literature search was performed utilizing CINAHL and Medline databases. Only journal articles that included a comparison between the use of FES compared to having treatment excluding FES were included. Thirteen studies involving 367 participants matched the inclusion criteria that were established. All studies were published between the years 2004 and 2010. The articles were evaluated using the 2008 American Academy for Cerebral Palsy and Developmental Medicine (AACPDMD) methodology to give each a level of evidence as well as a conduct rating.

**Summary of Use :** The 13 included articles ranged from moderate to strong in methodological quality. There were eight Level II group studies, three Level II single subject designs, one Level IV single subject design, and one Level V single subject design. Gait speed, ankle dorsiflexion ROM, and muscle strength were the most common outcomes examined in the studies, with gait speed being the most commonly reported outcome across studies. These were all found in many of the studies to have significantly improved ( $p < 0.05$ ). Only one study reported a long-term follow-up at six months.

**Importance to Members:** There is significant evidence to show that integrating FES into the PT for post-stroke patients is more effective in improving multiple aspects of gait than conventional PT without the use of FES. The strongest evidence points to gait speed as the outcome that can best be predicted to improve with this intervention. Level I research is needed in this area, as well as more long-term follow-up studies, in order to strengthen the evidence for the integration of this intervention in the gait training of post-stroke patients.

**TITLE:** Gait Coordination in Parkinson Disease: Effects of Step Length and Cadence Manipulations

**AUTHORS/INSTITUTIONS:** A.J. Williams, G. Earhart, , Washington University in St. Louis, Saint Louis, MO;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Freezing of Gait (FOG) is an inability to produce effective stepping during ambulation and can result in falls and decreased quality of life in people with Parkinson disease (PD). Cadence and step length are two aspects of gait that may be important contributors to FOG. The aim of this study was to observe the effects of individually altering cadence and amplitude (i.e. step length) on FOG. We used Phase Coordination Index (PCI) as a surrogate measure of FOG, as PCI has been shown to correlate with FOG severity.

**Number of Subjects :** Ten people participated, five with idiopathic PD (Hoehn & Yahr 2-3) and five age-matched controls.

**Materials/Methods :** Each participant first completed three NATURAL walking trials at a comfortable pace on a GAITRite walkway (CIR Systems, Inc., Havertown PA). Preferred step length and cadence were determined and used as the starting point from which step length was reduced to 50% of natural and cadence increased to 150% of natural. After adequate practice walking at altered step length and/or cadence, each participant completed three trials of SMALL walking where cadence was natural and step length was 50% of natural, three trials of FAST walking where step length was natural and cadence was 150% of natural, and three trials of SMALL FAST walking where step length was 50% of natural and cadence was 150% of natural. To assess coordination in the different conditions, we calculated PCI, a measure of the accuracy and consistency of interlimb coordination during walking that correlates with FOG. A mixed model repeated measures ANOVA with group (PD vs. CTRL) and condition (NATURAL, SMALL, FAST, SMALL FAST) as factors was used.

**Results :** PCI values during NATURAL walking were higher in those with PD ( $PCI = 5.5 \pm 2.6$ ) than in controls ( $3.8 \pm 0.7$ ), indicating poorer coordination in the PD group. PCI values changed little in the FAST condition for either group (PD =  $6.0 \pm 2.6$ , CTRL =  $3.5 \pm 1.0$ ). Both groups showed poorer coordination in the SMALL (PD =  $7.4 \pm 5.1$ , CTRL =  $5.4 \pm 2.5$ ) and especially the SMALL FAST (PD =  $10.0 \pm 2.7$ , CTRL =  $6.5 \pm 2.1$ ) conditions relative to NATURAL. There was no main effect of group and no interaction, but there was a significant effect of condition ( $p < 0.001$ ). Coordination in the SMALL FAST condition was significantly worse than coordination in the NATURAL and FAST conditions.

**Conclusions :** While FOG is often characterized by short and fast steps, increased cadence alone may not be a major contributor to FOG. However, short steps do appear to negatively impact coordination when cadence is natural and have an even greater impact when cadence is fast. A larger sample size is needed to confirm these preliminary observations.

**Clinical Relevance :** FOG is notoriously difficult to elicit in clinical settings and also difficult to treat. An enhanced understanding of factors contributing to FOG may inform the design of clinical interventions that better target these factors.

**TITLE:** Effects of Passive Standing, Dynamic Standing and Dynamic Standing Augmented by Functional Electrical Stimulation on Urinary Calcium, Spasticity and Bowel Function in a Person with Paraplegia

**AUTHORS/INSTITUTIONS:** B.E. Day, D.J. Simpson, , CarePartners Health Services, Asheville, NC; E. Diez, , Comprehensive Rehabilitation Care Physicians PLLC , Asheville, NC;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Persons with spinal cord injury (SCI) are at elevated risk of metabolic calculi due to immobility, lack of weight bearing and abnormal neurologic regulation. Static standing in a frame is commonly used in SCI rehabilitation to address pathological osteogenesis though dynamic repetitive loading is more effective in animal models. Since dynamic standing combines upright stance with range of motion, it could be effective in bowel and spasticity management. A literature review was negative for information on the efficacy of static versus dynamic standing in SCI rehabilitation. The purpose was: 1) to pilot an investigation of the relative effects of three common SCI rehabilitation techniques, 2) track outcomes important to patients: calciuria as a risk factor for renal calculi, bowel function and spasticity. The hypothesis was: 1) Dynamic standing will decrease calciuria more than static standing, 2) dynamic standing augmented by functional electrical stimulation (FES) will have greater effect by increasing stress on bone, and 3) spasticity and bowel function will follow the same trend.

**Number of Subjects :** 1

**Materials/Methods :** A n=1 crossover research design A1-B1-C-B2-A2 was executed to compare static standing (A), dynamic standing in the EasyStand Glider (Glider) (B), and FES augmented Glider (C). Each phase was comprised of 45 minute sessions, 3 times per week for 6 weeks. Subject demographic: 16 month history of T-8 ASIA A paraplegia with episodes of metabolic renal calculi post injury. Outcomes were: urinary calcium, self-reported spasticity on a visual analog 0-10 scale, and minutes required for bowel program.

**Results :** Urinary calcium was within normal range during each phase and without statistically significant difference. Average and standard deviation for each phase: Spasticity: A1 3.6(2.3), B1 2.4(0.8), C 1.9(0.8), B2 2.4(1.6), A2 3.0(0.8). Bowel time: A1 10.8(5.4), B1 5.7(2.9), C 7.4(3.6), B2 6.5(4.1), A2 7.6(3.2).

**Conclusions :** Urinary calcium data was unstable and a poor measure. It may be more sensitive in subjects closer to injury and more likely to have hypercalciuria. It is also affected by uncontrolled variables. Spasticity and bowel program time are both appropriate outcomes for a larger study, especially one with enough statistical power to investigate dynamic standing versus the same activity augmented by FES.

**Clinical Relevance :** Since all of the techniques and equipment used are common in SCI rehabilitation, a greater understanding of their effects is vital to optimal outcomes. Each of these represents expensive equipment and significant time on the part of the patient, therapist and caregiver. There is little information to guide clinicians in how to best utilize these resources.

**TITLE:** Treadmill training with Lokomat-applied resistance to enhance functional ambulation in people with incomplete spinal cord injury

**AUTHORS/INSTITUTIONS:** T. Lam, K. Pahl, School of Human Kinetics, University of British Columbia, Vancouver, British Columbia, CANADA; A. Krassioukov, Division of Physical Medicine and Rehabilitation, University of British Columbia, Vancouver, British Columbia, CANADA; J. Eng, Department of Physical Therapy, University of British Columbia, Vancouver, British Columbia, CANADA; A. Bigelow, , Neuromotion Physiotherapy, Vancouver, British Columbia, CANADA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** People with motor-incomplete spinal cord injury (SCI) can recover walking with intensive training, such as body-weight support treadmill training (BWSTT). However, even with recovery of basic walking function, there are deficits such as foot drag or difficulty clearing obstacles that may be associated with impaired flexor activation during swing. We know that sensory feedback pathways contribute to flexor muscle activity during walking and have shown that resisting the legs during swing enhances flexor activation. Therefore, the purpose of this study was to evaluate the effectiveness of combining BWSTT with Lokomat-applied resistance in people with motor-incomplete SCI.

**Number of Subjects :** 15 subjects with chronic incomplete SCI (AIS D)

**Materials/Methods :** Subjects were randomly allocated to either a control or experimental group. The control group underwent BWSTT with standard Lokomat software control, whereby leg movements were driven by the Lokomat. The experimental group underwent BWSTT with the Lokomat applying a resistance against the hip and knee. Training took place 3 times/week for 12 weeks, 45 minutes per session (not including rest breaks). Outcome measures included the 10-meter walk test (10MWT), 6-minute walk test (6MWT), and the Spinal Cord Injury-Functional Ambulation Profile (SCI-FAP), a measure of skilled walking, such as obstacle crossing and stairs. Outcomes were recorded at baseline, post-training, and after 1- and 6-months. Baseline values of each outcome measure were compared across groups. A group X time repeated measures ANOVA was performed for each outcome.

**Results :** Fifteen individuals participated in the study. Seven subjects were randomized into the control group and 8 to the experimental group. Baseline values between groups were similar for all outcomes ( $p>0.05$ ). For both the 10MWT and 6MWT, there were significant main effects for time ( $p<0.01$ ) but no significant group or interaction effects ( $p>0.05$ ). For the SCI-FAP, there was a significant group X time interaction ( $p<0.01$ ). Subsequent analysis showed that within the control group, there were no significant effects of time ( $p>0.39$ ). In the experimental group, there were significant differences between baseline vs. post-training ( $p=0.02$ ) and vs. 1-month follow-up ( $p = 0.04$ ). Baseline vs. 6-month follow-up approached significance ( $p=0.06$ ).

**Conclusions :** Both training protocols were associated with improvements in walking speed and distance, consistent with previous reports. However, our results also suggest that treadmill training with robot-applied forces against leg movements could provide further advances in skilled functional ambulation tasks in people with a motor incomplete SCI.

**Clinical Relevance :** Therapists should be aware of the potential for robotics-based therapies to offer advanced approaches for improving functional ambulation capacity. This pilot study indicates that adding resistance against leg movements during treadmill training could augment functional ambulation in people with incomplete SCI.

**TITLE:** Non invasive brain stimulation enhances ankle motor skill acquisition and retention

**AUTHORS/INSTITUTIONS:** B. Shah, S. Madhavan, Physical Therapy, UIC, Chicago, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** In the past two decades transcranial direct current stimulation (tDCS) has emerged as a promising tool to modulate neural excitability and enhance motor learning and motor behavior in humans. Most tDCS studies have focused on stimulating the primary motor cortex (M1) to facilitate motor learning. Recent reports have used tDCS to show that the cerebellum also plays an important role in adaptive upper limb motor skill learning. There are very few studies examining the effects of tDCS on lower limb motor function. Fundamental differences in the neural networks and motor function preclude us from extrapolating results of the upper limb studies to lower limb function. Hence, this study was performed to dissociate the role of the motor cortex and cerebellum in lower limb motor skill learning.

**Number of Subjects :** Twenty healthy young individuals

**Materials/Methods :** Subjects practiced a visuomotor tracking task with their non-dominant ankle for 15 minutes while receiving facilitatory anodal transcranial direct current stimulation (tDCS) to the motor cortex, cerebellum or sham stimulation over three different sessions. Pre and post cortical excitability measures were obtained to verify that tDCS achieved an up-regulation of the stimulated hemisphere. Subjects were tested immediately and 24 hours after practice. Tracking accuracy was calculated as the main outcome variable.

**Results :** Preliminary results revealed a significant main effect of stimulation ( $p < 0.001$ ) on tracking accuracy. Tracking accuracy was significantly higher during stimulation of the cerebellum (14.5 % improvement) compared to motor cortex (10.2% improvement) or sham (5.3 %)→. tDCS of the motor cortex resulted in increased retention (8%) compared to cerebellar or sham stimulation.

**Conclusions :** This is the first study to compare skill acquisition of the lower limb following adjuvant enhanced motor practice of the cerebellum and motor cortex.

**Clinical Relevance :** The study makes a significant contribution towards developing non-invasive brain stimulation as an adjuvant to enhance lower limb control, laying the foundation for the development of new stimulation-enhanced lower limb training protocols for individuals with neurological impairments.

**TITLE:** Comparison of “less affected limb” reaching kinematics in individuals with chronic stroke and healthy age-matched controls

**AUTHORS/INSTITUTIONS:** K. Carnahan, S. Peacock, A. Van Buskirk, S.A. Combs, M.A. Finley, Krannert School of Physical Therapy, University of Indianapolis, Indianapolis, IN;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Several studies have suggested deficits exist in the upper extremity ipsilateral to the lesion in people who have had a stroke, but few have examined the specific impact on the biomechanics of goal-oriented reaching. The purpose of this study was to compare kinematics of the non-paretic, “less affected” upper extremity during reaching tasks in persons with chronic stroke to a control group without disability. It was hypothesized that the less affected upper limb of persons with chronic stroke would exhibit altered movement patterns during reaching activities.

**Number of Subjects :** Fifteen participants with chronic stroke (age=62±8 yrs; stroke onset=12-171 mo) were matched by age to 15 participants without disability (age=60±11yrs)

**Materials/Methods :** Participants with stroke were assessed with the Fugl-Meyer Upper Extremity Motor Assessment (FM-UE=48±18). Three-dimensional kinematics of each upper extremity were collected (Motion Monitor™) while participants performed three consecutive repetitions of reaching to targets placed ipsilateral to the reaching limb, while seated with trunk restraint. Reaching was performed at self-selected and fast speed conditions. Order of extremity and speed condition were randomized. Mean speed, peak speed, movement smoothness (mean/peak speed), movement duration, and peak elbow extension were calculated. Paired t-test determined if kinematic differences existed between limbs of the control group, and analyzed differences based on pre-stroke limb dominance of the group with stroke (dominant=8, nondominant=7, p≤0.05). T-test analyzed differences in reaching variables between the group with stroke (less affected limb) and control group by speed condition (p≤0.05).

**Results :** Given no statistically significant difference existed in reaching kinematic variables between the dominant and nondominant upper extremities of the control group, the dominant limb was compared to the less affected limb of the group with stroke. No between group differences were found in any variables of the self-selected velocity condition. In the fast velocity condition, decreased peak speed (p=0.038) and mean speed (p=0.018) with increased duration of movement (p=0.010) was found in the participants with stroke compared to the control group. No significant difference in smoothness was found between groups. Also in the fast velocity condition, persons with the less affected limb classified as dominant pre-stroke demonstrated greater movement smoothness than those with the pre-stroke nondominant limb (p=0.039).

**Conclusions :** Results indicated when moving at a self-selected pace, reaching kinematics of the limb ipsilateral to the lesion are not altered. However, when demands require fast movement velocities the differences are evident, especially when the less affected is the pre-stroke nondominant limb.

**Clinical Relevance :** When treating patients with stroke, this study indicated that it is appropriate to incorporate the less affected limb into interventions, especially with activities that require faster velocities.

**TITLE:** Barriers to Exercise in Persons with Parkinson Disease

**AUTHORS/INSTITUTIONS:** T. Ellis, T.R. DeAngelis, L.E. Brown, Physical Therapy & Athletic Training, Boston University; College of Health & Rehabilitation Sciences, Boston, MA; J.K. Boudreau, J. Cavanaugh, Physical Therapy, University of New England, Portland, ME; G.M. Earhart, Physical Therapy, Washington University, Saint Louis, MO; M. Ford, Physical Therapy, University of Alabama at Birmingham, Birmingham, AL; K.B. Foreman, L.E. Dibble, Physical Therapy, University of Utah, Salt Lake City, UT;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Exercise is known to reduce disability and improve quality of life in persons with Parkinson disease (PD). Although barriers to exercise have been studied in older adults, these barriers are not well defined in persons with chronic progressive diseases. The purpose of this study was to identify the barriers to exercise among persons with PD.

**Number of Subjects :** Two-hundred and sixty community-dwelling individuals with PD participated in a cross-sectional study (mean age = 67.7 +/- 9.2 years, 57% male, Hoehn & Yahr = 2.35 +/- 0.7, disease duration = 6.29 +/- 4.8 years).

**Materials/Methods :** Participants were categorized as exercisers (N= 164) or non-exercisers (N= 96) based on responses to the Stages of Readiness to Exercise Questionnaire. Subjects self-administered the barriers subscale of the Physical Fitness and Exercise Activity Levels of Older Adults Scale endorsing or denying specific barriers to exercise participation. Multivariate logistic regression analysis using a backward elimination procedure was used to examine the contribution of each individual barrier to exercise behavior.

**Results :** Three of thirteen potential barriers were retained in the regression model. Low outcomes expectation (OR= 3.93, 95% CI 2.08-7.42), time (OR= 3.36, 95% CI 1.55-7.29) and fear of falling (OR= 2.35, 95% CI 1.17-4.71) were significantly associated ( $p < 0.05$ ) with exercise participation.

**Conclusions :** In a sample of community-dwelling individuals with mild to moderate PD, those who were not engaged in regular exercise identified low outcome expectation, perceived time limitations and fear of falling as barriers to participation in exercise.

**Clinical Relevance :** The patient-perceived barriers to exercise identified in this study are potentially modifiable. Physical therapists that are prescribing exercise programs for patients with PD may need to emphasize the health-related benefits of exercise in the presence of a chronic condition, incorporate time management strategies and reduce fear of falling in order to facilitate successful engagement in exercise programs. The efficacy of these intervention strategies to facilitate regular exercise participation in persons with PD requires further investigation.

**TITLE:** Operant Conditioning of Tibialis Anterior and Soleus H-reflex Improves Spinal Reflex Modulation and Walking Function in Individuals with Motor-Incomplete Spinal Cord Injury

**AUTHORS/INSTITUTIONS:** K.J. Manella, Physical Therapy, University of Miami Miller School of Medicine, Miami, FL; E.C. Field-Fote, The Miami Project to Cure Paralysis, University of Miami Miller School of Medicine, Miami, FL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Ankle clonus, common after spinal cord injury (SCI) and other disorders of the central nervous system, is attributed to loss of supraspinal circuits that mediate inhibition of soleus stretch reflexes (SSRs) and maladaptive reorganization of spinal reflex pathways. Concomitant with ankle clonus, reciprocal facilitation of tibialis anterior (TA) and soleus (SOL) result in coactivation that impairs walking ability in individuals with motor-incomplete lesions (MISCI). Operant conditioning has increased muscle activation and decreased stretch reflexes in individuals with SCI. Our aim was to compare two operant conditioning-based interventions to reduce SSRs in individuals with ankle clonus and impaired walking ability due to MISCI. We hypothesized that intensive training to (1) increase TA EMG activation (TA $\uparrow$ ) would enhance supraspinal drive to spinal interneurons, improve soleus reciprocal inhibition, presynaptic inhibition, and ankle motor control, and (2) inhibit the SOL H-reflex (SOL $\downarrow$ ) during active dorsiflexion would modulate stretch reflex pathways at the spinal cord level, decrease SSRs and ankle clonus, and improve ankle motor control.

**Number of Subjects :** 12

**Materials/Methods :** EMG biofeedback, training targets and rewards were provided during TA $\uparrow$  to increase TA percent of maximal voluntary contraction (%MVC), and during SOL $\downarrow$  to decrease SOL H-reflex amplitude (mV) during dorsiflexion. Three baseline and 12 training sessions that each included 300 repetitions were conducted three times per week. The week before and after training we measured SOL H-reflex reciprocal inhibition (RI), presynaptic inhibition (PI), and low frequency depression, SOL/TA coactivation ratio during clonus, clonus duration, plantar flexor (PF) reflex threshold angle, timed toe tapping, dorsiflexion (DF) active range of motion (ROM), lower extremity motor scores (LEMS), and walking step height, speed and distance.

**Results :** TA $\uparrow$  was associated with increased TA%MVC (48%), decreased PF reflex threshold angle (-4.33 $^\circ$ ) and DF active ROM angle (-4.32 $^\circ$ ), and increased DF (0.8), training (2.2) and non-training leg (0.8) LEMS, step height (4.8 mm), and walking distance (12.09 m). For SOL $\downarrow$  we found decreased SOL H-reflex amplitude (-0.47 mV) and SOL/TA coactivation ratio (-0.21), and increased non-training leg LEMS (1.8), walking speed (0.02 m/s) and distance (6.25 m).

**Conclusions :** Both interventions improved walking distance during a 2-minute period that exceeded the minimally important difference of 4 meters for individuals with chronic MISCI. Each training protocol modulated neurologic and clinical variables in unique ways. TA $\uparrow$  effects were associated with decreased PF reflex threshold and enhanced PI of SOL H-reflex. SOL $\downarrow$  effects were associated with decreased SOL/TA coactivation during clonus; an enhanced SOL Ib inhibition mechanism was postulated.

**Clinical Relevance :** Intensive training that increases TA strength or reduces SOL spasticity may improve walking function in individuals with chronic MISCI.

**TITLE:** The Effectiveness of Mirror Therapy Following Stroke: A Systematic Review of the Literature

**AUTHORS/INSTITUTIONS:** J. Mount, C. Hunsberger, K. Lagzdins, A. Quimby, J. Ulichney, R. Wishart, Physical Therapy, Thomas Jefferson University, Philadelphia, PA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Mirror therapy (MT) is a relatively new intervention for people with stroke. The purpose of this study is to systematically review the literature to evaluate the effectiveness of MT following stroke for improvement of motor control, functional ability, perceptual ability, pain, and spasticity

**Number of Subjects :** Among the 8 randomized controlled trials with low risk of bias, a total of 255 subjects were included.

**Materials/Methods :** A systematic literature search was performed in March 2011 using Ovid Medline, Medline In Process & Other Non-Indexed Citations, OLDMedline, HealthMaster, EBM Reviews, Cochrane Database of Systematic Reviews, Central Register of Controlled Trials, Scopus, CINAHL, PsychInfo, OTSearch, GoogleScholar, and PEDro. The quality of selected studies was assessed using the Physiotherapy Evidence Database (PEDro) Rating Scale. Strength of evidence for outcomes were evaluated using criteria developed for the Agency for Health Care Policy and Research for stroke rehabilitation.

**Results :** Eight randomized controlled trials were found evaluating the effectiveness of MT following stroke. PEDro scores ranged from six to eight out of ten. Five of the seven studies evaluating motor control reported significantly greater improvement with MT. The other two studies reported trends in favor of MT. Three out of five studies evaluating functional ability reported that MT caused significantly greater improvement, the other two studies found no significant difference between groups. One study reported significant improvements in favor of MT for tactile sensation and hemi-neglect, but not for proprioception. Three studies examined the effect of mirror therapy on pain. The two articles focusing on people with Complex Regional Pain Syndrome Type I (CRPSt1) following stroke reported significantly greater reduction of pain. No significant between-group difference in pain was found by the study in which CRPS was not an inclusion criterion. Three studies evaluating spasticity revealed no significant between-group differences.

**Conclusions :** Studies evaluating the effectiveness of MT following stroke provide strong evidence that it improves motor control and functional ability, and decreases pain related to CRPSt1. There is moderate evidence that it also can improve tactile sensation and reduce hemi-neglect.

**Clinical Relevance :** Mirror therapy is an intervention that is easy to perform both in the clinic and as a home exercise program. While it is just one of many therapeutic approaches for improving motor control and functional ability for people with stroke, it is the only physical therapy intervention for which there is strong evidence that it reduces pain caused by CRPSt1 among people with stroke.

**TITLE:** Multiple contributions to balance impairment after mild traumatic brain injury

**AUTHORS/INSTITUTIONS:** E. Anson, Physical Therapy, Adventist Rehabilitation Hospital of Maryland, Silver Spring, MD;

**ABSTRACT BODY:**

**Background & Purpose :** Recovery of standing and walking balance ability are often primary goals following mild traumatic brain injury (mTBI). Dizziness and dual tasking impairments often complicate this recovery. The presence of benign paroxysmal positional vertigo (BPPV) associated with mTBI may present with secondary balance impairments, separate from the primary balance impairments from the mTBI. This suggests that treatment interventions should address BPPV early to identify what portion of the functional balance impairments are related to BPPV and what portion is related to the mTBI. This single subject case study describes how balance impairments during standing and walking following mTBI result from multiple causes.

**Case Description :** A 49 year old male presented following mTBI to an outpatient rehabilitation center with loss of balance during standing and walking accompanied by complaints of vertigo and dizziness. At the initial evaluation he presented with positive Hallpike-Dix positional testing bilaterally, indicating posterior canalithiasis. Subjective ratings of dizziness and balance ability demonstrated substantial perceived balance impairment (DHI score 62/100, ABC score 38%). Balance and mobility testing (FGA = 12/30, TUG = 14.98s) indicated increased fall risk and he required moderate assistance to prevent falls when vision and/or proprioceptive cues were less accurate or absent. Dual tasking was also impaired (single:dual ratio for TUG = .59). Treatment for bilateral posterior canalithiasis BPPV with canalith repositioning treatments (CRT) was provided early in rehabilitation. He also participated in individualized activities designed to improve static and dynamic balance and sensory organization impairments. All activities designed to improve balance ability and reduce fall risk were presented in single and multi-tasking formats to further promote improved functional mobility activities.

**Outcomes :** Improvements were seen for all outcome measures. Subjective improvement in symptoms and perceived balance abilities are as follows: DHI score decreased to 4/100, ABC score increased to 93%. Hallpike-Dix tests were negative bilaterally following single treatments with CRT directed to each posterior canal. FGA score improved to 29/30, TUG improved to 8.7s, TUGc improved to 9.14s (single:dual ratio for TUG = .95), stance on foam EO improved from 37s to 60s, and stance on foam EC improved from 27s to 60s. During TUGc performance improvement in the cognitive component was measured as counts/sec: initially .4 counts/sec improved to .56 counts/sec.

**Discussion :** Balance impairments in a patient post mTBI result from multiple etiologies when BPPV is also present. Treatment for bilateral posterior canalithiasis resulted in marked, but incomplete improvement in balance and functional mobility. Subjective dizziness and perceived balance ability improved along with all static/dynamic balance measures and functional mobility. Dual tasking as measured using the TUGc demonstrated unequal improvements in the physical component and the cognitive component.

**TITLE:** Prediction of discharge walking ability from initial inpatient assessment in a stroke rehabilitation population  
**AUTHORS/INSTITUTIONS:** M. Bland, C.E. Lang, Program in Physical Therapy, Washington University, St. Louis, MO; A. Sturmoski, , The Rehabilitation Institute of St. Louis, St. Louis, MO; M. Whitson, Rehabilitation Services, Barnes Jewish Hospital, St. Louis, MO; L. Tabor Connor, Program in Occupational Therapy, Washington University, St. Louis, MO; R. Fucetola, T. Huskey, M. Corbetta, Department of Neurology, Washington University, St. Louis, MO;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To investigate which physical therapy assessments administered at admission to an inpatient rehabilitation facility (IRF) could predict discharge walking ability in a local population of people with stroke.

**Number of Subjects :** 111 IRF participants with stroke who consented to have records stored in the Brain Recovery Core database between January 2010 and January 2011.

**Materials/Methods :** All participants admitted with stroke to this IRF undergo standardized admission and discharge assessments. Independent variables from the admission assessment included: lower extremity Motricity Index, somatosensation on dorsum of foot, Modified Ashworth Scale at the ankle, Functional Independence Measure (FIM) walk item, Berg Balance Scale, walking speed, age, history of previous stroke, and time from stroke onset to IRF assessment. The dependent variable was discharge walking ability, defined as walking speed on the 10 m Walk Test. Pearson Product Moment correlations were used to examine relationships with and between the admission variables and discharge walking ability. Step-wise multiple regression was used to determine the most parsimonious combination of variables that could explain variance in discharge walking ability. Logistic regression was used to determine the likelihood of achieving household (< 0.4 m/s) versus community ( $\geq 0.4 - 0.8$ , > 0.8 m/s) ambulation categories.

**Results :** Admission variables had weak, moderate, and strong correlations with discharge walking ability. Two admission variables, Berg Balance Scale score and FIM walk item score explained 80% of the variance in discharge walking ability in the stepwise model. For the logistic model, the odds ratio of achieving only household ambulation at discharge was 20 (95%CI: 6-63) when the combination of having a Berg Balance Scale score  $\leq 20$  and a FIM walk item score of 1 or 2 was present. The logistic model correctly classified 92% of subjects achieving only household ambulation and 64% of subjects achieving better than household ambulation.

**Conclusions :** These findings suggest that performance on the Berg Balance Scale and the FIM walk item at admission to an IRF can explain most of the variance in discharge walking ability. Having the combination of a Berg Balance Scale score  $\leq 20$  and a FIM walk item score of 1 or 2 at admission indicates that a person is highly likely (20 times more likely than not) to be only a household ambulator at discharge from the IRF.

**Clinical Relevance :** These findings, taken from all consenting individuals with stroke in an IRF, will assist physical therapists in making accurate prognostic decisions. Knowing at the time of IRF admission that a person with stroke is not likely to achieve limited community or community ambulation status will allow for earlier discharge planning with respect to needed assistance at home, durable-medical equipment, and home modifications.

**TITLE:** Locomotor learning is slowed after stroke.

**AUTHORS/INSTITUTIONS:** D. Reisman, Physical Therapy, Univ Delaware, Newark, DE; C.M. Tyrell, BIOMS, University of Delaware, Newark, DE;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** When healthy subjects walk on a split-belt treadmill, where each belt (leg) moves at a different speed, initially their walking pattern is quite asymmetric. However, with several minutes of practice, this asymmetry is greatly reduced (Reisman et al, 2005). When subjects return to walk on the split-belt treadmill the next day, the initial asymmetry is less than on the first day, suggesting that the subjects learned and retained something about how to walk symmetrically in this novel environment (Malone et al, 2010). This paradigm, therefore, is useful for investigating the capacity of individuals who have had a stroke to learn a new walking pattern. In this study we investigate the rate of learning and the magnitude of retention in both neurologically intact adults and in those post-stroke. We hypothesize that individuals post-stroke will demonstrate a slower rate of learning, and a reduced amount of retention compared to neurologically intact age-matched participants.

**Number of Subjects :** In an ongoing study, 7 individuals with chronic stroke (>6 mos) and 6 age-matched neurologically intact subjects have been tested.

**Materials/Methods :** Subjects were tested on each of 5 consecutive days, followed by a retention test after 2 days without practice. On day 1, baseline walking data was collected (belts tied -2min) followed by split-belt walking (belts split in a 2:1 speed ratio-15min). On all remaining days, subjects completed split-belt walking only. Step length was calculated as the sagittal distance from one heel marker to the contralateral heel marker at initial contact. Step length symmetry was evaluated by the step length ratio (paretic/nonparetic). Rate of learning over 5 days was determined by calculating the number of strides required to reach a plateau in step length symmetry (plateau = 3 consecutive strides within  $\pm 5\%$  of the mean step length ratio at end of day 5). Retention was calculated by comparing step length symmetry of the first 30 strides on day 6 to that of day 5.

**Results :** The individuals who had a stroke required  $1433 \pm 914$  strides to demonstrate learning of the split belt pattern, whereas the neurologically intact subjects required  $472 \pm 291$  strides. At the retention test, there were no substantial group differences (stroke retained  $106 \pm 10\%$ , neurologically intact subjects retained  $98 \pm 6\%$ ).

**Conclusions :** The results partially support our hypothesis and suggest that individuals who have had a stroke are slower to learn a novel walking pattern as compared to their age-matched neurologically intact counterparts. Contrary to our hypothesis, subjects with stroke retained the same amount as the neurologically intact subjects when tested after 2 days without practice.

**Clinical Relevance :** Despite the fact that those who have had a stroke do not learn as quickly as those who are neurologically intact, it does appear that they retain what they have learned. This has implications for the amount of practice and the structure of therapy sessions for this patient population.

**TITLE:** Postural Orientation Influences Corticospinal Excitability to the Representation of the Arm

**AUTHORS/INSTITUTIONS:** S. McCombe Waller, M. Rogers, Physical Therapy and Rehabilitation Science, University of Maryland, School of Medicine, Baltimore, MD; G.F. Wittenberg, , Baltimore VA Medical Center, GRECC and University of Maryland, School of Medicine, Baltimore, MD; J. Rino, , University of Delaware, Newark, DE;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Progression of neuromotor training of upper extremity function from sitting to standing in patients with hemiparesis post stroke is a current focus of rehabilitation interventions we are testing in our lab. However, little is known about the potential modulatory effects of postural state conditions on corticospinal excitability to the muscles of the arm in sitting versus standing. The purpose of this pilot study is to assess the corticospinal excitability to resting upper extremity muscles using transcranial magnetic stimulation (TMS) as a function of whole-body postural orientation in healthy adults.

**Number of Subjects :** 6 healthy adults (age  $51.8 \pm 8.1$ ) with no history of seizures or neurological disability were tested.

**Materials/Methods :** Using single pulse (TMS) we first determined the recruitment curves in sitting and standing starting at 90% resting motor threshold (RMT) for the anterior deltoid (AD), increasing by 10% increments up to 200% or maximal stimulator output for the dominant arm. Three subjects were tested in sitting first with three tested in standing first. In a second session 5 of the 6 subjects were tested using paired pulsed TMS to determine the facilitatory and inhibitory ratios in the AD in sitting and in standing. All subjects were tested in the seated position first. In standing the stimulator intensity was modified (decreased) until the single pulse motor evoke potential (MEP) average was within a single standard deviation of the seated single pulse MEP average to allow for comparison of paired pulse results between sitting and standing.

**Results :** In all subjects average MEP amplitudes were higher for the recruitment curves in standing versus sitting despite similar thresholds. Paired-pulse TMS testing revealed that in 4/5 subjects decreased inhibition was evident in standing compared to sitting position with little evidence of facilitation in standing.

**Conclusions :** Increased MEP amplitudes in standing recruitment curves indicate either increased facilitation or decreased inhibition from the corticospinal system to the AD. Our paired-pulse results indicate it is more likely a disinhibition process. Given the proximity of the AD to the trunk in standing this may permit those muscles to be in state of readiness or preparation for movement to initiate either postural responses or voluntary movements of the arm as needed given the task at hand.

**Clinical Relevance :** This pilot project provides evidence of corticospinal excitability changes to upper extremity representation in standing versus sitting which appear to be disinhibitory in nature. The findings have implications for rehabilitation interventions involving upper limb training in standing for patients with post-stroke hemiparesis.

**TITLE:** Non-motor symptoms in Parkinson's disease: characteristics of fallers and non-fallers

**AUTHORS/INSTITUTIONS:** M.S. Bryant, S. Rivas, A. Fernandez, E. Protas, , University of Texas Medical Branch, Galveston, TX; G. Hou, , Baylor College of Medicine, Houston, TX; E. Lai, , The Methodist Neurological Institutes, Houston, TX;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To characterize non-motor symptoms in individuals with Parkinson's disease (PD) who experience falls compared to those who do not fall.

**Number of Subjects :** 54.

**Materials/Methods :** Fifty four individuals with PD were studied (75% male). Their mean age was  $70.76 \pm 8.39$  years. Thirty six were fallers and eighteen were non-fallers. The average time since diagnosis was  $8.75 \pm 5.56$  years. Fatigue was assessed by the Iowa Fatigue Scale. Excessive daytime sleepiness was assessed by the Epworth Sleepiness Scale, and depressive symptomatology was assessed by the short form Center for Epidemiologic Studies Short Depression Scale (CES-D-10).

**Results :** Compared to non-fallers, fallers had more severe disability, had greater general physical fatigue ( $p = 0.024$ ), had lower energy levels ( $p = 0.042$ ) and had less productivity ( $p = 0.007$ ). Fallers were more depressed than the non-fallers ( $p = 0.01$ ). Excessive daytime sleepiness was not different between the two groups ( $p = 0.695$ ).

**Conclusions :** Individuals with PD who fell had more severe motor and non-motor symptoms than those who did not fall. These non-motor symptoms included physical fatigue, energy, productivity, and depressive symptomatology.

**Clinical Relevance :** The findings suggest that clinical evaluation of persons with PD should incorporate assessment of not only motor symptoms, but also the often under-recognized non-motor symptoms, particularly fatigue and depression. Perhaps by managing the non-motor symptoms, the occurrence of falls may be reduced.

**TITLE:** Factors that relate to community mobility in person's with Parkinson disease

**AUTHORS/INSTITUTIONS:** M.P. Ford, P. Harbin, D. Forte, Physical Therapy, University of Alabama at Birmingham, Birmingham, AL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this project was to explore the relationship between changes in community ambulation and changes in motor and non-motor symptoms in persons with Parkinson disease

**Number of Subjects :** 39 individuals with Parkinson disease; mean age: 67 yo (41-80 yo); mean Hoehn & Yahr: 2.2; mean Unified Parkinsons Disease Rating Scale (UPDRS): 57.3 (19-121)

**Materials/Methods :** This report on 39 individuals is part of larger, multi-site, prospective longitudinal cohort "Unveiling the natural history of quality of life and mobility decline in persons with Parkinson disease." Data collection occurs at Boston University, The University of Alabama at Birmingham, The University of Utah, and Washington University-St. Louis. The data reported on for this project was collected at the University of Alabama at Birmingham. Each participant visited UAB for both a baseline, and 6 month follow up assessment. Participants answer questionnaires related to medical/health history, # of falls, physical activity, exercise habits, attitudes towards exercise, and parkinsons disease symptoms, function, and quality of life (PDQ-39). Investigators also assessed parkinson's related symptoms (UPDRS), functional mobility (walking speed; 6 min. walk test), balance (BERG; FGA), and community mobility (Life Space Assessment; LSA). Dependent T-tests were used to assess differences between measures at baseline and 6 month. Changes in measurements were determined between baseline and 6 months. We also measured correlations between baseline measures, and between change scores over 6 months.

**Results :** Motor symptoms related to PD (via UPDRS) worsened over 6 months (base: 27 vs. 6 mo: 31.7;  $p<.002$ ). However, there was not a statistically significant change in community mobility as measured via the LSA (base: 80.2 vs. 6 mo: 78.6;  $p<.38$ ). Furthermore, there was not a statistically significant difference in all other measures between baseline and 6 months. At baseline, LSA significantly ( $p<.05$ ) correlated with PD symptoms, quality of life, balance, walking speed, and 6 minute walk distance. Measures of change over 6 months showed that changes in LSA significantly correlated with changes in measures of depression (GDS), physical activity scale for elderly (PASE), and PDQ social.

**Conclusions :** When persons with PD showed an increase community ambulation this was related to decreases in depression and increases in social support, while a decrease in community ambulation was related to an increase in depression and decrease in social support.

**Clinical Relevance :** A decrease in community mobility would typically be associated with poor walking ability and balance. These data show that depression and social support are related to how much a person with PD participates in their community environment. Persons with PD have difficulty with walking and balance; however physical therapists should consider other factors when assessing the level of disability of their patients with PD.

**TITLE:** Regardless of walking speed capacity, daily walking duration and intensity is decreased after stroke

**AUTHORS/INSTITUTIONS:** K. Rudolph, D. Reisman, Department of Physical Therapy, Univ Delaware, Newark, DE; M. Roos, Biomechanics and Movement Science, University of Delaware, Newark, DE;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Previous research has found that walking speed is predictive of community walking and participation after stroke. Recent evidence suggests that patterns of walking activity after stroke may not be so highly related to walking speed and may be better characterized by systematically evaluating patterns of real-world walking activity. Using accelerometers to identify differences in patterns of walking activity provides insight to clinicians and researchers about how an individual translates his/her physical capabilities into activity at home and in the community.

This is particularly important when it comes to the intensity of walking activity since this may influence the health benefits observed with increases in activity. The purpose of this study was to identify differences in the duration and intensity of daily walking behavior between individuals post stroke and older adults who are neurologically intact.

**Number of Subjects :** 29 persons post stroke (STR) and 11 older adults who were retired or semi-retired (CON) participated.

**Materials/Methods :** The Stepwatch Activity Monitor (SAM) was calibrated to each individual and subjects wore the device on their non-impaired lower extremity (STR) or the leg corresponding to dominant hand (CON) during waking hours for a period of 4 days. The exported data file from SAM was analyzed with a custom MATLAB program. We categorized duration as time of walking bouts (BDUR), and total time walking (TTW); intensity was defined as number of steps spent at HIGH (>60 steps/min), medium (MED) (between 30-60 steps/min) and LOW activity (<30 steps/min) as well as the peak activity index (PAI) (average step rate of the fastest 30 minutes over 24 hours). STR subjects were classified based on gait speed according to Perry et al (1995).

**Results :** DURATION: significant differences were found between all STR and CON subjects in TTW ( $p < .0125$ ) but not in BDUR. INTENSITY: All STR subjects had fewer steps in the LOW & MED step intensity categories and PAI compared to CON. Household (HHA) and limited community ambulators (LCA) had significantly fewer steps in the HIGH step intensity category than CON group ( $p < .001$ ). HHA and LCA were not significantly different in any of the intensity or duration variables.

**Conclusions :** Individuals post stroke utilize their ability to ambulate for longer durations and at greater intensities in different ways. Despite showing differences in walking speed, and thus the physical capacity for greater intensity of walking activity, LCA do not differ from HHA. This suggests that other factors besides walking speed limit walking intensity after stroke. These factors must be identified and addressed to maximize physical activity and its related health benefits post stroke.

**Clinical Relevance :** Walking interventions that focus on increasing time spent walking with varying intensities may maximize health benefits and community participation.

**TITLE:** Exercise Training Improves Muscle Function Without Muscle Structure Changes in Persons with Moderate Parkinson Disease

**AUTHORS/INSTITUTIONS:** O. Addison, K.B. Foreman, R.L. Marcus, P.C. LaStayo, L.E. Dibble, Physical Therapy, University of Utah, Salt Lake City, UT;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The long-term neurologic consequences of Parkinson Disease (PD) contribute to changes in both muscle structure (lean tissue content) and function (force production). While the effects of exercise training on mobility function in PD are becoming more well accepted, there is a lack of understanding of the mechanisms by which exercise influences muscle structure and muscle force producing capabilities in persons with PD. To directly examine the role that muscle structure changes contribute to muscle function changes, we investigated, the impact of exercise training on thigh lean tissue mass and muscle force production in individuals with moderate PD.

**Number of Subjects :** 24 individuals with moderate PD (Mean [sd] age= 69.17 [11.68] years; Hoehn and Yahr level= 2.69 [.49]).

**Materials/Methods :** Participants completed isometric knee extension muscle force production testing 1-1.5 hours after L-dopa administration. On a separate day, participants underwent magnetic resonance imaging scans of the thigh to determine average cross sectional area (CSA) of lean tissue. After the completion of pre-testing, participants underwent 12 weeks of an exercise program that included twice weekly aerobic and resistance training. All measures were repeated after the completion of exercise. Paired t-tests were used to determine changes in lean tissue, strength, muscle quality (MQ) [force per unit of cross sectional area of lean tissue] after exercise training. The level of significance was set at  $p < .05$ .

**Results :** Strength significantly improved post exercise (pre =291.58 [107.39] post =323.08 N [119.35]  $p=.008$ ), in the absence of significant changes in lean tissue. As a result, there were significant improvements in MQ (pre =2.59 [.76] post=2.85 [.78]  $p=.014$ ).

**Conclusions :** Despite force production improvements, exercise training did not alter lean tissue mass. Improvements in muscle function (force production) in the absence of structural changes suggests an alteration in the existing muscle's ability to produce force that cannot be accounted for by hypertrophy. The improved MQ in this case suggests an alteration in neural recruitment that requires further investigation. Future research should utilize measures such as EMG, central activation ratio, or corticomuscular coherence to examine neural recruitment as well as more specific examination of muscle composition, using measures such as MRI and biopsy based analysis of intramuscular adipose tissue.

**Clinical Relevance :** Even in the absence of structural changes in the muscle of individuals with moderate PD, exercise training improves strength and mobility. Physical therapists should encourage exercise training in this population and future research should seek to determine the neurologic adaptations that accompany exercise training.

**TITLE:** Patterns in Seating Equipment Evaluation/Provision and Patient Satisfaction: Findings from the SCIR rehab Project

**AUTHORS/INSTITUTIONS:** S. Taylor Schroeder, Allied Health, Rehabilitation Institute of Chicago/University of Michigan, Ann Arbor, MI;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Describe equipment evaluations used to determine appropriate seating systems (wheelchairs and cushions) for patients with traumatic spinal cord injury (SCI) and patients' satisfaction with the equipment 12 months after injury.

**Number of Subjects :** 600 patients in a practice based evidence, observational, cohort design

**Materials/Methods :** Physical therapists (PTs) and occupational therapists (OTs) providing regular care to patients with SCI documented the content of each therapy session using portable electronic devices featuring customized software.

Details about treatment provided during group and individual physical and occupational therapy sessions that included wheelchair (WC) mobility training were combined.

**Results :** PTs and/or OTs provided WC equipment evaluations (mat evaluations, assessment/prescription trials, and fitting) specific to wheeled mobility to order appropriate equipment for discharge. During inpatient rehabilitation, 8.2% of the 600 patients participated in a mat evaluation for their seating system in 88 sessions; 65% participated in WC assessment and prescription in 787 sessions; and 65% participated in WC fitting in 2100 sessions.

At 12-months post injury, 82% of the 331 patients who received a manual WC were still using it, 88% of the 16 patients were still using their power assist WC, and 93% of 161 patients who received a power WC continued using it. 351 patients received a cushion for their WC; 89% still used it at 12-months post injury. 85% of patients reported satisfaction with the fit and function of their manual WC, 79% were satisfied with their power assist WC, 84% with their power WC, and 92% with their wheelchair cushion. Vendors and rehabilitation centers played a major role in fitting mobility equipment. Vendors fit 31% of power WC, 32% of manual WC, 31% of power assist WC, and 33% cushions.

Centers fit 66% of power WC, 63% of manual WC, 69% of power assist WC and 62% of cushions. It is not known where the remainder were fit.

**Conclusions :** The majority of patients with SCI participated in equipment evaluations so that therapists could determine appropriate mobility/seating equipment for discharge. WC fitting was the most frequent activity performed in ensuring a patient was safe in their wheelchair equipment, while mat evaluations were used infrequently. Most patients were satisfied with the fit and function of their wheelchairs (manual, power assist, and power) and with their WC cushion. Rehabilitation centers play a larger role than vendors in fitting equipment.

**Clinical Relevance :** Physical and occupational therapists play a critical role in determining appropriate wheeled mobility devices for patients with SCI. Therapists primarily used WC fitting to determine seating systems. Mat evaluations were not used frequently. Selection of appropriate wheeled mobility devices impacts the long term utilization of the devices. More patients received a wheelchair fitting from a center than from a vendor.

**TITLE:** Examination of the Balance Evaluation Systems Test (BESTest): reliability and clinical insights

**AUTHORS/INSTITUTIONS:** P.K. Padgett, J.V. Jacobs, S.L. Kasser, Rehabilitation and Movement Science, University of Vermont, Burlington, VT;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** This study sought to determine the inter-rater reliability of the Balance Evaluation Systems Test (BESTest) as a clinical exam of balance impairment, and based on this experience, to provide suggested improvements to the administration and scoring of the exam in order to enhance its reliability.

**Number of Subjects :** 20

**Materials/Methods :** Two cohorts of 10 people participated in separate studies of inter-rater reliability of the BESTest. These participants were 51-83 years of age and included people with and without diagnosed balance disorders. Study 1 examined the inter-rater reliability of the BESTest and produced suggested changes to the scoring and administration of the test. These changes were then incorporated in Study 2 in order to re-examine the test's inter-rater reliability. Four raters simultaneously scored each participant. The inter-rater reliability of the exam's total scores was assessed by intraclass correlation coefficient (ICC). The inter-rater reliability of each test item was determined by Kendall coefficients of concordance and by the number of participants in which any of the 4 raters disagreed in their scoring of an item.

**Results :** The ICC for total BESTest scores was 0.986 for Study 1 and 0.978 for Study 2, indicating strong agreement among the four raters. Kendall coefficients of concordance ranged from 0.176 to 1.000, with only seven of the BESTest's 36 items having coefficients of less than 0.70 for either study (although the specific items were different between Studies 1 and 2). The number of participants for whom the raters' scores disagreed decreased from Study 1 to Study 2 for 27 of the exam's 36 items, while increasing the number of participants with score disagreements for only 2 items.

**Conclusions :** Overall the BESTest demonstrated strong inter-rater reliability for the total score and the item-wise analysis. In the first study, 7 of the 36 items, however, did not indicate good reliability in the item-wise analysis. One reason for this may have been that the extent of movement indicative of "instability" or "significance" was not operationalized and led to inconsistency across the raters when evaluating the criteria associated with these items. Another factor may have been the difficulty to elicit the desired participant response by virtue of the instructional set. These issues were addressed by more specific training and changes to the written form. A second reliability study with these suggestions implemented showed improved inter-rater reliability for most individual items, although some new challenges arose by virtue of (1) novel observations during the second cohort's performance and (2) the second cohort's more challenging performance relative to cut-off scores.

**Clinical Relevance :** The clinical potential of the BESTest to evaluate multidimensional postural dyscontrol across a multitude of balance disorders is supported by our independent assessment of its inter-rater reliability, although some ambiguous scoring criteria warrant further examination.

**TITLE:** Sequencing bilateral proximal and unilateral task oriented arm training improves arm and hand function in patients with moderate severity chronic hemiparesis.

**AUTHORS/INSTITUTIONS:** S. McCombe Waller, A. Gaeta, T. Jenkins, J. Whittall, Physical Therapy and Rehabilitation Science, University of Maryland, Baltimore, MD; W. Liu, Department of Physical Therapy, University of South Alabama, Mobile, AL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The recovery of useful arm/hand function after stroke is a major scientific challenge especially for patients with limited spontaneous motor return. Progress in improving hand function has been demonstrated in patients with substantial residual function but results in patients with more severe limb impairment are more equivocal. In previous work using bilateral arm training with rhythmic auditory cueing (BATRAC) we have shown improvements although limited, in arm function in individuals with moderate severity paresis. Previous BATRAC training did not address whole arm task training. To extend these limited gains, we hypothesized that proximal bilateral arm training could "prime the nervous system" in this level of patient to advantage them for participation in more challenging whole arm task-oriented training.

**Number of Subjects :** Twenty six individuals with chronic moderate severity hemiparesis of the upper extremity

**Materials/Methods :** We compared the use of a sequential combination of 6 weeks BATRAC followed by 6 weeks unilateral task oriented training using the Saeboflex training orthosis (COMBO) compared to 12 weeks task oriented training with the Saeboflex orthosis alone (UNI). Primary outcome measures included the Fugl-Meyer(FM), the Modified Wolf Motor Function Test (mWMFT), Box and Blocks (BB), the University of Maryland Arm Questionnaire for Stroke(UMAQS). In a subset of participants, 3-D motion analyses of both unilateral and bilateral reaching were completed. Pre, Post and Retention (after 8 weeks) measures were analyzed using within group repeated measures ANOVA.

**Results :** Both groups showed significant gains ( $p < .05$ ) in the FM and UMAQs scores which were retained after 8 weeks. Only COMBO demonstrated significant gains in the BB and the WMFT test scores which were retained. Temporal control measures of the paretic arm during fast speed unilateral and bilateral reaching showed improvements in movement time, mean velocity, percentage of peak velocity, and peak acceleration for the COMBO group, not seen in the UNI group.

**Conclusions :** Both training approaches led to some improvements in arm function and use, but the combination of bilateral arm training followed by unilateral task oriented training demonstrated improvements in both arm and hand function and temporal control of reaching. This is especially notable given all participants had moderate severity arm paresis with no functional hand use at baseline. It is possible that preceding unilateral task oriented training with bilateral proximal arm training had a priming effect on the nervous system setting the stage for more success with a unilateral task oriented training.

**Clinical Relevance :** This small randomized controlled trial demonstrates that the sequential combination of bilateral proximal training and unilateral task oriented training led to gains in both arm and hand function. Particularly in patients with more severe paresis, bilateral proximal training may be warranted prior to beginning paretic arm/hand task training.

**TITLE:** Grip type and task goal modify reach-to-grasp performance in people with post-stroke hemiparesis

**AUTHORS/INSTITUTIONS:** S.Y. Schaefer, S.L. DeJong, K.M. Cherry, C.E. Lang, Program in Physical Therapy, Washington University School of Medicine, St.Louis, MO;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Daily life requires reaching and grasping various objects in different ways for a variety of purposes. Upper extremity (UE) movements typically can be modified to accommodate object properties and goals of intended actions. It remains unclear, however, whether stroke affects the ability to modify movement control depending on the movement context. The purpose of this study was to determine whether reaching and grasping performance in people with post-stroke hemiparesis is influenced by grip type and/or task goal, and therefore to determine how stroke might affect the flexibility of UE movement control.

**Number of Subjects :** Sixteen adults (age  $58 \pm 11$  yrs) with mild to moderate UE paresis following stroke and twelve neurologically-intact adults (age  $53 \pm 16$  yrs) participated in this study. In the stroke group, time post-stroke ranged from 14 days to 9.6 years.

**Materials/Methods :** Within a single session, subjects in each group (stroke or control) reached to and grasped a cylindrical object using one of two grip types (3-finger or palmar) to achieve one of two task goals (hold or lift). We measured UE motion using 3-dimensional motion analysis and quantified force exerted on the object using a pressure sensor. Effects of grip type, task goal, and group on reaching and grasping performance variables were analyzed using ANOVA, followed by post-hoc tests where appropriate. We examined whether effects of grip type and task goal were influenced by time post-stroke or severity of functional loss, using Pearson correlations.

**Results :** The stroke group showed more curved handpaths and slower peak reach velocities than the control group, regardless of grip type or task goal. These main effects of group are characteristic of hemiparetic limb movement during reach-to-grasp. For other measures of reaching and grasping, however, effects of grip type (group x grip interaction effects for reach time, velocity at object contact, and peak thumb-finger aperture during reach) and task goal (group x goal interaction effect for reach time) differed across the two groups. These effects were independent of time post-stroke and severity of UE functional loss.

**Conclusions :** These results show that people with stroke alter their movements across conditions, but in different ways than healthy individuals. Interaction effects may be interpreted as evidence of altered strategies that people with stroke used to compensate for their motor impairment in order to accomplish the instructed task.

**Clinical Relevance :** Information about how different movement contexts influence performance post-stroke may assist therapists in planning how and what to practice during task-specific UE training. Future training studies are needed to examine how manipulating movement contexts during therapy might impact functional recovery after stroke.

**TITLE:** Assessing Balance Using the Brunel Balance Assessment in a Patient With an Acute Stroke: A Case Study

**AUTHORS/INSTITUTIONS:** J. Mowder-Tinney, , Nazareth College, Rochester, NY; J. Parsons, , University of Rochester Medical Center, Rochester, NY;

**ABSTRACT BODY:**

**Background & Purpose :** Nearly nine million people a year are affected by a stroke world-wide with balance impairments being a significant complication. Currently, there is no Gold standard tool to measure balance in individuals who are severely impaired after stroke. Although the StrokeEDGE taskforce has made recommendations for the use of outcome measures with individuals with stroke in different settings, there are few measures for those with limited function. The Brunel Balance Assessment Tool can be used with individuals of varying functional ability after stroke. However, the Brunel tool has limited psychometric data available and research has only been performed by the originator. Thus, the purpose of this case study was to assess the face validity and feasibility of the use of the Brunel for an individual with severely impaired balance in the acute rehabilitation setting.

**Case Description :** A 68-year-old male with vertebrobasilar artery stroke affecting the right cerebellum and brainstem participated in this case study. He presented to the acute rehabilitation unit with all MMT and ROM within functional limits and required maximal assist for bed mobility and sit pivot transfers. He was unable to maintain sitting balance without support and was unable to ambulate.

**Outcomes :** Progress was noted on both outcome measures from initial evaluation to discharge (21 days): Berg Balance Scale (1/56 to 8/56) and Brunel Balance Assessment (Level 2 to Level 5). No changes were noted in ROM and MMT. Improvements in the Berg were found in two tasks (static sitting and standing) while the Brunel progressed from being able to sit supported to standing with arm movements. The Berg took approximately 10 minutes to complete due to the individuals limited functional ability to participate in the test. The Brunel also took approximately 10 minutes, but allowed one to three attempts to progress to the next level.

**Discussion :** This case study suggests that both outcome measures demonstrated progress in balance for an individual with an acute stroke. Although the individual did improve on his Berg score, the severity of the patient's impairments resulted in a score too low to identify fall risk or to show functional progress. The Brunel provided a more functional explanation of the individuals balance impairments and was more sensitive to small improvements with functional skills. Even though both the Brunel and Berg required 10 minutes to complete, more tasks were assessed during the Brunel. Future studies using the Brunel tool should be considered to allow therapists to have increased options for an efficient objective balance assessment of individuals with low functional abilities.

**TITLE:** The Relationship between Apathy and Physical Functioning in Individuals with Parkinson's Disease

**AUTHORS/INSTITUTIONS:** M. Masterson, L. Vuyk, Rehabilitation Sciences, University of Toledo, Toledo, OH;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Parkinson's disease (PD), a movement disorder, also results in many non-motor symptoms such as apathy, which affects 42% of individuals with PD. Characteristics of apathy include decreased interest and participation in activity, lack of initiative, and lack of goal-directed behavior. It is possible these characteristics may negatively influence an individual's ability to engage in daily exercise, which has been shown to positively influence the motor symptoms of PD. Thus, lack of exercise because of apathy could result in increases in motor symptoms and/or decreases in functional abilities. Therefore, the purpose of this study was to examine the relationship between apathy and physical functioning in individuals with PD.

**Number of Subjects :** 220

**Materials/Methods :** Evaluation data from patients with PD who were evaluated by various health care professionals in an interdisciplinary clinic for PD that was conducted separate from and prior to this research study were entered into a clinical database, which was de-identified and approved by the Institutional Review Board to be used retrospectively for research purposes. Patient data were grouped according to scores recorded from an apathy survey such that 126 patients were classified as apathetic (90 males, 36 females; mean age = 73.5 years, age range 49-97 years; range of time since PD diagnosis = 1-30 years) and 94 patients were classified as non-apathetic (58 males, 36 females; mean age = 70.7 years, age range 47-90 years; range of time since PD diagnosis = 1-39 years). Data from standardized functional tests performed in the interdisciplinary clinic included the Berg Balance Scale (BBS), Functional Reach Test (FRT), timed tandem stance (TS), timed single leg stance (SLS), 8' Timed Up and Go (TUG), and repeated chair stand test. Motor symptoms were assessed using items #13-15, 29-31 of the Unified Parkinson's Disease Rating Scale (UPDRS).

**Results :** There were significant differences ( $p \leq 0.05$ ) in the BBS, FRT, TS, SLS, and repeated chair stand tests and in the UPDRS items related to walking, postural stability, and bradykinesia between the apathetic and non-apathetic groups. In addition, apathy scores were significantly different ( $p \leq 0.05$ ) between those who were sedentary and those who were physically active on a regular basis.

**Conclusions :** The results of this study suggest that there is a relationship between apathy, physical functioning, and physical activity level among individuals with PD. Further research is needed to establish if there is a causal relationship between apathy and these other variables of function.

**Clinical Relevance :** Given the findings of this study, apathy must be addressed and considered when developing and implementing a physical therapy plan of care and/or a home exercise program for individuals with PD.

**TITLE:** The effect of aerobic exercise on perceived fatigue in people with multiple sclerosis

**AUTHORS/INSTITUTIONS:** E.T. Cohen, A. Dubreuil, T. Hockey, R. Johnson, M. Mehra, D. Zeitlin, Doctor of Physical Therapy Program, UMDNJ and Rutgers, Stratford, NJ;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Fatigue is one of the most common and disabling symptoms of people with multiple sclerosis (PWMS). The fatigue experienced by PWMS is complex, and accurate assessment is complicated by its subjective nature. Fatigue in PWMS may be primary, secondary, or a combination of the two. The purpose of this systematic review was to examine the effect of a program of aerobic exercise on perceived fatigue in PWMS, and to make relevant recommendations based on the results.

**Number of Subjects :** N/A

**Materials/Methods :** A search of Ovid, PubMed and CINAHL databases were conducted in September, 2010 using the keywords multiple sclerosis, aerobic exercise and fatigue. Articles were included in the review if they were randomized controlled trials applying an aerobic exercise program to PWMS with at least one outcome measurement of fatigue. Seven research studies met these criteria.

**Results :** Each article was examined for internal validity using MacDermid's Evaluation of Effectiveness of Study Design (MEESD). The MEESD has a range from 0-48, with 48 being the highest quality. Two team members reviewed each of the seven articles, and the average score was recorded for each article. The average MEESD score was 32.7/48 (range 25-39.5). Aerobic exercise interventions varied in exercise type, frequency, duration and intensity. Five studies measured perceived fatigue with the Fatigue Severity Scale (FSS), one with the Modified Fatigue Impact Scale (MFIS) and one with the Multidimensional Fatigue Inventory (MFI). In addition to measurement of perceived fatigue, six of the studies measured outcomes typically associated with endurance and aerobic capacity (e.g. 2- or 6-Minute Walk Tests (2MWT and 6MWT, respectively) and  $VO_2$ max).

**Conclusions :** No significant changes in perceived fatigue were found in six of the seven studies. The one study in which a significant change in fatigue was found after the aerobic exercise intervention measured fatigue with the MFI. This improvement was found in only one of the MFI's five categories: general fatigue. Significant improvements were found in many of the measures of endurance and aerobic capacity, including improved 2MWT and 6MWT distances,  $VO_2$ max and other cardiopulmonary exercise testing outcomes.

**Clinical Relevance :** The current evidence indicates that aerobic exercise has little ameliorating effect on perceived fatigue in PWMS. The lack of change in perceived fatigue is evident despite improvements in endurance and aerobic capacity, two outcomes that clinicians typically associate with fatigue. This is relevant for two reasons. The first is that clinicians should consider that although aerobic training may improve fitness in PWMS, it may not address perceived fatigue. The second is that clinicians and researchers should recognize that the most frequently used measures of fatigue for PWMS may not be sensitive to the type or dimension of fatigue that might be reduced by a program of aerobic exercise training.

**TITLE:** Vestibular rehabilitation for persons with post-concussion syndrome

**AUTHORS/INSTITUTIONS:** F. Fakhoury, G. Mattoccia, J. Papp, J. Pinkerton, S. Salvatore, E.T. Cohen, Doctor of Physical Therapy Program, UMDNJ and Rutgers, Stratford, NJ;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The prevalence of post-concussion syndrome (PCS) has increased in recent years, but the manifestations of the pathology are still poorly understood. People with PCS are often referred for vestibular rehabilitation (VR) to address the common problems of dizziness, balance and vestibular dysfunction. The purpose of this systematic review was to determine the efficacy of VR in the treatment of vestibular dysfunction in persons with PCS and make appropriate recommendations.

**Number of Subjects :** N/A

**Materials/Methods :** A keyword search was conducted in September, 2010 using the following terms: post-concussion syndrome, vestibular rehabilitation, rehabilitation for concussion, mild traumatic brain injury (TBI) rehabilitation. The terms were used to search the CINAHL, OVID Medline, and Google Scholar databases. Articles were excluded if participants did not have a definitive diagnosis of concussion or mild TBI or had only peripheral vestibular dysfunction, or the experiment had no VR intervention. This resulted in six articles included in the analysis.

**Results :** Each article was examined for internal validity using MacDermid's Evaluation of Effectiveness of Study Design (MEESD). The MEESD has a range from 0-48, with 48 being the highest quality. Two team members scored each of the articles and differences were discussed until a consensus score was reached. The mean MEESD score was 26.17/48 (range 13-31).

**Conclusions :** The evidence regarding the benefits of VR for persons with PCS is limited. The studies found included three retrospective studies, two non-controlled clinical trials, and one case report. VR interventions were varied in initiation of treatment post-injury, frequency, duration, and VR techniques. Improvements were found in various outcome measures including the Sensory Organization Test, Dynamic Gait Index and Dizziness Handicap Inventory. Despite the absence of randomized controlled trials, the evidence indicates that VR may be beneficial in treating dizziness, balance impairment and vestibular dysfunction experienced by persons with PCS.

**Clinical Relevance :** The current evidence suggests that VR may be beneficial for persons with PCS who experience dizziness, balance impairment and vestibular dysfunction, however, the generalizability of this finding is limited. The majority of study participants were male military personnel who sustained blast injuries. Less evidence exists regarding VR for persons with PCS who are older adults that sustained falls, or athletes who sustained impact injuries. Future prospective research that examines these, and other, patient populations will provide more robust evidence about the efficacy of VR for persons with PCS. Furthermore, although the reviewed studies included treatment with VR, the specific interventions were not consistent. Future studies should consider developing best-practice guidelines for the delivery and therapeutic dosing of VR.

**TITLE:** The Effect of Task-Specific Training in a Person with Cerebellar Ataxia and Vertigo

**AUTHORS/INSTITUTIONS:** P. Cameron, J. Freund, , Elon University, Elon, NC;

**ABSTRACT BODY:**

**Background & Purpose :** This case report describes the effects of task-specific training including progressive locomotor training (overground and treadmill walking with a safety harness) and golfing on balance, gait and endurance in a person with ataxia and vertigo secondary to a hemorrhagic cerebellar stroke. There is limited research on physical therapy interventions for persons with ataxia and vertigo secondary to stroke.

**Case Description :** The subject was a 57 year old female who had a cerebellar stroke from an arteriovenous malformation 14 months prior. She walked independently with a single point cane, a wide base of support and reported constant vertigo. Her gait speed and endurance were limited. Her initial goal was to decrease her dizziness and return to golfing and walking for exercise. As a volunteer participant in a university physical therapy course, she attended 9 of 10 scheduled sessions in 5 weeks, including: 2 examination sessions, 6 intervention sessions of locomotor training and golfing, and a re-evaluation session. Both overground walking and golfing were performed on various surfaces and terrains indoors and outdoors. She also concurrently participated in twice weekly outpatient physical therapy sessions which included treadmill walking with upper extremity support, gait activities and elliptical training.

**Outcomes :** The following measures improved (pre to post intervention): 10 meter gait speed (.71 to .96 m/s), average step width as measured using an electronic walkway (GAITRite®) (23.39 to 21.39 cm ), 6 Minute Walk Test (6MWT)(267.3 to 324 m), Five Times Sit to Stand Test (5TSTS)(17.1 to 11.4 s), Dizziness Handicap Inventory (DHI) (56 to 44 points), Stroke Impact Scale (63.6 to 81.8%) and Dynamic Gait Index (DGI) (18/24 to 21/24 ). In the final intervention session she was able to drive golf balls independently at a driving range.

**Discussion :** Locomotor training and golfing may be effective in increasing gait speed, endurance, balance and quality of life in persons with ataxia. The increase in 10 meter gait speed indicates a change from limited community ambulator to community ambulator and 6MWT improvement indicates a substantial change. Improved DGI denotes decreased falls risk. Although her reported vertigo did not change, her DHI improved from severe to moderate handicap. The change in SIS exceeded the minimal clinically important difference (MCID) in multiple domains. This case report provides support for continued research on task-specific training in persons with ataxia and vertigo secondary to cerebellar stroke.

**TITLE:** Maximum elbow extension is achieved when initially combined with greater amounts of horizontal shoulder flexion; a kinematic evaluation of reaching in chronic severe stroke.

**AUTHORS/INSTITUTIONS:** M.D. Ellis, K. Hussar, L. Alsauskaite, K. Kumar, J. Westgate, J.P. Dewald, Physical Therapy and Human Movement Sciences, Northwestern University, Chicago, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Reaching work area decreases as a function of abduction loading in individuals with chronic stroke. The quantification of work area is performed with a robotic device, ACT<sup>3D</sup>, by superimposing maximum circular reaching envelopes for clockwise and counterclockwise movement trials. A long standing clinical observation has described reaching movements across the body involving horizontal shoulder flexion to result in greater elbow extension abilities (extension synergy). Therefore, we hypothesize that movements beginning with shoulder flexion and elbow extension will allow for both greater reaching work area and greater maximum elbow extension than movements beginning with shoulder extension and elbow extension due to first moving into the extension synergy.

**Number of Subjects :** 9 individuals (1 female, 8 male) with chronic severe stroke participated in the study.

**Materials/Methods :** Maximum voluntary shoulder abduction torque was measured with a 6-DOF load cell for use in the robotic evaluation. Work area was calculated using the ACT<sup>3D</sup> for four loading conditions (supported on a haptic surface, 0%, 12.5%, and 25% of max abduction) and two movement directions (starting moving into shoulder flexion/elbow extension and starting moving into shoulder extension/elbow extension). Maximum elbow extension was determined at maximum horizontal shoulder flexion and extension for each loading level and movement direction.

**Results :** RMANOVA showed a significant effect ( $p < 0.05$ ) for both abduction load and initial direction of movement on work area. A priori paired comparisons within each loading level demonstrated a trend toward larger work areas for movements that began moving into shoulder flexion, but yielded insignificant p-values (0.05-0.10). RMANOVA showed a significant effect ( $p < 0.05$ ) for abduction load, initial direction of movement, and shoulder position on maximum elbow extension. A priori paired comparisons demonstrated a significant increase in maximum elbow extension at maximum horizontal shoulder flexion during movements that began moving into shoulder flexion.

**Conclusions :** Reaching movements beginning in the direction of shoulder flexion/elbow extension allow for greater reaching work area and greater maximum elbow extension than reaching movements beginning in the direction of shoulder extension/elbow extension. This is likely due to movement within the extension synergy that couples horizontal shoulder flexion with elbow extension. Early achievement of greater elbow extension is more readily maintained throughout the work area.

**Clinical Relevance :** Our results highlight the relevance of movements containing elements of flexion and extension synergies. Reaching abilities are greater, even under abduction loading conditions where flexion synergy manifests, when the movement incorporates components of the extension synergy. This effect can be quantified with robotics and targeted with impairment-based interventions in an attempt to improve the more impaired movement directions.

**TITLE:** TITLE: Increased Functional Mobility After Implementation Of Activity Based Locomotor Training In An Individual With Chronic Incomplete Spinal Cord Injury.

**AUTHORS/INSTITUTIONS:** S.A. Ostertag, A. McDonald, Physical Therapy, University of Montana, Missoula, MT;

**ABSTRACT BODY:**

**Background & Purpose :** Activity Based Locomotor Training (ABLT) provides a structured program to improve mobility for individuals with neurological injuries. ABLT consists of stepping training on a treadmill, overground (OTG) walking training, and community ambulation training. The purpose of this case study is to describe how incorporating ABLT into the rehabilitation of a person who is 8 years post incomplete spinal cord injury resulted in an improvement in overground ambulation skills and community integration of ambulation and standing skills.

**Case Description :** MC is a 43 year old male who sustained an incomplete C5/C6 injury 8 years ago. He was evaluated on 11-06-06. Ambulation training was initiated in 5-2007 3x/wk with 60 minute treatments. Body weight support (BWS) treadmill training was added in 9-2007 with 55% BWS and speed 0.1 mph for 15 min of stepping training. Treatment variables were provided per recommendations of Behrman et al (2005, 2006) and Field-Fote et al (2005), with a treatment goal to eventually attain <40% BWS while maintaining <40 degrees of knee flexion in stance. OTG ambulation and standing training were performed with BWS or a table top walker. Standing was performed at home in a standing frame or walker. On 5-11-10, BWS step training had improved with decreased BWS to 44% and speed up to 2.2 mph for 30 minutes. Ambulation training OTG with a table top walker was up to 302 ft, but he was not walking outside of therapy. In 6-2010, ABLT was implemented per the recommendations of Harkema et al (2007). Treatments 3-4x/wk were increased to 90 min sessions. Within 13 months, BWS had decreased to 28%, and speed increased up to 3 mph for 30 min of stepping training. The patient required minimal to moderate assist with pelvis management and during swing phase with his lower extremities.

**Outcomes :** By 8-2010, MC attained full standing with unilateral UE support so as to participate in outdoor recreational activities. By 5-20-2011, MC was assessed at a level 13 on the Walking Index for Spinal Cord Injury, as compared to a level 6 on 9-11-2007. He was able to transfer to standing and ambulate 220 ft with a bilateral platform 4WW and no physical assist in therapy. The patient had initiated community integration of his improved mobility with 120ft of mall walking and ambulation across his 60 ft parking lot with his walker and personal staff. He was able to stand up to one hour with unilateral UE support and 25 min without UE support.

**Discussion :** Through the use of existing literature and case studies, a progressive locomotor training program was initiated in 2007. Continual gains were made in physical therapy, but the patient was unable to initiate walking outside of therapy. Treatment was modified in 6-2010 through incorporation of ABLT principles(Harkema 2007). Within 13 months, this individual with chronic incomplete spinal cord injury had initiated community integration of the standing and ambulation skills that he had acquired through his rehabilitation.

**TITLE:** A step activity monitoring program improves real world walking activity post stroke

**AUTHORS/INSTITUTIONS:** K.A. Danks, D. Reisman, Physical Therapy, University of Delaware, Newark, DE; M. Roos, Biomechanics and Movement Science, University of Delaware, Newark, DE, DE;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** As a group, those with chronic stroke are extremely inactive and many report a 43% decrease in mobility and physical activity in the year following conventional physical therapy. These declines lead to a risk of developing co-morbidities and a repeated need for rehabilitation intervention. Many typical physical therapy interventions improve walking in those with chronic stroke, but have a limited effect on real-world daily walking activity. Step activity monitoring programs, however, are an effective way to improve real world walking activity in other patient populations and therefore may be effective following stroke. The purpose of this study was to examine the effectiveness of a step activity monitoring program on improving walking activity in those with chronic stroke.

**Number of Subjects :** To date, 10 subjects with chronic (>6 months) post-stroke hemiparesis.

**Materials/Methods :** Daily walking activity was measured with a StepWatch Activity Monitor (SAM) for 6 days prior to the start of the program. Based on this, a step activity goal of 25% greater walking activity was established. Subjects wore the SAM during waking hours for the following 3-4 weeks. Each week, subjects attended a counseling session where their step activity for the previous week was reviewed, including whether their step activity goal was met. If the goal was met on 3 out of the previous 7 days, their step activity goal was increased by another 25%.

**Results :** A paired sample t-test revealed that as a group, subjects had a significant improvement in average walking activity (5,691 (+/- 2,210) steps/day pre to 6,777 (+/- 2,421) steps/day post;  $p < 0.01$ ). Change in individual walking activity was evaluated relative to categories for pedometer-determined activity in healthy adults as described by, Tudor-Locke et al., 2004. This comparison revealed a change in activity categories in 6/10 subjects; 2/10 subjects from sedentary to low active, 3/10 subjects from low active to somewhat active, and 1/10 subjects from somewhat active to active categories. Of the 4 subjects who did not elevate into a higher activity category, 3 did have an improvement in real-world walking activity; 66%, 17%, and a 12% positive change respectively. The remaining subject had no change in activity.

**Conclusions :** Results of this study demonstrate that activity monitoring that includes use of a SAM and a weekly counseling program promotes an increase in real-world walking activity in those with chronic stroke. For a majority of the subjects, these improvements lead to a change in activity category (Tudor-Locke et al, 2004). Despite this, many subjects were still in relatively low-level activity categories, suggesting that combining this program with rehabilitation interventions that can also improve real-world walking activity may be critical to maximizing physical activity after stroke.

**Clinical Relevance :** A step activity monitoring program may be a low cost adjunct during and after physical therapy to promote real-world walking activity in persons with chronic stroke.

**TITLE:** Impairments in low level force control of paretic hip flexors are associated with clinical measurements of function

**AUTHORS/INSTITUTIONS:** K. Kirking, H. Kuhnen, E. Burns, S. Hunter, B.D. Schmit, A. Hyngstrom, Department of Physical Therapy, Marquette University, Milwaukee, WI; E. Christou, Applied Physiology and Kinesiology, University of Florida, Gainesville, FL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Post stroke, motor impairments limit a person's ability to control force production. This may impact balance or control of the leg during gait. Fluctuations in force measurements are used as a metric for the resolution of motor unit control, and can vary with the demands of the task (e.g. load level). The relationship between force fluctuations produced during hip flexion and clinical measures of function in people post-stroke is not known. The purpose of this study was to quantify load-related differences in the magnitude of force fluctuations between the paretic (PL), non-paretic (NPL), and control (CL) legs during a sustained sub-maximal isometric hip flexion contraction and relate the differences with walking speed and a clinical measure of balance (Berg).

**Number of Subjects :** Ten individuals with stroke (mean age =  $59 \pm 11$  yrs) and ten age and activity-matched controls (mean age =  $59 \pm 12$  yrs) participated in this study.

**Materials/Methods :** Hip flexion torque was measured using a servomotor drive system equipped with leg braces instrumented with force transducers. At 20 degrees of hip flexion, the test leg (P, NP, CL) performed 3, 10s isometric hip flexion contractions at each of the following load levels: 5%, 10%, 15%, 20%, and 40% of the hip flexion maximal voluntary contractions. Force fluctuations were quantified as the coefficient of variation ( $CV = \text{standard deviation}/\text{mean torque} * 100$ ) and averaged across each of the three trials for each load condition. For the stroke subjects, the Ten Meter walk Test and Berg Balance assessments were performed prior to testing. An analysis of variance (ANOVA) was performed to detect differences in the magnitude of the C.V. between load levels (5%, 10%, 15%, 20%, and 40% of MVC) and test leg (PL, NPL, and CL) ( $\alpha = 0.05$ ). The coefficient of determination was calculated to detect associations between the C.V. and functional measures (respectively: walking speed and Berg score).

**Results :** Main effects (ANOVA,  $p < 0.05$ ): (1) the PL had a larger mean CV (10 %) compared with the NPL (7%) and CL (4 %), and (2) the 5% load had a larger CV (11%) compared with the 15% and 20% loads (both mean CV = 5%). There was an interaction between load level and test leg with the greatest difference for the PL at the 5% load level (mean CV = 20%). The CV for the PL at the 5% load level had the largest coefficient of determination for correlations with walking speed ( $r^2=0.45$ ) and Berg Balance Score ( $r^2=0.38$ ) compared to other load levels.

**Conclusions :** These data suggest that the PL has impaired resolution of control of the hip flexors at lower load levels which may be related to overall level of function.

**Clinical Relevance :** It may be important to examine force regulation at different load levels, especially low levels, to get a more complete picture of overall function as well as to determine how to challenge the patient during rehabilitation. This may be applicable to decisions regarding loading in body-weight support gait training especially if working on targeted stepping or maintaining balance on uneven surfaces.

**TITLE:** Step Length Symmetry Adaptation Generalizes from Treadmill to Overground Walking in Nondisabled and Persons with Stroke and Hemiparesis

**AUTHORS/INSTITUTIONS:** D. Savin, J. Whitall, Physical Therapy and Rehabilitation Science, University of Maryland Baltimore, Baltimore, MD; S.M. Morton, Graduate Program in Physical Therapy and Rehabilitation Science, University of Iowa, Iowa City, IA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Stroke and hemiparesis often result in gait asymmetries which have been resistant to traditional forms of treatment. Recently, motor adaptation, a practice dependent alteration in movement, has shown potential to temporarily improve aspects of hemiparetic gait asymmetry. However, to be useful in hemiparetic gait rehabilitation, motor adaptation during treadmill walking must generalize to overground walking. Thus the purpose of this experiment was to determine the extent to which treadmill motor adaptation generalized to overground walking and the rate at which adaptation decayed overground in nondisabled and persons post-stroke. We hypothesized participants would show a generalization of step length symmetry adaptation from treadmill to overground walking, temporarily improving symmetry in those with stroke. We also hypothesized that participants with stroke would have slower rates of adaptation decay than controls. Finally, we hypothesized that if step length symmetry improved, overground gait speed would increase in participants with stroke.

**Number of Subjects :** Ten participants (seven female) with unilateral stroke and hemiparesis without known cerebellar pathology, age  $62.8 \pm 9.4$  years (mean  $\pm$  1 SD) and 10 age- and gender-matched controls completed the study.

**Materials/Methods :** Participants walked in three successive conditions: Baseline overground on an instrumented gait mat, Adaptation to a novel swing phase perturbation designed to alter step length symmetry on a treadmill, Generalization overground on a gait mat. Outcome measures included: step length symmetry, rate of step length symmetry decay, overground gait speed. A factorial ANOVA with repeated measures was used to compare step length symmetry and gait speed across three testing conditions: Late Baseline, Early and Late Generalization. Rate of decay was assessed by a t-test.

**Results :** Step length symmetry adaptation showed significant generalization to overground walking in both groups ( $p < 0.001$ , no interaction) and decayed at similar rates ( $p = 0.11$ ). For participants with stroke, generalization resulted in a temporary improvement of overground step length asymmetry. Additionally, gait speed increased for both participant groups by the end of the experiment ( $p < 0.01$ ).

**Conclusions :** Our results indicate that generalization of motor adaptation from treadmill to overground walking in this sample is not impaired by stroke and hemiparesis. These results support previous findings, using a different paradigm, suggesting greater importance of the cerebellum as opposed to the cerebrum in locomotor adaptation. Further study is needed to determine whether the duration of generalization and resulting improvement in gait symmetry can be maintained by locomotor adaptation training over time.

**Clinical Relevance :** These results suggest that treadmill locomotor adaptation may be an effective means of driving improvements in overground gait symmetry in persons post-stroke.

**TITLE:** Validity of the K-9 & BESTest balance measures in community-dwelling stroke survivors

**AUTHORS/INSTITUTIONS:** J. Breger, N. Collins, A. Deshpande, L. Johnston, J. LeJeune, P. Palit, K. Potter, L.D. Hedman, D.A. Brown, Physical Therapy and Human Movement Science, Feinberg School of Medicine, Northwestern University, Chicago, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Stroke survivors with chronic hemiplegia are at an increased risk for falling compared with age-matched individuals without a history of stroke primarily due to poor motor control, gait, and balance deficits. Therefore, it is important for clinicians to use a balance assessment tool that is valid and reliable, as well as one that measures ability to succeed with functional tasks. The purpose of this study was to determine the concurrent, discriminative, and construct validity of a new balance measure, the KineAssist 9 Task Balance Test (K-9), by comparison to a gold standard, the Berg Balance Scale (BBS) and a new balance measure, the Balance Evaluation Systems Test (BESTest), respectively. The K-9 test utilizes a KineAssist robot to assess a patient's ability to perform nine functional balance tasks. The KineAssist Robot allows the patient to complete each task to his/her point of failure without the fear of falling and possible guidance from the therapist. We hypothesized that 1) the nine functional tasks measured with the K-9 would correlate to one or more of the six components of balance control described in the BESTest, 2) the K-9 and BESTest scores would be highly correlated with the BBS, and 3) an age-similar control group made of non-impaired individuals would have statistically significantly higher scores on the K-9 and the BESTest when compared to the stroke survivor group.

**Number of Subjects :** Participants included fifteen community-dwelling individuals with chronic post-stroke hemiplegia and fifteen age-similar individuals with no prior history of stroke.

**Materials/Methods :** Data was collected from a single trial of the BBS, K-9, and BESTest. Total scores for the BBS, K-9, and BESTest, and subscores for the BESTest were calculated.

**Results :** There was a statistically significant correlation ( $R^2=0.632; p<0.0004$ ) between the scores on the K-9 and the BBS in chronic stroke survivors, but not with non-impaired subjects. The non-impaired subjects scored significantly higher than the chronic stroke survivors on the K-9 ( $p<0.0001; t=-6.341$ ) as well as the BESTest ( $p<0.0001; t=-8.507$ ). There was a significant correlation between the scores of the K-9 and BESTest with the chronic stroke survivors, but not with the non-impaired subjects.

**Conclusions :** The results of the study demonstrate the concurrent validity of the K-9 when compared with the BBS and the BESTest. The K-9 was able to discriminate between subjects with balance impairments post-stroke and non-impaired subjects. These results also support the construct validity as a measure of functional balance for stroke survivors.

**Clinical Relevance :** The K-9 is a highly valid measure of balance impairment for community dwelling stroke survivors. More research should be conducted to further establish the validity and reliability of the K-9, including its ability to predict fall risk and gait capability.

Funding Support: U.S. Department of Education, NIH/NIDRR #H133E070013

**TITLE:** The need for speed: Better movement quality during faster task performance after stroke

**AUTHORS/INSTITUTIONS:** S.L. DeJong, S.Y. Schaefer, C.E. Lang, Program in Physical Therapy, Washington University, St. Louis, MO;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Although slow and insufficient muscle activation is a hallmark of hemiparesis post-stroke, movement speed is rarely emphasized during upper extremity rehabilitation. Moving faster may increase intensity of task-specific training, but positive and/or negative effects on paretic limb movement quality are unknown. The purpose of this study was to determine whether moving quickly instead of at a preferred speed either enhances or impairs paretic limb performance of a reach-grasp-lift task after stroke.

**Number of Subjects :** Sixteen people with mild to moderate post-stroke hemiparesis (age  $59 \pm 11$  years) and 11 healthy individuals (age  $55 \pm 15$  years) participated. In the group with hemiparesis, time since stroke ranged from 2 weeks to 9 years and Action Research Arm Test scores ranged from 20 to 53 (57 = normal).

**Materials/Methods :** Within a single session, each participant reached to, grasped and lifted a cylindrical object at their preferred speed and as fast as possible, using palmar and 3-finger grip types. We measured durations of the reach and grasp phases, straightness of the reach path, thumb-index finger separation (aperture), and efficiency of finger movement, using 3-dimensional motion analysis, and quantified force exerted on the object using a Tekscan pressure sensor. For each variable, effects of speed condition (preferred speed or fast), grip type (3-finger or palmar) and group (stroke or control), were evaluated using ANOVA and post-hoc tests where appropriate.

**Results :** As expected, reach and grasp phase durations decreased in the fast condition in both groups (main effect of speed condition), showing that participants were able to move more quickly when asked. When moving fast, the group with hemiparesis had reach durations equal to those of healthy controls moving at their preferred speed. Aspects of movement quality also improved. Reach paths were straighter and peak apertures were greater in both groups in the fast condition (main effect of speed condition). The group with hemiparesis also showed improved efficiency of finger movement (speed condition x group interaction). Differences in peak grip force across speed conditions did not reach significance.

**Conclusions :** People with hemiparesis are able to move faster than they choose to, and when they do, aspects of movement quality are improved. Faster reach-grasp-lift movements are associated with straighter reach paths, increased hand opening, and improved efficiency of finger movement.

**Clinical Relevance :** Simple instructions to move faster could be a cost-free and effective means of increasing rehabilitation intensity after stroke. Our findings in this single-session study show that speed-related instructions may also enhance movement quality. Further studies are needed to determine whether instructions to move more quickly during task-specific training can improve outcomes.

**TITLE:** Use of the Wii Fit for Balance Rehabilitation: Establishing Parameters for Healthy Individuals, Preliminary Results

**AUTHORS/INSTITUTIONS:** M. Burns, K. Andeway, P. Eppenstein, K. Ruroede, Physical Therapy, Marianjoy, Wheaton, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study is to establish balance parameters for the Wii Fit in a sample of healthy adults, for evaluation of balance measurement reproducibility.

**Number of Subjects :** The Wii Fit has been introduced as a cost-effective adjunct to balance training used in rehabilitation. There is scant literature on evidence based approaches to incorporate entertainment technology into rehabilitation protocols using valid and reliable measurements. An IRB approved this prospective study of a healthy subject sample for exploratory analysis; 75 healthy subjects were approved for recruitment and planned to be evenly distributed across ages 21-65. The initial 40 participants' measurements are discussed here. Participants' had no history of neurological conditions or orthopedic injury that would limit study participation; body mass index below 35; self-reported to be physically active for moderate physical exertion and able to walk one mile; no self-reported history of seizures; normal blood pressure or under control with medication; female volunteers cannot be pregnant; normal or corrected to normal vision; and no previous experience with the Wii Fit.

**Materials/Methods :** All participants completed three consecutive trials of three common balance activities on the Wii Fit, during a single session. The three activities, randomly ordered by the investigators, included: 1) Balance Bubble; 2) Body Fit/Center of Balance; and 3) Tight Rope Walking. All data were analyzed with the IBM SPSS Statistics 19.

**Results :** The 40 participants' age distribution were grouped into ranges; 21-35 (n = 18), 36-50 (n = 10), and 51-65 (n = 12). Descriptive statistics for distance, duration, and rates for the Bubble Balance and Tight Rope Walking were measured. Right and left Center of Balance distribution percentages were also measured across three trials. Bar graphs, line charts, and boxplots were generated to evaluate the distribution appearance and range of scores for each parameter. Analysis and visual displays were generated with all participants as one group then separated according to age group and trial. Detailed mean parameters are not reported given the partial sample at this point; however, several general observations can be provided. The distance and duration for the Balance Bubble means are much larger than the Tight Rope Walking, perhaps indicating Balance Bubble is the easier of the two Wii Fit balance activities. Participants generally increased performance across trials. Center of Balance distributed weight percentages were fairly equal across all trials on right and left sides.

**Conclusions :** More subjects need to complete the Wii Fit activities to evaluate a sample of healthy participants' parameters. Preliminary analysis suggests that the Wii Fit can discriminate between participants on balance measurement and age.

**Clinical Relevance :** To establish whether the Wii Fit can be used as a tool to measure and treat balance dysfunction in the clinical setting.

**TITLE:** Mobility and Balance Diagnostic Classification System for Neurologic Physical Therapy

**AUTHORS/INSTITUTIONS:** A. de Joya, Physical Therapy, TIRR Memorial Hermann Hospital, Houston, TX; A. de Joya, Physical Therapy, University of Alabama at Birmingham, Birmingham, AL;

**ABSTRACT BODY:**

**Purpose :** Establishing a diagnosis related to the human movement system is an essential element of the physical therapy (PT) patient management model. Existing classification systems categorize patients based on movement related impairments. To date, classification systems that include the activity and participation domains of the International Classification of Functioning, Disability and Health (ICF) are not documented. The purposes of the Mobility and Balance Diagnostic Classification System (MBDCS) are to classify movement dysfunction related to neurologic conditions across the activity and participation domains of the ICF and to guide clinical decision making in neurologic PT practice.

**Description :** The MBDCS is based on Patla and Shumway-Cook's conceptual framework for mobility and also self-efficacy, life-space and participation dimensions to capture the holistic view of the movement function of a patient. Each dimension is related to one or more of the following eleven diagnostic categories: gait distance dysfunction, gait speed dysfunction, sensory organization dysfunction, balance disorder associated with postural maladjustment, balance disorder associated with abnormal postural responses, functional ambulation dysfunction associated with various terrain surfaces, balance disorder associated with cognitive impairment, balance disorder associated with abnormal postural responses in the presence of obstacles, restricted community integration associated with balance self-efficacy disorder, decreased community/social role functioning and/or decreased satisfaction with life/quality of life associated with limited participation in important social roles, restricted pattern of mobility associated with limited life-space and/or decreased level of independence. Data obtained from tests and measures serve as the criteria to make decisions about the diagnostic categories the patient's movement dysfunction is assigned to. Categorizing the patient's movement dysfunction directs the treatment intervention to maximize the range in which the patient can function in each dimension.

**Summary of Use :** Clinicians establish a diagnosis related to movement dysfunction which guide and direct treatment interventions, improve their communication among colleagues and other members of an inter-disciplinary team and enhance their efficiency of identifying evidence-based treatment interventions. A standard of care through this organized clinical decision making process lessens variability in neurologic PT practice.

**Importance to Members:** The MBDCS guides neurologic PT practice in clinical decision making that goes beyond the impairment level and focuses on the activity and participation domains of the ICF. This provides a holistic framework for identification and management of human movement system dysfunction related to a neurologic condition. The diagnoses made by clinicians grounded in the human movement system establishes the PT professional identity.

**TITLE:** Modification of the Four Square Step Test and its Reliability and Validity in People Post Stroke

**AUTHORS/INSTITUTIONS:** D.S. Reisman, G. Hicks, S. Binder-Macleod, K. Rudolph, Department of Physical Therapy, Univ Delaware, Newark, DE; M. Roos, Biomechanics & Movement Science, University of Delaware, Newark, DE;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Early identification of falls risk in people post stroke is vital as up to 70% experience at least one fall and up to 50% fall while walking. In older adults, increased falls have been noted with obstacle avoidance with imposed time constraints and people post stroke are less successful avoiding obstacles than healthy controls. The Four Square Step Test (FSST), a balance assessment that measures time needed to avoid obstacles, was unable to be completed by 11/21 (52%) subjects post stroke during a preliminary investigation. We decided to modify the FSST and establish its reliability and validity in a wide range of people post stroke.

**Number of Subjects :** 36 subjects (Ss) post stroke

**Materials/Methods :** The FSST was modified in 2 ways: 1) 4 canes that subjects step over during the FSST were replaced by colored tape; 2) Ss performed the test and were allowed to rotate their hip (AR) and were told not to rotate their hips (NR). Subjects were videotaped while performing the test with canes (C) and with tape (T) under AR and NR conditions. Five raters timed the subjects performing the test under the 4 conditions. An ordinal scale scoring rubric was used to evaluate loss of balance, hip rotation and touching the cane/tape, which are the conditions that would deem a subject unable to perform the FSSTs. The Activities Specific Balance Confidence Scale (ABC), Berg Balance Scale (BBS), Six Minute Walk Test (6MWT), and Timed Up and Go (TUG) were used for the construct of "poor dynamic balance" and used to test validity. Subjects were classified as having poor dynamic balance (GRP1) if they met all of the following criteria: scored score < 81% on ABC, < 52 on BBS score, > 13.5 sec on TUG, and were ≤ 50th percentile on the 6MWT. Remaining subjects were placed in GRP 2.

**Results :** Videotapes of 26 Ss attempting to perform the test under each condition were used for the reliability testing. Of the 26 Ss, the numbers of subjects who completed each form of the test were as follows: CNR=8; CAR=16; TNR=15; TAR=18. Data from the taped conditions are reported here. INTRA-RATER RELIABILITY: ranges of weighted kappas were: TNR = 0.604 to 0.922; TAR = 0.838 to 1.0. INTER-RATER RELIABILITY: ranges of weighted kappas were: TNR = 0.482 to 0.745 and TAR = 0.839 to 1.0. Data from 36 subjects were used in testing the validity of the form of the test that was completed by the largest number of subjects, TAR which we operationally defined as the "Modified Four Square Step Test" (mFSST). Based on construct criteria 9/36 subjects were classified as having poor balance (GRP1). The time to complete mFSST was significantly longer for GRP 1 compared to GRP2 (p=0.000) demonstrating that the mFSST was able to identify people with poor balance, thus construct validity was established.

**Conclusions :** The mFSST as defined in this study is reliable and has construct validity and can be performed by more people post-stroke than the FSST.

**Clinical Relevance :** The mFSST is easy to perform, requires limited space and equipment and may prove useful in research studies and clinical practice.

**TITLE:** Development of 3D immersive videogame to improve arm-postural coordination in patients with TBI

**AUTHORS/INSTITUTIONS:** A. Schafer, K. Ustinova, , Central Michigan University, Mount Pleasant, MI;

**ABSTRACT BODY:**

**Purpose :** Traumatic brain injury (TBI) disrupts the central and executive mechanisms of arm(s) and postural (trunk and legs) coordination. To address these issues, we developed a 3D immersive videogame Octopus using the basic principles of videogame design. Unlike many other custom-designed virtual environments, Octopus included an actual gaming component with a system of multiple rewards, making the game challenging, competitive, motivating and fun. The game was developed using WorldViz software, integrated with the Qualysis system for motion analysis. The purpose of the study was test the effect of short-term practice with the Octopus game on arm-postural coordination in patients TBI.

**Description :** Thirteen individuals with TBI participated in the study. Participants had mild-to-moderate coordination deficits affecting gait, postural control, and upper extremity movements, with clinical test scores ranging: a) 39-55 points on the Berg Balance test b) 12-29 points on the Functional Gait Assessment Test; and c) 5-12 points on the Ataxia Test according to Klockgether, with 35 points identifying severe ataxia. While standing in front of the screen, the participants practiced reaching and popping virtual bubbles with the left or right hand avatar. The bubbles, blown by the Octopus followed a specific trajectory. Interception of the bubbles allowed flexible use of the postural segments (trunk and legs) for balance maintenance and arm transport. All participants practiced ten 90-s gaming trials during a single session, followed by a retention test. Arm-postural coordination was analysed using principal component analysis.

**Summary of Use :** As a result of the short-term practice, the participants improved in game performance, arm movement time, and precision, mostly by adapting efficient arm-postural coordination strategies. Of the 13 participants, 10 showed an immediate increase in arm forward reach and single-leg stance time.

**Importance to Members:** These results support the feasibility of using the custom-made 3D game for retraining of arm-postural coordination disrupted as a result of TBI.

**TITLE:** The feasibility and efficacy of a community exercise class for individuals with early stage Parkinson's disease

**AUTHORS/INSTITUTIONS:** R. Tappan, H. Roth, Sensory Motor Performance Program, Rehabilitation Institute of Chicago, Chicago, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Recent evidence has demonstrated that high intensity balance and aerobic training focusing on large amplitude based movements improves gait speed, step length, and dynamic balance in individuals with Parkinson's Disease (PD). A community-based exercise class was developed from this evidence targeting a higher functioning population. We tested the hypothesis that individuals participating in the biweekly exercise class would demonstrate improvements in gait and balance after an 8 week session.

**Number of Subjects :** 14 subjects with diagnosis of PD

**Materials/Methods :** A community exercise class provided intensive, evidence based exercise for individuals with PD Hoehn and Yahr Stages 1 and 2. The one-hour biweekly class was led by 1-2 staff and consisted of education, high intensity aerobic training, balance activities and self- stretching, with cues for large amplitude movements throughout all activities. Outcome measures including the 10 meter walk test at self selected velocity (SSV) and fast velocity (FV), Timed Up and Go (TUG) and the dual task TUG (dTUG) were collected during the first and last week of each eight week session.

**Results :** To date, a total of six (6) eight week sessions have been conducted with 12-15 participants in each session. There were no adverse events or falls noted throughout this time period. Statistical significance was determined using repeated measures ANOVA. The 14 subjects who attended >50% of classes in session one demonstrated an improvement on the dTUG. Their group mean decreased from  $12.53 \pm 4.78$  sec to  $9.63 \pm 2.28$  sec, which is statistically significant with  $p=0.025$ . This group also showed a decrease in TUG mean from  $9.34 \pm 1.64$  sec to  $8.38 \pm 1.86$  sec which is approaching statistical significance with  $p=0.056$ . There were no significant improvements in the 10m at SSV or FV. The 9 subjects who attended >50% of classes in at least two sessions also showed significant improvements from baseline to the end of the second session, with a decrease in TUG mean from  $9.81 \pm 1.80$  sec to  $8.63 \pm 1.58$  sec ( $p=0.024$ ), and a decrease in dTUG mean from  $13.46 \pm 5.74$  sec to  $10.32 \pm 2.58$  sec ( $p=0.012$ ).

**Conclusions :** High intensity community-based exercise programs are safe and feasible for individuals with PD. Further, this high intensity exercise class led to improvements in balance in this population, indicating that exercise delivered in a community context has the potential to positively influence physical function despite the degenerative nature of this disease.

**Clinical Relevance :** Exercise for individuals with PD in the context of a community-based class has the potential to deliver ongoing, cost-effective and safe exercise intervention to people in the early stages of PD. This study provides preliminary data regarding the gait and balance changes that occur over the course of several months of such an exercise class.

**TITLE:** Physical Activity Intensity of Inpatient Stroke Rehabilitation is Related to Functional Outcome

**AUTHORS/INSTITUTIONS:** S. Duffy, K. Zalewski, Human Movement Sciences, , Milwaukee, WI;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Functional ability after stroke rehabilitation is related to stroke morbidity and mortality. The purpose of this study is to investigate the relationship of physical activity (PA) intensity and functional mobility outcomes during inpatient stroke rehabilitation.

**Number of Subjects :** 52 people admitted to a rehabilitation unit over an 8-month window with first stroke were invited to participate. 40 people consented to participate; 2 withdrew before data collection was complete.

**Materials/Methods :** Data collection occurred in two sessions; session 1 within the first 10 days of admission, session 2 within 3 days of discharge. Physical activity intensity was measured using a custom PA observation (OPA) every 10 minutes from 8 am through 5 pm. Total steps (PA) and stepping intensity (SI) were collected using a StepWatch Activity Monitor (SAM) worn on the uninjured ankle. Functional outcomes of comfortable and fast gait speeds, and functional ambulation category (FAC) were evaluated at discharge. Correlations between measures of activity intensity (OPA, PA and SI) and functional outcomes are evaluated using Pearson's (R) and Spearman's Rho ( $\rho$ ). Differences in PA and OPA by FAC are evaluated with ANOVA and Kruskal-Wallis. Discharge FAC is predicted using discriminant functions analysis.

**Results :** 38 people, mean age of 64 ( $\pm 8.4$ ) years, 5 with hemorrhagic stroke; 32 ischemic spending 18 ( $\pm 7.0$ ) days in rehabilitation participated. Participants averaged 1714 ( $\pm 1411$ ) steps per day with 79% of the day inactive, 18% low, 2% moderate, and 0.5% high activity. Average OPA ranged from low (mean 1.2  $\pm$  .35) to low-moderate (mean 2.3  $\pm$  .30). Mean comfortable gait speed is 0.5 ( $\pm 0.38$ ) m/s and fast 0.9 ( $\pm 0.44$ ) m/s. FAC classification at discharge identified 1 participant non-ambulatory (FAC 0); 7 dependent level II (FAC 1); 6 dependent level I (FAC 2); 14 supervised (FAC 3); 5 independent level surfaces (FAC 4), and 3 independent (FAC 5).

PA is moderately correlated to OPA ( $\rho = .505$ ,  $p < .00$ ), comfortable ( $R = .60$ ,  $p < .00$ ) and fast ( $R = .57$ ,  $p < .00$ ) gait speeds. As FAC increases, total steps increase from 500 ( $\pm 370$ ) in FAC 1 to 1922 ( $\pm 280$ ) in FAC 3, to 4237 ( $\pm 605$ ) in FAC 5. OPA was different only between participants classified as FAC 1 and 5 ( $K = 3.37$ ,  $p < .05$ ). Discriminant analysis using only PA and SI predicted FAC classification in 62.9% of the participants.

**Conclusions :** There is an association between the PA intensity during rehab and functional independence at discharge. Whether PA is tied to stroke severity or a function of selected interventions is difficult to assess.

**Clinical Relevance :** This study invites reflection on whether dosage and intensity of inpatient rehabilitation is sufficient to optimize functional mobility.

**TITLE:** Use of Research Methodology to Evaluate the Effectiveness of Medication on Functional Performance in the Traumatic Brain Injury Population

**AUTHORS/INSTITUTIONS:** C. Tassini, MossRehab, Elkins Park, PA;

**ABSTRACT BODY:**

**Purpose :** Physicians often prescribe medications to patients with TBI to impact function without any objective evaluation of the effectiveness of the drug on the desired outcome. As clinicians we are often biased by what we anticipate will be achieved by adding a new medication. Utilization of research designs such as a blinded crossover study or blinded on/off trials can be useful for the treating clinician to decrease bias and objectively evaluate the impact of medications on function in patients with TBI. This poster will explain the value of objective evaluation of medications through a case example.

**Description :** An 18 year old male was admitted to an inpatient TBI unit one month after falling, sustaining bilateral cerebral and occipital contusions. For 3 months after admission he demonstrated minimal functional gains. The team was blinded to the start of dextroamphetamine (Dex) or placebo with the goal to improve initiation. The team remained blinded during a 3-week administration period and one-week crossover period of the alternate medication. Therapists collected data on transfers and walking ability (assistance, quality, and distance). Social interaction, communication, and ADL's were also monitored. One day prior to initiating the study he was dependent for ADL and transfers, ambulating 25 feet with maximal assistance, not speaking or eating. After starting the study, rapid progress was made in multiple domains. By crossover, nutrition was 100% oral, he required moderate assist for ambulation, transfers and stairs, and minimal to moderate assistance for dressing. He demonstrated increased initiation for conversation, eating and other activities. Immediately after crossover to the alternate condition staff identified a significant decline in function. To determine course of action, on day 2 after crossover, the study was unblinded and it was revealed that he had been on Dex initially and placebo at crossover. Dex was resumed and within one day he returned to pre-crossover status.

**Summary of Use :** Research methodology can be a very useful tool for therapists in collaboration with physicians to evaluate the impact of medications on function. It is feasible to apply basic research designs in the clinic in order to decrease bias and improve evaluation of medications. Physical therapists play an important role in the application and evaluation of medications by collaborating with the medical team to clearly define the goal of the medication and then choose appropriate measures and means to collect data and analyze data.

**Importance to Members:** Use of research designs such as blinded crossover or blinded on-off trials are a valuable tool for evaluating medications by decreasing clinician bias. Therapists should work to collaborate with the treating physicians in order to objectively quantify the impact of medications on function and this can be done through some very simple research design and data analysis.

**TITLE:** Vertigo and BPPV in an adolescent.

**AUTHORS/INSTITUTIONS:** J.L. O'Brien, Vestibular Rehabilitation, NYU Langone Medical Center Rusk Institute, New York, NY;

**ABSTRACT BODY:**

**Background & Purpose :** Benign Paroxysmal Positional Vertigo (BPPV) is the most frequent labyrinthine pathology in adults, characterized by imbalance and brief attacks of vertigo occurring after specific position changes due to the presence of otoliths in the semicircular canal. BPPV is considered rare in children, and there is limited literature to describe the incidence of this condition in pediatrics. The most common cause of episodic vertigo in children is benign paroxysmal vertigo (BPV), thought to be a variant of migraine, characterized by short lived attacks of vertigo and postural imbalance resolving spontaneously. Marcelli et al report children with BPPV had a normal vestibular examination with the exception of a positive Dix-Hallpike (DH) test, whereas children with BPV had a positive vestibular examination and a negative DH. Children with BPV also have a positive family history of migraine and motion sickness (MS). The purpose of this poster is to present the case of an 11 year old boy with complaints of vertigo as a result of BPPV as well as possible BPV due to family history of migraines and history of MS.

**Case Description :** The patient was an 11-year-old male with history of migraines and complaints of vertigo with positional changes, and head movement for 4 years. He had a 4-year history of headaches (HA) lasting hours in duration and relieved with sleep. HA were triggered by bright lights, loud noises, and occasionally accompanied by dizziness, nausea, and MS. Patient had difficulty riding the school bus and participating in wrestling during gym class. Patient was seen in vestibular clinic for evaluation presenting with normal oculomotor findings, and a normal vestibular examination with the exception of Left DH. DH test revealed left torsional upbeat nystagmus lasting approximately 40 seconds with severe complaints of vertigo in test position. Canal repositioning maneuver (CRM) was performed to treat left posterior canalithiasis during initial evaluation. Multiple CRMs were performed in each session over the course of four visits. The patient and his mother were trained in performance of self-CRM to perform at home in order to continue treatment of BPPV.

**Outcomes :** Vertigo intensity in DH position decreased and nystagmus lasted approximately 10 seconds. Dizziness Handicap Inventory (DHI) scores increased post treatment from 20 to 22. Visual Analog Scales (VAS) measurements of dizziness and balance decreased.

**Discussion :** CRM was effective in reducing complaints of dizziness, however symptoms and nystagmus were still present after treatment. DHI scores increased post treatment, however VAS scores for dizziness decreased demonstrating modest improvement in symptoms. The DHI is not a validated outcome measure for pediatrics and given the difficulty with this self-report of symptoms in children it is difficult to determine the cause of this patient's continued symptoms. Further studies to determine the relationship between migraines and BPPV in children are indicated.

**TITLE:** Post-concussion syndrome: A multi-modal intervention approach

**AUTHORS/INSTITUTIONS:** P. Vidal, A. Guarini, P. Caldiero, K. Smarrito, , Specialized Physical Therapy, LLC, Cherry Hill, NJ; A. Goodman, , Children's Hospital of Philadelphia, Voorhees, NJ;

**ABSTRACT BODY:**

**Background & Purpose :** Post-Concussion Syndrome (PCS) is a growing problem in adolescent sports. Signs and symptoms of PCS are cognitive, physical, and emotional in nature and may include headache, dizziness, neck pain, difficulty with balance, and difficulty with concentration and memory. The initial treatment for PCS is rest and avoidance of activity, however emerging trends and published data support the role of physical therapy intervention in the treatment of PCS. Limited data is available on the most appropriate type of physical therapy intervention for PCS. Given the multitude of signs and symptoms that may occur with PCS, a multi-modal intervention approach is recommended.

**Case Description :** A 17 year old female with primary complaints of headache, dizziness, neck pain, fatigue, and light sensitivity after sustaining a concussion while playing lacrosse was referred to a private practice physical therapy office. No loss of consciousness occurred, although one prior concussion occurred about six months earlier. Initial physical therapy examination was three weeks post onset and revealed impaired oculomotor control, postural control, and muscle performance. Objective measurements included symptom intensity, Sports Concussion Assessment Tool 2, modified clinical test of sensory integration of balance, King-Devick test, Dizziness Handicap Inventory, Dynamic Gait Index, and range of motion measurements, as well as ImpACT. Multi-modal intervention included vestibular rehabilitation therapy (VRT), manual physical therapy (MPT), and aerobic conditioning (AC). Treatment frequency and duration was one time a week for four weeks. Treatment intensity was progressed to facilitate a safe return to activity.

**Outcomes :** At the end of four weeks of treatment, all objective measurements demonstrated significant improvement and the individual was able to safely return to activity.

**Discussion :** The outcomes achieved in this individual support the use of a multi-modal treatment approach. VRT to address impairments in oculomotor and postural control. MPT to resolve symptoms of headache and neck pain. AC to facilitate progressive physical activity and a safe return to activity. Modifications in the school environment as recommended by the individual's physician also facilitated recovery. The overall management and treatment of PCS should be multi-disciplinary and based on each specific individual. A multi-modal intervention approach addressing the individual's impairments is recommended.

**TITLE:** Intermittent walking results in greater distance and less fatigue than continuous walking in persons with Multiple Sclerosis

**AUTHORS/INSTITUTIONS:** H.I. Karpatkin, B. Breisemeister, R. Hartmann, D. Napolione, R. Luu, Physical Therapy, Hunter College, City University of New York, New York, NY;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Neurogenic fatigue is a common finding in Multiple Sclerosis (MS), limiting the ability to engage in sustained physical activity as occurs in walking. Walking longer distances can be particularly limited by fatigue. Difficulties in walking longer distances can increase the risk of falls and injury in persons with MS, as well as preventing persons with MS from walking a sufficient amount to improve endurance. Intermittent walking (IW), where breaks are taken over the course of a walk, may offer a way to allow persons with MS to walk greater distances with less accumulation of fatigue and thereby increase overall walking distance. The purpose of this study was to compare IW to continuous walking (CW) to see if greater distances and less fatigue would be found in the IW condition. We hypothesized that IW would result in greater distances walked with fewer complaints of fatigue than CW in persons with MS.

**Number of Subjects :** 14

**Materials/Methods :** Subjects with a definite diagnosis of MS were recruited as a sample of convenience. Following collection of demographic and subject characteristics, subjects were randomized into either a continuous walking or an intermittent walking group. The continuous walking group (CWG) walked 6 minutes continuously over a marked indoor course, with distance walked measured every 2 minutes. The intermittent walking group (IWG) walked 6 minutes taking a 2-minute seated rest every 2 minutes, with distance walked measured every 2 minutes. Subjective sensation of fatigue was measured before and after each walk using the Visual Analog Scale of Fatigue (VASF). 7-14 days later the subjects returned and performed whichever type of walk that they did not perform the first time.

**Results :** The Intermittent group walked further than the continuous group (1183.4 vs 1128.4, respectively), the difference approaching significance ( $p=.08$ ). At the 3rd tertile of walking time (minutes 5 and 6), the intermittent group walked significantly further than the continuous group (4408.33' vs. 4098.50' [8% more],  $p < .01$ ). Mean VASF pre-post walking difference scores were smaller in the intermittent vs. continuous group (12.72 vs 25.00, respectively), ( $p = .06$ )

**Conclusions :** Subjects walked farther in the intermittent condition as opposed to the continuous condition, and found the intermittent walking less fatiguing. The longer the walk, the greater the difference between the 2 groups became. The pattern of slowing down during the 6MWT in the continuous group is typical of the MS population, whereas the maintained speed in the intermittent group more closely approximates an unaffected population.

**Clinical Relevance :** Persons with MS may be able to walk greater distances with less fatigue if they take breaks while walking as opposed to performing the walks continuously. By taking rests during walking, a greater volume of work can be performed, and therefore greater exercise gains may be made, as well as decreasing the risk of falls and injury associated with walking fatigue.

**TITLE:** Maximum Walking Speeds Obtained Using Treadmill and Overground Robotic System in Persons with Post-Stroke Hemiplegia

**AUTHORS/INSTITUTIONS:** C.E. Capo-Lugo, C. Mullens, Interdepartmental Neuroscience Program, Northwestern University, Chicago, IL; D.A. Brown, Department of Physical Therapy and Human Movement Sciences, Feinberg School of Medicine, Northwestern University, Chicago, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** After stroke, individuals with moderate to severe impairments walk at speeds that range from approximately from 0.3 – 1.3 m/s, when encouraged to walk at their self-selected maximum walking speed (SSMWS). These speeds are significantly lower than those exhibited by age-matched individuals. The assessment of walking beyond SSMWS could provide novel insights regarding the capabilities of this population to adapt current neuromuscular mechanisms into more challenging walking tasks. The purpose of this study was to determine the capacity of stroke survivors to reach faster speeds than their SSMWS while walking on a treadmill belt or while being pushed by a robotic system (i.e. “push mode”). We hypothesized that these participants will be able to walk at higher speeds, compared with overground SSMWS, when provided with external propulsive forces that push them to attempt dynamic stability maintenance at higher gait speeds.

**Number of Subjects :** Eighteen chronic stroke survivors ( $59 \pm 14$  years old) with hemiplegia participated in the study.

**Materials/Methods :** In individuals with hemiplegia, we calculated their self-selected comfortable walking speed (SSCWS) and SSMWS using a 5-meter walk test (5-MWT). Then, they were exposed to walking at increased walking speeds, on a treadmill and while in “push mode” in a robotic device. We recorded the time and number of steps during each trial and calculated gait speed, average cadence and average step length.

**Results :** Nine participants were unable to walk at increased speeds according to the a priori established criteria and were excluded from the analyses. Maximum walking speed in the “push mode” was significantly higher than the maximum walking speed on the treadmill and both were higher than the maximum walking speed overground. Moreover, in many cases participants were able to match the top speed limit of the robotic device (2.0 m/sec). Subjects achieved these faster speeds by initially increasing both step length and cadence and, once individuals reached the limit of their step length, they increased cadence only.

**Conclusions :** With post-stroke hemiplegia, individuals are able to walk at faster speeds than their SSMWS overground, when provided with a safe environment that assists with propulsion. These results support the growing body of evidence that shows the feasibility and benefits of training this population at high walking speeds. Moreover, this study suggests the possibility that people post-stroke can be trained at higher speeds than previously attempted.

**Clinical Relevance :** Chronic stroke survivors have the capacity to adapt their current walking pattern to achieve faster speeds and they should be trained and encouraged to achieve greater walking speeds in order to attain better cardiovascular results and achieve higher levels of independence. However, further clinical trials should be performed in order to identify appropriate training parameters that respond to patients’ needs.

Funding/support: Foundation for Physical Therapy-PODS I and U.S. Department of Education-NIH/NIDRR #H133E070013.

**TITLE:** Dance video game training causes shifts in striatum and cerebellum activity

**AUTHORS/INSTITUTIONS:** S. Bronner, J. Noah, ADAM Center, Long Island University, Brooklyn, NY; A. Tachibana, Dept. of Physiology and Neuroscience, Kanagawa Dental College, Yokosuka, Kanagawa, JAPAN;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Both the cerebellum and basal ganglia play a role in motor learning. It has been suggested that cerebellum activity is associated with early learning, particularly in rhythmic tasks. This activity may be related to error correction in a role as comparator. In contrast, studies report striatum activity after implicit learning that may be linked to consolidation of the behavior. Striatum activity has also been linked to reward. These two areas still present many unknowns regarding their activity in motor learning and development of increased skill. Few studies have investigated neural changes with extended practice.

**Number of Subjects :** Ten healthy adults (mean age 25 years) underwent 30 hrs of Dance Dance Revolution (DDR) training.

**Materials/Methods :** We examined a rhythmic dance video game, DDR, with multiple external cues to assess the effect of increased skill on modification of these neural circuits. We hypothesized that 30 hrs of DDR training would shift patterns of activation from cerebellum-dominant activity to increased basal ganglia activity. Subjects played a modified 2-arrow version of DDR during two fMRI sessions (1.5T, GE) pre and post DDR training. BOLD signal analyses were performed using SPM8 in MATLAB. Games scores from the fMRI sessions were compared with paired t-tests ( $p < 0.05$ ).

**Results :** Despite the relative simplicity of the 2-arrow scanner game, scanner pre and post training game-scores demonstrated a mean 55% improvement ( $p < 0.05$ ). Comparison of fMRI results indicated significant BOLD changes in cerebellum and basal ganglia activity. In a Pre–Post subtraction, there was minimal striatum BOLD activity; but in the Post–Pre subtraction, increased activity was seen in the caudate bilaterally. Cerebellum activity changed from bilateral anterior cerebellum lobules IV and V (Pre–Post subtraction), to right posterior cerebellum lobules VIII and IX (Post–Pre subtraction). This laterality was seen despite a game that involved equal use of both feet.

**Conclusions :** The shift to increased caudate activity with prolonged practice may be related to learning-related changes such as enhanced sensori-motor integration, motor planning, execution, and memory. Basal ganglia activation may also reflect reward-related processing. Shifts to posterior cerebellum activity with improved motor performance suggest that this area is actively involved in both the learning and/or performance of skilled motor output. These results are consistent with previous studies suggesting that there are separable motor-striatal and motor-cerebellum loops that contribute differentially to learning.

**Clinical Relevance :** These results indicate that 30 hrs of training is sufficient to modify activity within subcortical-motor loops. This suggests why rhythmically cued tasks are effective for basal ganglia disorders like Parkinson's disease. Future studies will examine this training in subjects with Parkinson's disease.

**TITLE:** Retention of a Walking Visuomotor Adaptation in Healthy Adults

**AUTHORS/INSTITUTIONS:** A.S. Hanson, S. Tseng, S.M. Morton, PT & Rehab Science, Univ of Iowa, Iowa City, IA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Previous studies have demonstrated that locomotor adaptations can be used to produce novel patterns of interlimb symmetry in healthy individuals. However most adaptations decay within minutes, thus limiting their possible future utility in rehabilitation interventions. Here, we wished to determine whether a locomotor adaptation could be retained longer if the feedback used to drive the adaptation was subsequently removed. We hypothesized that healthy adults would show at least partial retention of a newly acquired asymmetric walking pattern 24 hours after adaptation.

**Number of Subjects :** Nine non-disabled healthy adults (34 years  $\pm$  13.4 years, mean age  $\pm$  1 SD) participated in this study.

**Materials/Methods :** Leg kinematics were measured using the Optotrak system (Northern Digital Inc.) while participants walked on a treadmill at a self selected speed during two consecutive days of testing. Day 1 consisted of baseline, adaptation and post-adaptation periods. Real-time visual feedback of right and left leg single limb support (SLS) times was provided via a computer display. During baseline, the visual feedback accurately reflected participants' SLS times. During adaptation, the feedback of SLS times was altered so that it appeared increased by 15% on one side and decreased by 15% on the other side. Participants were asked to restore the visual display to an apparent symmetry, which required walking with a novel asymmetry of SLS times. During post-adaptation, the visual feedback was removed and participants were asked to maintain the new altered SLS time asymmetry. On Day 2, participants were asked to attempt to reproduce the altered walking pattern from the previous day without visual feedback. They then repeated the Day 1 testing protocol. Changes in interlimb symmetry of SLS times and step lengths were compared across all testing periods using a repeated measures ANOVA.

**Results :** Participants acquired the expected novel visuomotor adaptation, as demonstrated by significant asymmetries in SLS times on one side ( $p < 0.05$ ) and step lengths bilaterally ( $p < 0.05$ ) by the end of the Day 1 adaptation period. Interestingly, SLS time asymmetries often increased rather than decayed during the Day 1 post-adaptation period. On Day 2, participants showed significant retention of asymmetric SLS times ( $p < 0.05$ ) as well as faster re-adaptation compared to Day 1.

**Conclusions :** The results indicate healthy adults can alter gait symmetry using visual feedback. The newly acquired asymmetric walking pattern can be retained for at least 24 hours and re-adapted more quickly during a second exposure. The findings suggest that removal of visual feedback can be used to lengthen the retention period of certain visuomotor adaptations.

**Clinical Relevance :** Gait retraining via motor adaptation with subsequent removal of feedback may be an effective method to facilitate restoration of gait symmetry in certain patient populations, such as clients with hemiparesis.

**TITLE:** The Effect of Manual Therapy and Gait Training on Balance, Mobility and Quality of Life in a Person with Parkinson's Disease and Knee Osteoarthritis

**AUTHORS/INSTITUTIONS:** A. Attorri, M. Garcia, J. Freund, Physical Therapy Education, Elon University, Elon, NC;

**ABSTRACT BODY:**

**Background & Purpose :** This case report illustrates the effect of manual therapy and gait training on balance, mobility and quality of life in a person with Parkinson's disease (PD) and unilateral knee osteoarthritis (OA). There is limited research on physical therapy interventions for persons with Parkinson's Disease (PD) and OA.

**Case Description :** The subject was a 77 year old male with idiopathic PD (diagnosed 3.5 years prior), a right total knee arthroplasty (3.5 years prior), left knee OA and chronic left knee pain. He had never received physical therapy for his PD symptoms, and received minimal physical therapy following the TKA. He was a household ambulator with a single point cane, but was pushed in a wheelchair for all mobility outside the home. Ambulation was limited by fear of falling, left knee pain and PD symptoms. As a volunteer participant in a university physical therapy course he attended 9 of 9 sixty-minute sessions in 5 weeks, including: an examination session, 7 intervention sessions and a re-evaluation session, and performed a home exercise program. His goals were to increase lower extremity strength, mobility and balance. Gait training, performed without an assistive device on various surfaces, included visual and verbal cues with an emphasis on increased stride length. Manual therapy was used to decrease pain and increase extension range of motion in the left knee prior to gait training each session.

**Outcomes :** The following measures improved (pre to post intervention): 10 meter self-selected gait speed (.71 to .78 m/s); 10 meter fast-paced gait speed (.83 to .90 m/s); simplified Activities-specific Balance Confidence scale (ABC-S), (29% to 60%); Berg Balance Scale (BBS), (38/56 to 47/56); 6 minute walk test (151.8 to 183.8 meters); mobility dimension of Parkinson's Disease Questionnaire-39 (PDQ-39), (50% to 25%); left knee pain verbal analog scale rating (5/10 to 0/10); and left knee extension (-20 to -5 degrees). The patient reported ambulating multiple times outside the home and no longer used a wheelchair.

**Discussion :** Manual therapy and gait training may be effective in increasing balance, mobility and quality of life in persons with PD and knee OA. The BBS outcome exceeded the minimal detectable change of 5 points. The ABC-S and PDQ-39 mobility dimension improved 31% and 25% respectively; however, the minimally important difference for these measures have not been established. This case report provides support for continued research on the evaluation of orthopedic impairments and intervention effects in persons with PD.

**TITLE:** A Retrospective Analysis of the Use of Vestibular and Vision Therapy in the Treatment of Post Concussion Syndrome in Athletes

**AUTHORS/INSTITUTIONS:** C. Durborow, D. Watson-Shaeffer, Physical Therapy, Bryn Mawr Rehabilitation Hospital, Malvern, PA; C. Beckley, Occupational Therapy, Bryn Mawr Rehabilitation Hospital, Malvern, PA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Recent evidence on Post Concussion Syndrome (PCS) is focused on accurate diagnosis; however, research that examines effective treatment is currently focused on cardiovascular interventions, and is lacking in the areas of recovery of vestibular and vision deficits. The purpose of this study was to determine the effect of vestibular and vision therapies on functional activities in individuals diagnosed with PCS resulting from a sports-related injury. These functional activities include: balance, gait, ocular motor control, visual reaction timing, and tolerance for normal daily levels of intensity of vestibular and visual stimulation.

**Number of Subjects :** A sample of convenience was used. Subjects who sustained PCS due to a sports-related injury and had been discharged from an outpatient mild traumatic brain injury program between 1/1/09 and 3/5/11 were identified. Subjects included 12 males and 20 females, ages 12-21. Subjects sustained injuries participating in cheerleading, football, basketball, hockey, soccer, gymnastics, lacrosse, golf, rollerblading, band, snowboarding, skiing, and wrestling.

**Materials/Methods :** Retrospective chart reviews were performed. Results from tests and measures as reported by the treating therapists at evaluation and discharge were collected. Pre/post-intervention data from the Motion Sensitivity Quotient, Sensory Organization Test (Balance Master), Head Shake Sensory Organization Test, Gaze Stabilization Test, Functional Gait Assessment, Dynamic Visual Acuity Test, Dynavision, Saccadic Fixation Times and symptoms were compared.

**Results :** Subjects showed a statistically significant change ( $p < .01$ ) in the sensory organization test, motion sensitivity quotient, gaze stabilization test, dynamic visual acuity, functional gait analysis, dynavision, saccadic fixation times and symptoms. The head shake Sensory Organization Test did show improvements, however these changes were not statistically significant ( $p = .120$ ).

**Conclusions :** Vestibular and vision therapies should be considered in the management of individuals with post concussion syndrome from a sports-related injury.

**Clinical Relevance :** Vestibular therapy resulted in improvements in balance control, tolerance to motion, gaze stability and dynamic visual acuity. These improvements allow individuals to receive and process multisensory information for basic activities while remaining symptom free and may also allow for a return to higher level performance activities, such as sports. Vision therapy resulted in improvements in visual reaction timing and saccadic fixation, which allow for improved protective responses and reaction times during activities like driving and sports. Improvement in visual tests allows for improved reading and computer activities, as well as gathering visual information quickly. Therapies also resulted in a decrease in reported symptoms, allowing individuals to tolerate the normal daily levels of intensity of vestibular and visual stimulation and maintain their ability to perform daily activities and participate in sports.

**TITLE:** Comparing the Efficacy of two Different Exercise Programs for People with PD Requires Sensitive Measures  
**AUTHORS/INSTITUTIONS:** J. Wilhelm, A. Serdar, J. Schlimgen, M. Smith, Physical therapy, Oregon Health Sciences University, Portland, OR; L.A. King, A. Salarian, F.B. Horak, Neurology, Oregon Health Sciences University, Portland, OR;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** While it is believed that Physical Therapy directed exercise may be beneficial in improving balance and gait in people with Parkinson's disease (PD), it is not known if such changes are intervention-specific. Here we compare outcomes from a novel, high-intensity sensorimotor agility program to those of a high-intensity treadmill program. We present preliminary balance and gait outcomes from 42 persons with PD who were randomized to one of two physical therapist-administered exercise programs.

**Number of Subjects :** Forty two

**Materials/Methods :** Forty-two people with idiopathic PD (age:  $67 \pm 7$ , UPDRS  $33 \pm 15$ ) participated in this delayed-start design study. Two baseline pretests (4 weeks apart) were obtained to determine stability of measures without intervention. Subjects were randomized into either an Sensorimotor Agility program (King, 2009) or a progressive Treadmill program (Herman, 2007). Both groups were under the direct supervision of a physical therapist, 4 times a week for 4 weeks, after which a post-test was administered.

Clinical scales included Berg Balance Scale and Mini-Bestest. Instrumented measures were obtained with the Instrumented Timed Up and Go test (ITUG) and Instrumented Sway test (ISway) with wearable sensors. All testing and exercise sessions were performed ON medication. For all measurements, standardized response mean (SRM) was calculated for the 2 baseline measures and for baseline versus intervention. SRM is the mean change (d) reported in units of standard deviation of change (SDdiff),  $SRM = d / SDdiff$ . For SRM, a value of 0.20 represents a small change, of 0.50 a moderate, and a value of 0.80 represents a large change.

**Results :** Both Agility and Treadmill groups improved in the clinical scales similarly. Specifically, both groups had large changes in the miniBest (.94 Treadmill and 1.04 Agility) and moderate changes in the Berg Balance Scale (.6 and .8).

Unlike clinical scores, instrumented measures showed program-specific improvements. The Treadmill group improved moderately in gait parameters of stride velocity (.56) and arm swing speed (.43) whereas the Agility group only improved in gait symmetry (stride length asymmetry -.79). In contrast, several measures of turning improved for the Agility group only, including duration of turn (-.41), step time during turn (-.62), first step before turn (-.54) and speed during turn (.74). Only the peak speed of the turn improved in the Treadmill group (.58). Lateral sway amplitude in stance increased in the Agility group only (.78).

**Conclusions :** Although some clinical tests are adequate to show improvements after high intensity exercise regardless of type of intervention, instrumented tests can measure task-specific changes related to specific exercises.

**Clinical Relevance :** In prescribing exercise, instrumented measures could help define impairments to customize a targeted exercise program.

**TITLE:** The Effects of the GivMohr Sling on Gait Parameters Post Stroke.

**AUTHORS/INSTITUTIONS:** K. Dieruf, R. Hearting, S. Wilkie, , University of New Mexico, Albuquerque, NM;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The role of the upper extremity (UE) during gait has been well documented, and it has been demonstrated that inhibiting arm swing in normal subjects has a negative effect on energy expenditure and induces abnormal muscle activation in the trunk and lower extremities. In addition, research has shown that in subjects who have sustained a stroke, wearing a single strap sling improves gait, but this type of sling may decrease function of the UE. Restoration of movements of the UE may enhance normal movements of the trunk, pelvis, and lower extremity while walking; including increasing walking speed and weight bearing on the paretic side.

The GivMohr sling is designed to position the low tone UE appropriately while providing joint compression through the glenohumeral joint, elbow and wrist. The sling holds the UE in a functional position consisting of retraction and depression of the scapula, with the humerus in near neutral rotation, and the elbow held in mild flexion. This position leaves the involved UE free to swing and provide counterbalance weight shifting in the upright position. It was hypothesized that there would be a positive change in gait parameters in participants who have sustained a stroke while wearing the GivMohr sling.

**Number of Subjects :** Fourteen subjects

**Materials/Methods :** Fourteen adults who had sustained a cerebral vascular accident which resulted in hemiparesis walked (with an assistive device as needed) across the GAITRite mat up and back, with and without the GivMohr sling in a randomly assigned order. Subjects walked at a self-selected speed with standby assist for safety.

**Results :** Eleven of the fourteen subjects showed an improvement in gait velocity (0.2-12.9cm/sec) and step length (0.2-13.7cm) with the sling compared to without the sling. Eight out of fourteen showed a decrease in double support time (0.1-2.3 seconds), but they were not always the subjects who had increased gait velocity or step length. There was also an improvement in Wisconsin Gait Scale score in eight of the thirteen subjects that allowed videotaping ranging from 1.0-4.0 points of improvement.

**Conclusions :** While research is continuing to increase the sample size, it appears that use of a GivMohr Sling improves gait parameters in subjects with hemiparesis.

**Clinical Relevance :** This is a simple and inexpensive treatment that not only supports and protects the UE, but properly positions it during upright postures. Early gait training in subjects with low tone UE's is often difficult and may be delayed. Proper support and positioning of the UE allows earlier, safe upright activities. If just adding a sling can help to normalize gait and improve velocity, the long term outcomes of individuals post stroke including wellness and functional ability should be enhanced.

**TITLE:** Walking Speed and Distance Improves with a Short-Burst of Either Body Weight Supported Treadmill Training or Overground Walking Training for Persons with Chronic Stroke

**AUTHORS/INSTITUTIONS:** S.A. Combs, L. Brower, D. Colburn, A. Harmeyer, T. Poole, Krannert School of Physical Therapy, University of Indianapolis, Indianapolis, IN; A.A. Schmid, , Roudebush VA Medical Center, Indianapolis, IN;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this pilot study was to compare walking speed and distance after a short-burst of body weight supported treadmill training (BWSTT) or overground walking training (OWT) with persons with chronic stroke.

**Number of Subjects :** Twenty participants (11 male; mean age  $60.9 \pm 8.3$  years) with chronic stroke ( $61.2 \pm 48.9$  months post stroke; 8 right hemiparesis) who walked  $\leq 0.8$ m/s were randomly assigned to BWSTT or OWT.

**Materials/Methods :** Intervention sessions were administered 5 times a week for 2 consecutive weeks, for 30 minutes of walking each session. BWSTT followed a standardized protocol to increase treadmill speed and decrease body weight support. OWT followed a standardized protocol to increase speed/distance walked over a level surface. Manual and verbal cues were provided to both groups as needed. Walking intensity was monitored with the Borg Rating of Perceived Exertion Scale (RPE) at 5 minute increments throughout intervention sessions, aimed to maintain a moderate training intensity (ratings of 11-14). Participants were evaluated the week before (pre-test) and after intervention (post-test) by an examiner masked to group assignment. The clinical outcome measures included: comfortable 10-meter walk test (CWT), fast 10-meter walk test (FWT), and 6-minute walk test (6MWT). Total distances walked and mean RPE were calculated across intervention sessions. Results were analyzed with a 2x2 mixed model ANOVA,  $p < 0.05$ . Eligible post-hoc comparisons were performed with a Bonferroni correction.

**Results :** No statistically significant differences were found between groups for all measures at pre-test and post-test ( $p > 0.05$ ). Both groups demonstrated significant improvements from pre- to post-test with increased gait speed on the CWT and increased distance walked on the 6MWT ( $p < 0.05$ ). Both groups increased mean speed on the FWT, but only the OWT group made a significant change. From session 1 to session 10 both groups demonstrated a statistically significant increase in total distance walked during the intervention period, while maintaining RPE within the moderate intensity level.

**Conclusions :** Both BWSTT and OWT improved walking function for these participants with chronic stroke.

Participants in both groups were able to increase walking distance during training while maintaining a moderate intensity level on the RPE across the 10 intervention sessions. Similar walking distances performed by each group during the interventions may be due to the emphasis on maintaining a moderate training intensity. Intensity of training rather than type of walking intervention may be the more important factor for improving walking function over time.

**Clinical Relevance :** BWSTT and OWT at moderate training intensities are feasible options to improve gait function in persons with chronic stroke. A short-burst training dose may be an effective means of improving walking ability and shows promise for use within the clinical setting.

**TITLE:** The Effects of Strengthening on a Patient with Alexander Disease: A Case Report

**AUTHORS/INSTITUTIONS:** T. Laretta, C. Senesac, Physical Therapy, University of Florida, Gainesville, FL;

**ABSTRACT BODY:**

**Background & Purpose :** Alexander disease (AD) is a rare leukodystrophy characterized by the formation of Rosenthal fibers in astrocytes and diffuse white matter degeneration in the central nervous system. It is caused by a missense mutation in the gene that codes for the production of glial fibrillary acidic protein (GFAP). Individuals with AD are classified into 3 subtypes (infant, juvenile, and adult) based on onset of symptoms and location/extent of white matter involvement. Currently, there is little in the literature investigating the effects of physical therapy interventions in this patient population. The purpose of this case report is to describe the effects of a lower extremity and core strengthening program on strength outcomes for a patient with AD

**Case Description :** A 21 year old female diagnosed with Juvenile type AD participated in an 8 week lower extremity strengthening program that consisted of 16 treatment sessions and a home exercise program. The Biodex System 3 Isokinetic Dynamometer was used at pre and post testing to measure the peak and average peak torque produced by the hamstring and quadriceps muscle groups during isometric contraction at 30, 45, and 60 degrees.

**Outcomes :** Gains in peak and average peak torque were observed for the quadriceps and hamstrings in the right lower extremity. The largest gain, 17.5% was noted in peak torque at 60 degrees of knee flexion with the largest increase in average peak torque, 16.6% in the same muscle group at 45 degrees. The largest gain in peak torque for the hamstring muscles, 16.5% was noted at 45 degrees of knee flexion and average peak torque gain of 14.5% at 30 degrees. The hamstrings on the left demonstrated an increase at all angles with the largest noted in average peak torque of 11.4% at 60 degrees

**Discussion :** The results of this case study demonstrate the potential for improvements in strength related to physical therapy interventions in this population. The results suggest a possible relationship between a strengthening exercise program and improvements in peak and average peak torque production by hamstring and quadriceps muscle groups during isometric contraction. Further research needs to be conducted in this population to determine the efficacy of physical therapy interventions and their potential to improve quality of life in these individuals.

**TITLE:** Prevalence of Vestibular Hypofunction and Associated Risk Factors for Falls in Community Dwelling Elders

**AUTHORS/INSTITUTIONS:** K.M. Johnson, A. Burke-Doe, J. Laslovich, L. Johnson, Doctor of Physical Therapy, University of St. Augustine for Health Sciences, San Marcos, CA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to determine the prevalence of vestibular hypofunction, as measured by the horizontal head impulse test (h-HIT), in community dwelling elders and to examine their associated risk factors for falls.

**Number of Subjects :** One hundred and five community dwelling elders were subjects for this study. The subjects were either living in their own homes and utilizing a senior center or living in an independent living facility.

**Materials/Methods :** Subjects completed a series of questionnaires and physical testing procedures including health history, Senior Fitness Test (SFT), Dynamic Gait Index (DGI), modified Clinical Test for Sensory Interaction in Balance (mCTSIB), and h-HIT.

**Results :** Of the 105 subjects assessed, 19 females and 4 males with an age range of 63-95 years and a mean age of 79.9 years were found to have a positive h-HIT. Of these 23 subjects, 6 had a positive left h-HIT, 12 had a positive right h-HIT, and 5 had a positive bilateral h-HIT. Associated risk factors for falls within these 23 subjects included: 47.8% reported cardiovascular conditions which included heart disease, hypertension, and peripheral vascular disease; 39.1% reported neurologic conditions which included diabetes mellitus (DM), depression, and stroke; 70% reported previous falls; 22.2% reported dizziness; 13% reported use of an assistive device; 34.8% failed condition 4 of the mCTSIB; and 60.9% scored less than or equal to 19 on the DGI.

**Conclusions :** In the assessment of 105 community dwelling elders, the overall prevalence of vestibular hypofunction, as measured by positive h-HIT findings, was 21.9%.

**Clinical Relevance :** The prevalence of fall-related injuries and deaths are on the rise in the United States causing significant public health concerns. Since the vestibular system is an integral component of postural control, falls may be the result of poor inner ear function. Vestibular hypofunction, as measured by the h-HIT, is common among community dwelling elders and can significantly increase the likelihood of falls. In addition to associated risk factors for falls such as DM, stroke, and heart disease, special consideration should be given to the importance of screening, diagnosing, and early intervention associated with vestibular hypofunction.

**TITLE:** Kids STEP Study: Locomotor training outcomes and use of select long tracts as predictive biomarkers of responsiveness after chronic, incomplete spinal cord injury.

**AUTHORS/INSTITUTIONS:** A. Behrman, E.J. Fox, S.A. Trimble, S. Suter, C. Senesac, Physical Therapy, University of Florida, Gainesville, FL; J. Kleim, D.R. Howland, Neuroscience, University of Florida, Gainesville, FL; N.J. Tester, VA Brain Rehabilitation Research Center, Malcom Randall VAMC, Gainesville, FL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Locomotor training (LT), a promising therapy for recovery of walking after SCI, is viewed as efficacious for adults with incomplete SCI (ISCI) who exhibit some voluntary isolated leg movements. The goal of this pilot study was 1) to determine LT effects in non-ambulatory children with severe ISCI and little to no isolated leg movement and, 2) to identify neural substrates associated with or predictive of walking potential.

**Number of Subjects :** Seven children, 3.5-12 yrs, >1 yr post-SCI, severe, ISCI, ASIA Impairment Scale classified B or C were enrolled in the study.

**Materials/Methods :** Tests were conducted pre- and post-LT. Standardized clinical assessments included tests of voluntary motor function and sensory function (including lower extremity motor score,LEMS), gross motor skills (Gross Motor Function Measure), ambulation, crawling, and pedaling. Neuorphysiologic tests included: motor evoked potentials (MEPs) and testing of the acoustic startle reflex (ASR). Subjects received 60+ sessions of LT, 5x/week which included: manual-assisted stepping on a treadmill with partial body weight support to optimize sensory input and provide mass practice followed by transfer and practice of skills in an over ground environment daily.

**Results :** Six/seven children completed the study. Although walking potential was not predicted from traditional clinical findings, 3/6 children developed stepping during LT and can independently initiate stepping and walk over ground using a reverse walker. All three had stable lower extremity motor scores (LEMS) of  $\leq 4/50$  pre- and post-LT. Unique features of these three compared to other subjects were: 1) Initiation of whole-lower limb extensor pattern; 2) No evidence of MEPs in the LEs suggesting lack of functional corticospinal tract connections in the caudal spinal cord; 3) Positive LE ASRs suggesting functional reticulospinal tract connections in the caudal spinal cord. All 6 children showed improved trunk control, gross motor skills, and/or reported improved sensation.

**Conclusions :** These results support the potential benefit of LT on walking recovery in children after chronic, ISCI deemed non-ambulatory by standard clinical tests of voluntary leg movement. Additionally, these results suggest training also may promote improvements in functionally critical non-stepping tasks such as trunk control critical for sitting, standing, reaching and transfers.

**Clinical Relevance :** These preliminary findings suggest that voluntary, isolated leg movements may not be required for walking recovery after ISCI. Tracts not traditionally identified as initiating walking in the human, such as the reticulospinal tract, may contribute to recovery of basic walking. Current methods to predict walking recovery after ISCI may not be sufficient to identify who will benefit from therapies that promote activity-dependent plasticity.

**TITLE:** A Systematic Review of the Effectiveness of Virtual Reality-Based Rehabilitation to Improve Gait in Patients Post Stroke

**AUTHORS/INSTITUTIONS:** K. Kyle, M. Horne, J. Hindman, R.M. Hakim, Physical Therapy, University of Scranton, Scranton, PA, PA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this systematic review was to assess the effectiveness of Virtual Reality (VR)-based interventions on improving gait in patients post stroke.

**Number of Subjects :** N/A

**Materials/Methods :** A literature search of EBSCOhost, MEDLINE, and Science Direct (2001-2011) was conducted to identify randomized controlled clinical trials (RCTs) examining the effect of VR-based training on gait. Inclusion criteria were: VR system intervention for gait, subjects post stroke, published in English, gait outcome measure(s), and scholarly, peer-reviewed journals. Studies were excluded if the design was not a RCT and if robotics were used to facilitate movement. Three reviewers independently assessed each study for methodological quality based on PEDro Guidelines.

**Results :** A total of 76 articles were screened for eligibility in this review. Three additional articles were identified through hand searching. Following a detailed appraisal, 6 studies fulfilled the inclusion/exclusion criteria and were included in this systematic review. The quality assessment ranged from a PEDro score of 3 to 7/10 with an average of 5. A variety of VR systems were used across all studies reviewed. Sample size ranged from 10 to 24 participants with a total of 92. All subjects were at least 6 months post CVA. Studies were conducted in outpatient, rehabilitation and laboratory settings. Three out of 6 studies using a VR-based intervention showed significant improvements in gait outcome measures when compared to conventional physical therapy programs.

**Conclusions :** Our systematic review showed mixed positive findings for the use of VR-based training on improving gait outcomes such as temporal-distance measures and functional classification in patients post stroke. Limitations included small sample sizes and a lack of uniform VR interfaces. Overall there is weak evidence supporting the effectiveness of VR interventions to improve gait in a clinical setting. There is insufficient evidence to recommend VR as the primary intervention to improve gait in the rehabilitation of patients post stroke.

**Clinical Relevance :** VR systems provide a safe, motivational, interactive environment that encourages locomotion. VR-based interventions show promise as a supplemental intervention to improve gait in the rehabilitation of patients post stroke.

**TITLE:** The Parkinson Wellness Recovery - PWR! Project. Developing “neurofitness for life” programming to optimize function, learning, and brain change for individuals with Parkinson disease (PD).

**AUTHORS/INSTITUTIONS:** B.G. Farley, Physiology, Univ. of Arizona, Tucson, AZ; V. Carter, Physical Therapy, Northern Arizona University, Flagstaff, AZ;

**ABSTRACT BODY:**

**Abstract Body :** Exercise is about more than fitness - it is a physiological tool to help protect, repair, and optimize brain function. Recent basic and clinical science research suggests that exercise and learning approaches may promote brain change (neuroplasticity) in persons with (PD), with the potential to alter disease progression. To achieve optimal and lasting benefits, early intervention and continuous access to exercise is essential. No one exercise approach appears to be superior, instead, studies altogether suggest principles of “how” to practice may be important drivers of neuroplasticity and skill acquisition for individuals with PD. These drivers include principles of intensity (high effort for whole body activation, increased repetition, greater frequency of practice), specificity of training (deficit-targeted practice), cognitive engagement (progressively challenge attentional focus by manipulating difficulty/complexity), emotional engagement (motivate through empowerment, education, group and social support, FUNction), sensory integration training (require self monitoring, augment accuracy and quantity of sensory feedback, reinforce success and quality), and neural readiness (aerobic conditioning/mental imagery).

The clinical translation of these neuroplasticity-principles of practice to rehabilitation is dependent upon overcoming many challenges. To date, early intervention and continuous access programs are not available. As one solution, we propose the development of community neurofitness centers where early intervention and continuous access to neuroplasticity-principled programming may be best adopted. Regional networks of PD-exercise experts would coordinate neurorehabilitation programming within these community neurofitness centers. One purpose of the PWR! Project is to develop this infrastructure and to train PD-exercise experts to support community neurofitness programming that becomes integrated within the healthcare system.

Another problem is that the translation of neuroplasticity-principles of practice are rarely implemented in rehabilitation for people with PD. To increase their translation, we have developed a novel clinical framework to teach and help organize the essential principles and therapeutic options, and then guide clinicians in HOW to develop treatment plans that target PD-specific motor/sensory/cognitive/emotional deficits. The Exercise4BrainChange™ framework is founded upon research in the fields of exercise science, motor control, and motor learning. It can accommodate multiple exercise approaches and strategies, and it allows for a similar language across a variety of PD-exercise experts. The translation of neuroplasticity principles to rehabilitation and community programs offers promise to delay disease onset, slow disease progression, restore motor function, and increase longevity and quality of life for people with PD.

**TITLE:** Outcome Measures in Acute Stroke Rehabilitation: A Comparison of the Berg Balance Scale and the PASS test

**AUTHORS/INSTITUTIONS:** S.A. Keller, M. Burns, K. Ruroede, , Marianjoy Rehabilitation Hospital, Wheaton, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** It will be feasible to perform the Berg Balance Scale and the PASS test with the inpatient stroke rehabilitation population at both admission and discharge. The Berg Balance Scale and the PASS test will demonstrate a positive response to change during acute rehabilitation.

**Number of Subjects :** All patients admitted to the stroke unit of a rehabilitation hospital from February 2010-March 2011 were assessed for appropriateness. Inclusion criteria included admission to the stroke unit and a CVA within the past 30 days as confirmed by chart review. Exclusion criteria included a previous stroke, MD order for limited weight-bearing, and patients who were not independent ambulators prior to the CVA. There were 221 patients who met criteria, with 21 patients being emergently discharged, thus leaving 200 patients that were included in the final data analyses. The mean age is 71 years (+/-13 years) with 100 males and 100 females. There were 164 patients with ischemic CVAs and 36 hemorrhagic CVAs.

**Materials/Methods :** Within 3 days of admission and discharge, the Berg Balance Test and the PASS test were performed with all patients who met the criteria. The patients underwent a standard rehabilitation program. Functional Independence Measure (FIM) scores are completed at admission and discharge as part of the rehabilitation program.

**Results :** The mean admission Berg Balance Score (0-56 scale) was 11 points (+/- 12) and the mean discharge was 30 points (+/-17). The mean change score for the Berg Balance Scale from admission to discharge was 19 points (+/- 12) with a statistically significant change (P=0.00). The mean admission PASS score (0-36 scale) was 14 points (+/- 9) and the mean discharge was 26 points (+/- 8). The mean change score for the PASS test was 11 points (+/- 6) with a statistically significant change (P=0.00). The mean admission FIM Motor Composite Score (0-77 scale) was 32 points (+/- 12) and the mean discharge was 50 points (+/- 15). The mean change in the FIM Motor Composite Score was 17 points (+/- 19). The mean number of days between initial and discharge testing was 17 days. Pearson correlation found significant correlation between all three measures at the .01 level.

**Conclusions :** Results reveal that it was feasible to give both the Berg Balance Scale and PASS test for patients admitted to acute stroke rehabilitation regardless of functional level or cognitive impairments. These two measures show a significant change during the inpatient rehabilitation stay. Patients who were at a lower functional level demonstrated more gains in the PASS test. Patients who were at a higher functional level demonstrated more gains in the Berg scale.

**Clinical Relevance :** Results show that both the PASS test and the Berg balance scale demonstrated a significant change and are feasible to use with the acute stroke rehabilitation population. This study also shows that the PASS test and BERG Balance Scale correlate significantly with FIM Motor Composite score.

**TITLE:** Analysis of Factors Predictive of Discharge Location following Acute Stroke Rehabilitation

**AUTHORS/INSTITUTIONS:** S.A. Keller, M. Burns, K. Ruroede, , Marianjoy Rehabilitation Hospital, Wheaton, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to identify variables that predict patients who are discharged home as compared to those discharged to a subacute facility.

**Number of Subjects :** All patients admitted to the stroke unit of an inpatient rehabilitation hospital from February 2010-March 2011 were assessed. Inclusion criteria included a cerebrovascular accident (CVA) within the past 30 days as confirmed by chart review. Exclusion criteria included a previous stroke, MD order for limited weight-bearing, and patients who were not independent ambulators prior to the CVA. There were 221 patients who met criteria, with 21 patients being emergently discharged, thus leaving 200 patients that were included in the final data analyses. The mean age was 71 years (+/-13 years) with 100 males and 100 females. There were 164 patients with ischemic CVAs and 36 hemorrhagic CVAs.

**Materials/Methods :** During each patient's inpatient rehabilitation stay the Berg Balance Scale, Postural Assessment of Stroke Scale (PASS), and Functional Independence Measure (FIM) scores were collected at both admission and discharge. A Canonical Discriminant Model was completed using the following predictive values: age, time from CVA onset to rehabilitation admission, change in Berg score, change in PASS score, change in FIM motor composite score, Motor FIM efficiency, and length of stay (LOS).

**Results :** The patients were categorized into two groups based on discharge destination, with 120 patients discharged to the community and 76 patients discharged to a subacute facility (4 patients excluded based on discharge outside groups). The mean age of the patients discharged to the community was 69 (+/- 14) years and to subacute was 73 (+/-11) years. The mean days of CVA onset to initial testing for patients discharged to the community was 8 days (+/- 6) and to subacute was 10 (+/-6). The LOS for those discharged to the community was 17 days (+/-7) and to subacute was 24 days (+/-6). The Berg change score for patients discharged to the community was 24 (+/-10) and to subacute was 12 (+/-11). The PASS change score for patients discharged to the community was 11 (+/-6) and to subacute was 11 (+/- 6). The FIM motor change score for those discharged to community was 20 (+/-8) and to subacute was 14 (+/-9). The FIM Motor efficiency for those discharged to the community was 1.3 (+/- .6) and to subacute was .6 (+/- .4). The canonical discriminant model utilizing these variables was 82% predictive of discharge location.

**Conclusions :** The variables of age, length of time of CVA onset to rehabilitation admission, change in Berg scores, change in FIM motor scores, and length of stay were statistically significant between groups. The only measure that did not demonstrate a statistical significance was the change in PASS score.

**Clinical Relevance :** These results demonstrate that there is a possibility to predict a patient's discharge destination by analyzing these variables. This data may allow therapists and families to start discharge planning at an earlier point in the patient's rehabilitation stay.

**TITLE:** Body-weight-support treadmill training with multi-angle theraband resistance for stroke patients

**AUTHORS/INSTITUTIONS:** B.D. Bishop, Rehabilitation, Henry Ford Health System, Allen Park, MI;

**ABSTRACT BODY:**

**Background & Purpose :** Stroke is one of the leading causes of disability in the United States. The rehabilitation of patients with stroke impairments cost the insurance companies millions of dollars each year to help regain functional independence. One intervention that clinicians use to treat the impairments resulting from a stroke is the body-weight-support treadmill system. Intensity is one key factor to challenge patients while on the treadmill, however it is sometimes difficult to challenge higher level stroke patients safely. The purpose of this case study was to determine if using theraband at multi-angles on the hemiparetic side while following the guidelines for frequency, intensity, and total time (FITT) would provide significant improvements in functional outcome scores.

**Case Description :** Two higher level patients with recent CVA were selected. Patient A was a 50 yr old male who suffered a right CVA with an onset date of 3/25/11. Patient B is a 62 yr old male who suffered a right CVA on 1/23/11. Body-weight-support treadmill training was implemented following the FITT guidelines. Patients were seen two times per week for 45 minute sessions. Intensity was set at their highest tolerable speed with a 80-85% predicted HR max and a RPE(rate of perceived exertion) to 17. Total time on the treadmill was ranged from 15-20 minutes. Theraband of varied or consistent resistance was placed onto the hemiparetic side or trunk to provide resistance during the gait cycle.

**Outcomes :** Functional outcomes that were used included the timed get-up-and-go test (TUG), gait velocity, and the six-minute walk test. Patient A exhibited a 43% improvement on the TUG and 67% improvement on gait velocity and greater than 26% improvement on the 6 minute walk test. Patient B exhibited a 50% improvement on the TUG, a 151% improvement on gait velocity and a 111% on the six minute walk test.

**Discussion :** The body-weight-support treadmill system in combination with multi-angle theraband can create a significant improvement in functional outcomes for speed, aerobic capacity and transitional mobility for higher level patients following a CVA.

**TITLE:** Combined motor control of the upper limb from corticospinal and reticulospinal systems.

**AUTHORS/INSTITUTIONS:** W.J. Herbert, Allied Medicine - Physical Therapy, The Ohio State University, Columbus, OH; L.R. Montgomery, Neuroscience Graduate Studies Program, The Ohio State University, Columbus, OH; J.A. Buford, Center for Brain and Spinal Cord Repair, The Ohio State University, Columbus, OH;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The corticospinal and reticulospinal systems have strong outputs to the upper limb. The reticulospinal system is focused on whole limb movements and the corticospinal system is focused on fractionated movement. The present study was designed to determine how outputs from these descending systems may combine or compete with each other for motor control of the upper limb.

**Number of Subjects :** The subjects were 3 adult male macaca fascicularis monkeys.

**Materials/Methods :** The subjects were prepared in a surgery under general anesthesia with cranial implants that allowed chronic access to the cerebral cortex and brainstem with recording and stimulating electrodes. After recovery from the surgery, the implant system allowed daily placement of electrodes for recording and stimulation in the brainstem in conjunction with recording and stimulation at a few cortical sites in cortical motor areas (primary motor cortex, M1; supplementary motor area, SMA; dorsal premotor cortex, PMd). The subjects were awake and performing a bilateral reaching task during the recording and stimulation session. To record motor outputs, EMG responses were recorded bilaterally through chronically implanted fine wire EMG electrodes placed in flexor and extensor muscles of both upper limbs, as proximal as trapezius and as distal as the forearm.

**Results :** For about half the EMG responses elicited for a given pair of cortical and reticular formation stimulation sites, the site of stimulation in the reticulospinal system affected one set of muscles, and the corticospinal site stimulated affected a different set. This was expected, but cases such as these could not reveal how the outputs combined. In the rest of the sites, at least one muscle was affected by stimulation at both sites. In about 80% of these combined in a relatively simple manner; for example, both facilitated a muscle when stimulated independently, and the facilitation was stronger with both sites were stimulated simultaneously. In the remainder of cases, there was a complex effect. For example, there were cases where the cortex alone appeared to have no effect, but the reticular formation site did; yet when cortical and reticular formation stimulation were combined, the nature of the reticular formation output was substantially different. In most cases, these complex effects were found in the arm contralateral to cortical stimulation and ipsilateral to the stimulation site in the brainstem.

**Conclusions :** Corticospinal and reticulospinal outputs often combine in simple ways, both recruiting muscles involved in reaching, with their recruitment effects additive. In certain instances, however, the outputs from these systems combine in complex ways, indicating that corticospinal projections to the spinal cord can gate reticulospinal outputs, and vice versa.

**Clinical Relevance :** Understanding how corticospinal and reticulospinal systems normally cooperate for control of reaching is a pre-requisite to understanding how the actions of these systems may be altered in recovery from stroke.

**TITLE:** Postural and Gait Retraining for Persons with Pusher Behavior Post Acute Stroke

**AUTHORS/INSTITUTIONS:** K.J. Komenda, M.M. Weightman, M.J. Finkelstein, Rehabilitation Services, Sister Kenny Institute, Minneapolis, MN;

**ABSTRACT BODY:**

**Background & Purpose :** Pusher behavior (PB), often associated with stroke, typically results in severe functional deficits and longer lengths of stay. PB is felt to result from an abnormal judgment of vertical, affecting posture and balance. Treatment focuses on re-orientation to vertical while in the upright position. The objectives of this study were to: describe our population of stroke patients with PB; describe usual physical therapy (PT) intervention in time and content; and pilot the feasibility of using PT focused on upright interventions including robot-assisted (Lokomat) and body-weight supported treadmill training (BWSTT) in an attempt to improve functional outcome and a more favorable discharge location.

**Case Description :** 24 retrospective patients admitted between June 2007 and December 2008 who exhibited PB per PT or OT documentation. Prospective subjects included those admitted with first stroke after July 2009 who exhibited PB indicated by a score of  $\geq 1.75$  on the Scale for Contraversive Pushing.

Treatment is described as the percent of 15 minute units for each activity type, Upright (gait, standing, BWSTT, Lokomat, aquatic); Sitting (sitting, transfers); and Supine (bed mobility, supine exercise). Treatment protocol for prospective patients called for 30 minute Lokomat or treadmill sessions 4x/week along with usual care. Due to the small number of prospectives, tests of significance were not possible.

**Outcomes :** 24 retrospective patients, 16 male, age 73.0 years (range 39.2-86.0), median time between stroke and rehab admission 8.5 days (range 4-210), admit median FIM of 45.5 (range 21-78) demonstrated significant improvements in FIM score, gait distance, with a median rehabilitation LOS of 17 (3-34) days. 11 patients discharged to home, 12 to a nursing home and 1 returned to the hospital. A total of 67.3% of treatment units were in Upright, 29.3% in Sitting and 8.6% in Supine. 5 prospective male patients, age 73.6 years (range 64.6-86.1), median time between stroke and rehab admission 12 days (range 4-21), admit median FIM of 25 (18-37) had a median rehabilitation LOS of 18 (11-38) days. Three discharged to a nursing home and 2 discharged back to acute hospital. Despite their lower admission FIM level, these 5 subjects received 51.5% of treatment units in Upright, 40.1% in Sitting and 8.8% in Supine. Four of 5 prospective patients were able to use the Lokomat although variability in medical status and multiple co-morbidities affected their ability to participate fully in our protocol featuring upright activity on the Lokomat or BWSTT.

**Discussion :** Preliminary findings demonstrated feasibility of using the Lokomat and BWSTT for stroke patients with severe PB. A larger study is needed to evaluate the effectiveness of intervention focused on upright postures and Lokomat training.

Interventions that shorten length of stay and result in discharge to home are desirable both from the patient/family perspective (quality of life) and societal perspective (cost burden).

**TITLE:** The effect of vestibular rehabilitation on adults with bilateral vestibular hypofunction: A systematic review

**AUTHORS/INSTITUTIONS:** F. Porciuncula, C.C. Johnson, L.B. Glickman, Department of Physical Therapy and Rehabilitation Science, University of Maryland School of Medicine, Baltimore, MD;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Adults who have bilateral vestibular hypofunction (BVH) experience significant disability. Currently, studies on the effect of vestibular rehabilitation (VR) on this population indicate varied results. A number of studies reported improvements in function following VR, while other studies suggested as many as half of those who have BVH might respond poorly to therapy. A systematic review was performed to assess the direction of available evidence.

**Number of Subjects :** 14 studies met the inclusion criteria.

**Materials/Methods :** Databases Searched: Cochrane, Cumulative Index to Nursing and Allied Health Literature (CINAHL), GoogleScholar, MEDLINE, and PubMed.

**Study Eligibility Criteria:** Studies were included if they contained the following: (a) population: adults with BVH without any noted central nervous system lesion, or mixed diagnoses if outcomes were reported separately for BVH, (b) interventions: vestibular exercises, balance training, patient education, or sensory prosthetics; (c) comparison: interventions studied singly, or compared with another psychophysical intervention, placebo, or to a healthy population; (d) outcomes: reported outcomes based on the International Classification of Functioning, Disability and Health (ICF) components of Body Functions and Structure, Activities and Participation; and (e) study designs: prospective and interventional, with Levels of Evidence from I to III based on the Centre for Evidence-based Medicine (CEBM) grading.

**Study Appraisal and Synthesis:** Study synthesis was based on Levels of Evidence, study conduct, and strength of evidence, following the grading scheme provided by the CEBM and the guidelines by the American Association of Cerebral Palsy and Developmental Medicine.

**Results :** After screening 11,561 records, 14 studies qualified for inclusion. Using the CEBM Levels of Evidence, there were 5 Level II studies, and 9 Level III studies. Among the 14 studies, all had outcomes on gaze and postural stability (ICF domain of Body Functions), 5 studies had outcomes on gait speed and perceptions of oscillopsia and disequilibrium (ICF domain of Activity), and 1 study utilized the Dizziness Handicap Inventory (ICF domain of Participation).

**Conclusions :** (a) Based on the ICF domain of Body Functions, there was moderate strength of evidence that adults with BVH improved their gaze and postural stability following exercise-based VR; (b) There were only indicative findings to support the benefit of VR on outcomes related to the ICF domain of Participation, moreover, insufficient evidence existed within the ICF domain of Activity; and (c) Sensory prosthetics appeared to be in its early phases of development, as demonstrated by current research's shortcomings in study design and risk of bias.

**Clinical Relevance :** While there was moderate strength of evidence in support of VR from an impairment level, clinical practice and research alike are needed to explore interventions that extend to Activity and Participation of adults with BVH.

**TITLE:** Translating evidence to clinical practice: Development of a task-specific circuit training group for persons with acquired brain injury in an outpatient community re-entry program

**AUTHORS/INSTITUTIONS:** J. Hale, , TIRR Memorial Hermann, Houston, TX; J. Seale, Physical Therapy, University of Texas Medical Branch, Galveston, TX;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Clinicians and researchers alike recognize the gap in translating scientific evidence to physical therapy (PT) practice, as well as the potential impact of this evidence on clinical outcomes. In recovery following brain injury (BI), current evidence indicates a need for high intensity, task-specific, repetitive practice to maximize motor recovery. These principles are well supported in the literature, but often not applied within the clinical setting. Circuit training (CT) is a novel intervention which utilizes a series of workstations to encourage greater intensity and repetition of motor tasks. CT is a cost effective intervention for promoting motor recovery in acute rehabilitation and outpatient settings. The goals of this research were to: 1.) demonstrate how a body of research can be synthesized and effectively translated to clinical practice 2.) assess the effectiveness of CT in promoting motor recovery in persons with acquired BI participating in an outpatient community re-entry program

**Number of Subjects :** 10

**Materials/Methods :** Individuals with acquired BI participated in 60 minutes of CT group therapy twice weekly, in addition to standard therapy (those who participated less than twice weekly were excluded). An average of 4 group participants rotated through a series of workstations, including gait, transfers, balance, obstacle negotiation, and lower extremity strengthening (specific to walking function). A PT was present to continually challenge and progress the participants as appropriate. Walking performance and balance were assessed pre and post intervention with the 6 minute walk test (6MWT), 10 meter walk test (10MWT), and Functional Gait Assessment (FGA). The average time duration of CT varied based on individual performance, with a range of 4-10 weeks (mean=6.6 weeks).

**Results :** The well founded principles from neuroscience research of high intensity, task-specific, repetitive practice were successfully integrated into an outpatient clinical practice. Following group CT, all participants demonstrated improvements in walking performance. The mean change on the 6MWT and 10 MWT from pre to post intervention was 484 feet and 0.5 m/s, respectively. Functional balance was assessed in five participants, with all demonstrating improvements. The mean change was 6.4 points from pre to post intervention.

**Conclusions :** The implementation of a CT group within an outpatient community re-entry program is feasible and appears to contribute to improved walking performance and balance, with the mean change in walking performance and balance exceeding the minimal detectable change (MDC) across all measures. Further research with a larger sample and control group is essential.

**Clinical Relevance :** CT is an evidence-based, cost effective intervention that was relatively easy to implement and warrants consideration across a variety of practice settings for persons recovering from BI.

**TITLE:** Effectiveness of Standardized Balance Outcome Measures in Adults with Chronic Traumatic Brain Injury

**AUTHORS/INSTITUTIONS:** L. Gadley, S.F. Wainwright, Physical Therapy, University of the Sciences in Philadelphia, Philadelphia, PA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** While review of the literature indicates that the TUG, Berg and Tinetti POMA are the most commonly used outcome measures in the chronic traumatic brain injury (TBI) population, there is a lack of evidence confirming the utility, validity and reliability of these tests in this population. The purpose of this research is to determine if these standardized balance measures are valid and reliable tools for predicting the risk for falls in people with chronic traumatic brain injuries.

**Number of Subjects :** Eleven individuals (7 male, 4 female) residing in assisted and independent living at Beechwood Rehabilitation with a primary diagnosis of TBI and documented falls in the previous 6 months were recruited. Mean age of the subjects was 42.3 years (range: 25- 59).

**Materials/Methods :** Each subject performed the TUG, Berg, and Tinetti POMA standardized tests initially in October 2010 and repeated testing 20 weeks later. All subjects used their normal footwear, orthotics, and assistive devices as needed when performing testing. The number of falls for each subject occurring during the testing period (as specified by the facility incident reports) was recorded. Ten subjects received concurrent individual or group physical therapy during the testing period.

**Results :** Nine of the 11 subjects experienced a fall during the testing period. Sequential testing using the 3 standardized balance outcome measures identified 8 of the subjects who fell as having risk for falls. The TUG accurately identified 6 of the 8 fallers, incorrectly identified 2 non-fallers as fallers, and did not recognize 3 fallers. The Berg correctly identified 7 fallers and 1 non-faller, but failed to recognize 2 subjects as fallers and incorrectly identified 1 non-faller as a faller. The Tinetti POMA identified 8 subjects as fallers and 3 subjects as non-fallers. Of these 8 identified fallers, 6 of the subjects were actual fallers, and all 3 of the non-fallers experienced a fall. Although each test demonstrated errors, the TUG (sensitivity = 85.7%, specificity = 50%) was most accurate in identifying fallers and non-fallers followed by the Berg, and lastly the Tinetti.

**Conclusions :** When used collectively, these 3 balance measures identified all subjects who experienced at least one fall, but did not accurately identify 2 subjects who experienced falls. The multi-factorial nature of falls, particularly the cognitive demands of mobility in this setting and patient population requires further study. This may include incorporating standardized balance measures that assess cognitive demands. The utility of these measures for practice site and patient chronicity are consistent with the Stroke EDGE recommendations.

**Clinical Relevance :** This study provides preliminary data for use of standardized balance measures in adults with chronic TBI in an assisted and independent living setting who are at risk for falls. Inclusion of assessments that incorporate cognitive demands may provide a more accurate prediction of falls risk.

**TITLE:** Visual and proprioceptive feedback influences stance time but not step length symmetry during locomotor training post-stroke

**AUTHORS/INSTITUTIONS:** M.D. Lewek, C. Giuliani, Division of Physical Therapy, University of North Carolina, Chapel Hill, NC; C. Wutzke, Human Movement Science Curriculum, University of North Carolina at Chapel Hill, Chapel Hill, NC; J. Feasel, F. Brooks, M.C. Whitton, Department of Computer Science, University of North Carolina at Chapel Hill, Chapel Hill, NC;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Step length and stance time asymmetries occur in nearly 50% of individuals post-stroke. Because the capacity for symmetric gait remains, we believe that the acquisition of more symmetric gait can occur with continuous visual and proprioceptive feedback of spatiotemporal symmetry during training. Our group has developed the Immersive Virtual Environment and Rehabilitation Treadmill (IVERT) system, which couples a responsive virtual environment (VE) and dual-belt treadmill. The purpose of this project was to assess the potential for 'learning' with our system. Motor learning theory states that more variable performance during training allows for the production of errors and exploration of novel movement patterns. Therefore, we hypothesized that the IVERT system will produce more symmetric, but variable gait during training; and that gait symmetry will be greater immediately following a single IVERT training session, compared to after a Control session.

**Number of Subjects :** 16 subjects with chronic stroke (9M/7F; 57±12 yrs old; LE F-M: 23±4)

**Materials/Methods :** Using a cross-over design, individuals completed two 20-minute sessions of high-intensity locomotor training with and without the IVERT system. No feedback was provided during the Control session and during the first two and last two minutes of the IVERT session. During the IVERT session, spatiotemporal asymmetry is depicted as a curved walking trajectory in the VE as belt speeds are updated independently to operate at different speeds. As gait becomes more symmetric, the walking trajectory in the VE becomes straighter and the difference in belt speeds decreases. Participants trained to improve step length (SLA, N=7) or stance time asymmetries (STA, N=9). Paired t-tests compared the training symmetry and its step by step variance between sessions. Repeated measures ANOVAs compared the change in gait symmetry between IVERT and Control sessions.

**Results :** Subjects trained to improve STA showed more variability during IVERT training compared to Control ( $p<0.01$ ), although average training STA was no different between conditions ( $p=0.14$ ). Training with the IVERT system yielded improved STA ( $p=0.002$ ), with a greater percentage of symmetric steps ( $p=0.04$ ) after training. The Control session did not alter STA ( $p>0.80$ ). Subjects who trained SLA did not exhibit different SLA variability ( $p=0.27$ ) or average asymmetry during training ( $p=0.95$ ) between sessions. These subjects also showed no change in SLA following either IVERT or Control sessions ( $p>0.71$ ).

**Conclusions :** Gait training to improve STA with continuous visual and proprioceptive feedback produced more variability during training and yielded improved symmetry, which did not wash out immediately following training. SLA was unaffected by the IVERT system both during and immediately after training.

**Clinical Relevance :** Although STA is difficult to change, our system produced positive within-session changes. Prolonged training with the IVERT system is needed to determine the long-term capabilities of training with such feedback.

**TITLE:** Use of the Nintendo Wii Gaming System to Improve Balance in a Community-Dwelling Older Adult with Peripheral Neuropathy and a History of Recurrent Near Falls: A Case Report

**AUTHORS/INSTITUTIONS:** R.M. Hakim, A. Balent, M. Keyasko, D. McGlynn, Physical Therapy, University of Scranton, Scranton, PA;

**ABSTRACT BODY:**

**Background & Purpose :** There is a need to address secondary prevention of falls in older adults who use assistive devices for ambulation. The purpose of this case report was to describe use of the Nintendo Wii gaming system to train standing balance in a community-dwelling older adult with peripheral neuropathy.

**Case Description :** A 76 y/o male presented with complaint of imbalance and a recent history of recurrent near falls. PMHX included: peripheral neuropathy of bilateral LEs(unknown etiology), OA, cervical fusion (2005), and CABG(1999). He lived alone in an apartment and was independent with all mobility skills wearing bilateral AFOs and using a straight cane. Examination of balance-related performance was conducted before and after the intervention (while wearing AFOs during testing). Outcome measures included: Sensory Organization Test (SOT), Limits of Stability (LOS), Motor Control Test (MCT) and Adaptation test (ADT) on the NeuroCom Equitest system, Berg Balance Scale (BBS), Timed Up and Go (TUG), 30 Second Chair Stand Test (CST) and the Activities-Specific Balance Confidence (ABC) Scale. Upon initial testing, a systems review revealed impaired sensation of bilateral distal lower extremities with active range of motion limited (R>L) by 15-25 degrees at the ankles. He displayed problems with sensory integration, delayed motor responses, difficulty with sit to stand, eyes closed and narrow BOS activities and decreased balance confidence. He participated in 1 hour of training on the Wii Fit balance board (while wearing AFOs) 2 times a week X 6 weeks. His customized program included: Wii games (e.g., ski jump, hula, penguin slide, bubble maze) to improve alignment, squatting, and dynamic weight shifting. Activities were progressed using the Wii level, time and rest periods between each activity.

**Outcomes :** Upon post-testing, he remained visually dependent with below normal SOT scores for conditions 2, 3, 4, 5, and 6 (composite ranged from 12 to 16 points). LOS maximum end point excursion improved by an average of 22% with normal reaction time and directional control. MCT improved for amplitude to WNLs, but remained below normal with delayed latencies bilaterally to forward and backward translations. ADT improved for responses to downward platform rotation, but remained below normal for upward rotations. ABC score improved from 57.5% to 70.6%. Clinical balance tests improved as follows: BBS from 28/56 to 34/56; TUG from 14.9 to 10.9 seconds; CST from 10 to 13 repetitions. Subjectively, he reported greater ease with walking and ADLs and enjoyment of the Wii games.

**Discussion :** After a 6-week Wii Fit intervention, this individual's balance abilities generally improved with increased dynamic postural control and balance confidence as indicated by most outcome measures. This type of program shows promise as an enjoyable, engaging method for improving balance in community-dwelling older adults who use assistive devices for mobility.

**TITLE:** A Novel Shoe-Based Sensor to Detect Activity Levels in People with Stroke

**AUTHORS/INSTITUTIONS:** G.D. Fulk, Physical Therapy, Clarkson University, Potsdam, NY; E. Sazonov, Electrical and Computer Engineering, University of Alabama, Tuscaloosa, AL; S. Edgar, Electrical and Computer Engineering, Clarkson University, Potsdam, NY;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Improving community mobility and increasing activity levels are important goals for people with stroke. Patient capacity in the clinic may not reflect actual performance in the home and community. Advances in sensor technology and signal processing techniques may provide the ability to accurately measure physical activity in the home and community. These technologies could also be used to provide behavioral enhancing feedback to increase activity levels. The purpose of this study was to determine the ability of a novel shoe based sensor and accompanying Artificial Neural Network (ANN) to identify functional postures (sitting, standing and walking) in people with stroke.

**Number of Subjects :** 7 people with chronic stroke: gait speed, 0.70 m/s; Berg Balance Scale, 41.0; and Fugl Meyer LE, 24.9.

**Materials/Methods :** Our unique sensor system collected plantar pressure and heel acceleration data through a wearable sensor system embedded into a pair of shoes. Subjects wore the shoe-based sensors while performing standardized ADL tasks in sitting, standing and walking. The ANN was trained using 2-second epochs of pressure and acceleration data from 4 subjects and validated with the remaining 3 subjects. The validity of the ANN to identify sitting, standing and walking was determined by calculating accuracy, recall and precision. Accuracy is the total number of true positive (TP) identifications by the ANN divided by the sum of the TP, false positives (FP), and false negatives (FN).  $\text{Recall} = \text{TP} / (\text{TP} + \text{FN})$  and  $\text{precision} = \text{TP} / (\text{TP} + \text{FP})$ .

**Results :** The shoe-based sensor and ANN were highly accurate. Overall accuracy was 0.97, accuracy for sitting (0.93), standing (0.93), walking (0.94) was also high. Recall was: sitting 1.00, standing 0.94, and walking 0.96. Precision was: sitting 0.93, standing 0.99, and walking 0.99.

**Conclusions :** Our unique shoe-based sensor using accelerometer and pressures sensors was able to accurately identify functional postures.

**Clinical Relevance :** This shoe sensor could be used to provide accurate information on activity levels in the home and community as well as provide behavioral enhancing feedback as part of comprehensive telerehabilitation intervention for people with stroke.

**TITLE:** Organization of the Reticulospinal Tract in a Non Human Primate Model as Revealed by Retrograde Tract Tracing

**AUTHORS/INSTITUTIONS:** J.A. Buford, Physical Therapy, The Ohio State University, Columbus, OH; L.R. Montgomery, L.B. Jakeman, Neuroscience Graduate Studies Program, The Ohio State University, Columbus, OH;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Upper limb movement involves coordination between multiple motor systems within the nervous system. The corticospinal tract has received the most attention due to its role in distal upper limb (hand/wrist) control. Other motor systems however are also important in upper limb control, often providing the platform of proximal activity upon which fine dexterous distal movements are made, and the reticulospinal tract is one of these systems. Many physiological studies have demonstrated the bilateral nature of upper limb muscle activity related to spontaneous activity within and stimulation of the reticulospinal tract and this has led to increasing interest in the role that the reticulospinal tract may play in arm recovery following cortical motor injury. Up until this point however the structural nature of the reticulospinal tract within primates has not been thoroughly explored. Based on previous physiological studies we hypothesized that the reticulospinal tract is bilateral in nature with cells located ipsilaterally and contralaterally with respect to the unilateral tracer injection in the spinal cord.

**Number of Subjects :** Two monkeys (*M. fascicularis*)

**Materials/Methods :** Unilateral retrograde tracer injections of cholera toxin subunit b (CTb) were made in the cervical cord enlargement (C5-C6 spinal segments). 3-14 days later tissue was harvested and subjected to immunohistochemical analysis in order to identify reticulospinal cells containing CTb in the pontomedullary reticular formation (PMRF). Unbiased stereological techniques using Stereoinvestigator software were use to count the number of labeled cells located ipsilaterally or contralaterally within the extent of the PMRF.

**Results :** As expected we found that there was a bilateral distribution of labeled reticulospinal cells in the PMRF. Although cells were found ipsilaterally and contralaterally with respect to the injection sites, a significantly larger number of labeled cells were seen ipsilaterally. The difference in the proportion of ipsilateral and contralateral reticulospinal cells was greatest rostrally and then the proportion of ipsilateral to contralateral cells progressively decreased in a rostral to caudal direction.

**Conclusions :** The reticulospinal tract is a bilateral system with a slight preponderance for ipsilateral compared to contralateral projections especially in more rostral portions of the PMRF.

**Clinical Relevance :** The bilateral nature of outputs from the reticulospinal tract places it in a unique position to assist with motor recovery following cortical injury. By understanding the structural organization of the reticulospinal tract in a primate model we will be able to identify potential pathways that may contribute to motor recovery following cortical motor injury such as stroke.

**TITLE:** Case Study Assessing the Bioness L300 for Improving Gait Post CVA.

**AUTHORS/INSTITUTIONS:** T. Rivers, L. Philpot, K. Sheridan, C. Stobaugh, J. VanLandingham, C. Lairamore, Physical Therapy, University of Central AR, Conway, AR;

**ABSTRACT BODY:**

**Background & Purpose :** Functional electrical stimulation (FES) to the lower extremity during gait is an emerging intervention used to treat foot drop for individuals post stroke. FES delivers electrical pulses to the lower leg causing the foot to lift allowing an individual to step the foot. FES has been shown to be effective when used for its brace like effect, however evidence is required to support the use of FES as a modality to improve gait. The purpose of this case study was to examine changes in gait after the use of FES for an individual with chronic stroke.

**Case Description :** The subject was a 66 year old male 15 months post stroke with right hemiparesis who wore an orthosis to correct foot drop. A single subject repeated measure design was used. Data were collected using the Emory Functional Ambulation Profile (E-FAP) and spatiotemporal data were collected using the GAITRite system. All data were collected when the subject ambulated without the Bioness L300 or orthosis. Prior to receiving the FES intervention a baseline was established. The subject performed testing on two occasions 7 days apart to assure no changes in ambulation were occurring. Once a baseline was established the subject was fitted with a Bioness L300 unit and trained on its use. The subject was instructed to wear the Bioness L300 unit for 4 consecutive weeks during normal daily activities with no added exercise. For weeks 1-4, the subject was instructed to wear the Bioness L300 for 1 hour a day, 2 hours a day, 4 hours a day, and 8 hours a day respectively. At the conclusion of each week, the subject was re-tested to assess any changes in gait. Also, the subject returned for follow up testing 1 month after the intervention was terminated.

**Outcomes :** The participant demonstrated an overall positive trend in gait over the duration of the study. Between weeks 1 and 2 (during baseline) a regression was observed in E-FAP scores and gait parameters. While utilizing the Bioness L300, the subject exhibited an improvement in all E-FAP tasks from weeks 2- 6 (during intervention). At week 10 (follow-up) E-FAP scores for the Up and Go continued to improve, while times for the Floor and Carpet tasks leveled off. Over the duration of the study the subject's velocity of gait increased in different environments as evidenced by the E-FAP, and the subject was able to complete the obstacle portion of the E-FAP at the conclusion of the study when he was unable to complete the task initially. In addition, the subject exhibited an increase in stance on the hemiparetic lower extremity.

**Discussion :** In general, the findings demonstrated an improvement in gait velocity, increased stance on the hemiparetic lower extremity, and decreased time required to complete the E-FAP after using the Bioness L300. Furthermore, the subject was able to maintain or continue to improve gait measures at the one month follow up even though he had returned to wearing his orthosis. The study indicates use of FES may have a therapeutic effect on gait in particular gait velocity and further study is warranted.

**TITLE:** Neuromuscular Plasticity in the Rat Forelimb After Cervical Spinal Cord Injury

**AUTHORS/INSTITUTIONS:** E.J. Gonzalez-Rothi, D.D. Fuller, R. Federico, K. Vandeborne, Physical Therapy, University of Florida, Gainesville, FL; P.J. Reier, M.A. Lane, Neuroscience, University of Florida, Gainesville, FL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Individuals with chronic cervical spinal cord injury (cSCI) indicate that recovery of upper extremity (UE) function is of utmost importance and would most enrich their quality of life. While the detrimental effects of cSCI on UE function are well documented, the underlying anatomical and physiological mechanisms remain unclear. Further, although some capacity for recovery of UE function has been demonstrated, the extent of recovery is limited, and the underlying mechanisms are ill defined. In contrast, functional recovery within the phrenic motor system after cSCI is well characterized and the neural circuitry associated with recovery of hemidiaphragm function following initial paralysis (i.e. crossed phrenic phenomenon) has been studied in great detail. While the phrenic and forelimb motor pools are in close proximity within the spinal cord, the extent to which these disparate motor systems are anatomically and functionally related following cSCI is not clear. Our main goal was to investigate the impact of incomplete cSCI on UE function, muscle morphology, and neuroanatomical circuitry. Additionally, we sought to investigate potential neuroanatomical links between forelimb and phrenic motor pools, both of which are considerably impaired following cSCI.

**Number of Subjects :** Using an established rat model of cSCI, lateral C2 spinal hemisection (C2Hx), we investigated functional, muscular, and neural forelimb adaptations in adult Sprague-Dawley rats(n=30).

**Materials/Methods :** Gross forelimb motor function was assessed prior to, and at 1 and 8 weeks post-injury using the limb-use asymmetry (cylinder) test. Immunohistochemical techniques were used to quantify muscle fiber cross sectional area (CSA) while neuroanatomical circuitry of the forelimb was assessed using the retrograde tracing techniques.

**Results :** Initial results indicate dramatic reductions in ipsilateral forelimb use (35% of pre-injury;  $p<0.01$ ) and average muscle fiber CSA (65% of pre-injury;  $p<0.05$ ) 1-week post-C2Hx. By 8-weeks post-C2Hx, ipsilateral forelimb use had improved (52% of pre-injury;  $p<0.01$ ) and average fiber CSA was moderately improved (79% of pre-injury;  $p<0.05$ ). Preliminary tracing studies revealed first-order labeling of forelimb motoneurons in the lateral ventral horn of the cervical and upper thoracic spinal cord.

**Conclusions :** These initial results indicate substantial remodeling and modest recovery in the forelimb following cSCI, and ongoing studies are exploring the neuroanatomical circuitry associated with forelimb dysfunction and recovery. Interestingly, the pattern of forelimb recovery appears to parallel the previously documented recovery of ipsilateral phrenic motor output following C2Hx. Accordingly, we are initiating studies to investigate the potential for "circuit interaction" between the phrenic and forelimb motor pools after cSCI.

**Clinical Relevance :** These experiments examine fundamental mechanisms underlying neuroplasticity and recovery of UE function following cSCI and may prove valuable for identifying therapeutic targets for rehabilitation interventions.

**TITLE:** The Role of Sleep in Learning a Functional Motor Task

**AUTHORS/INSTITUTIONS:** A.J. Sharman, C.F. Siengsukon, , University of Kansas Medical Center., Kansas, KS;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Sleep has been demonstrated to enhance motor skill learning for young adults. However, it remains unclear if performance on a “real-life” functional skill will benefit from sleep to produce off-line skill enhancement. The purpose of this study was to examine if sleep enhances the learning of a functional motor task in young and older adults.

**Number of Subjects :** Eight young ( $25.4 \pm 2.38$  years of age) and 7 older ( $70.4 \pm 3.3$  years of age) adults participated in this study. Participants in each age group were randomly assigned to either the sleep or no-sleep group.

**Materials/Methods :** The functional motor task consisted of walking around an irregular elliptical pathway. Participants were instructed to walk safely as quickly and accurately as possible while performing a mental task. The sleep group practiced the walking task in the evening and underwent retention the following morning; the no-sleep group practiced the walking task in the morning and underwent retention testing in the evening. The main outcome measure of interest was time around the path.

**Results :** In both age groups, the sleep group demonstrated significant off-line learning with a significant decrease in time around the path from the last practice block to retention block ( $p$ -value= 0.003 for young and 0.04 for older adults ). The magnitude of improvement was larger for the young group. This is supported by a two-way ANOVA [Group (sleep, no-sleep) X Age (young, older)] main effect of group ( $p=0.000$ ) and age ( $p= 0.02$ ), interaction was close to reach significance ( $p= 0.07$ ).

**Conclusions :** In both age groups, performance improved significantly in the sleep group compared to the no-sleep group. However, the magnitude of improvement was larger in the young group compared to the older group.

**Clinical Relevance :** Physical therapists are challenged to plan effective interventions that promote motor learning. During therapy sessions, clients frequently must learn new skills or re-learn old skills. In spite of support for the role of sleep in motor learning, no study has attempted to examine whether sleep enhances the learning of a functional task. As we do not completely understand how to best promote motor skill learning, research examining the mechanisms and/or procedures that impact learning and memory consolidation must be explored. We believe that integration of sleep into clinical interventions may hasten motor learning by allowing individuals to capitalize on sleep-dependent off-line motor learning. Understanding the impact that sleep has on more clinically relevant activities could impact how physical therapists teach individuals skills and may emphasize the need to encourage adequate sleep and address sleep issues in individuals undergoing rehabilitation

**TITLE:** BREATHING AND STEPPING COORDINATION DURING DUAL TASKS IN PERSONS WITH PARKINSONS DISEASE

**AUTHORS/INSTITUTIONS:** M. Wessel, D. Clarke, K. Kilbride, L. Welsh, C. Maher, Physical Therapy, Seton Hall University, South Orange, NJ; D. Glendinning, Department of Neuroscience and Cell Biology, RWJ Medical School-UMDNJ, Piscataway, NJ, NJ;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Parkinson's disease (PD) is a degenerative disease caused by loss of dopaminergic cells in the substantia nigra. The symptoms of PD include rigidity, tremor, akinesia, bradykinesia, decreased postural reactions, and a lack of automaticity. Our study focused on a specific area of non-automaticity: freezing of gait. Freezing of gait (FOG) is characterized by a sudden inability to move the lower extremities, and is related to falling and fear-or-falling. The pathophysiology of freezing of gait is not understood. It appears to be unrelated to bradykinesia and rigidity. Several authors have suggested that FOG is associated with a collapse in rhythmic interactions between moving limbs. Our study investigated whether there is also a deterioration of the rhythmic interactions between the limbs and respiration. Respiratory changes have been reported to precede FOG, and stress is a common factor in FOG, which may be related to breathing. We hypothesized that when compared to healthy controls, i) persons with PD will have more variability (less coordination) in breathing, stepping, and motor-respiratory coordination (MRC), particularly during dual tasks that typically elicit FOG and ii) coordination of breathing, stepping, and breathing-stepping will be improved through conscious effort.

**Number of Subjects :** There were 17 total subjects: 6 subjects with PD (Hoehn and Yahr Stage 1 & 2; 2M:4F; average age: 80±5yrs) and 11 healthy subjects (1M:10F, average age: 79±3yrs).

**Materials/Methods :** Breathing was measured using a thermistor threaded through a nasal cannula and stepping was measured by heel-toe strike transducers and all data collected were analyzed by BioPac Acknowledge Software. Breathing was recorded during standing at rest for 2 minutes. Next the subject's breathing and stepping were recorded while stepping at normal pace, at a higher frequency, at a lower frequency, during a dual task, and while mentally focusing on coordinating breathing and stepping. The order of these tasks was randomized. Measurements included breathing rate and variability, stepping rate and variability and motor-respiratory coordination (MRC), which was measured as i) the frequency ratio: the ratio of the stepping rate/breathing rate at each peak inhalation and ii) the variability of the frequency ratio

**Results :** Results showed shallower and more variable breathing in persons with PD; breathing rate was increased and inhalation time was decreased. Stepping cadence was similar to walking cadence. Cadence was also unaffected by PD or dual-tasks. However, cadence variability was increased in PD during dual-tasks and slow-stepping. MRC was more variable in PD during dual-tasks

**Conclusions :** These data findings suggest that motor blocks in PD may be associated with a breakdown in MRC given that this occurred during tasks that typically elicit FOG

**Clinical Relevance :** If the hypothesis and results are correct, FOG can be treated by instructing a patient in focusing on MRC.

**TITLE:** Minimal Detectable Change in Maximum Step Length, Gait Speed, and Five Times Sit to Stand in People with Stroke

**AUTHORS/INSTITUTIONS:** V. Pardo, D. Knuth, B. McDermott, J. Powell, Physical Therapy, Wayne State University, Detroit, MI; A. Goldberg, Department of Health Care Sciences, Program in Physical Therapy, Mobility Research Laboratory, Institute of Gerontology, Wayne State University, Detroit, MI;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The Maximal Step Length Test (MSL) is a test of stepping capabilities and clinical balance in older adults. Gait speed (GS) and the Five Times Sit to Stand (FTSTS) test (time needed to sit and stand five times) are measures of functional mobility. Minimal detectable change (MDC) represents a value for real change that exceeds the chance of variation in measurement. MDC can be used to interpret whether changes in these measures over time represent real change or are within the boundaries of measurement error. The purpose of this study was to quantify measurement error and MDC in the MSL, GS and FTSTS in people who have had a stroke.

**Number of Subjects :** Twenty participants with a history of chronic stroke who could walk without physical assistance were recruited from the Metro Detroit area.

**Materials/Methods :** MSL was assessed by having the participant step forward maximally and return in one step. Gait speed was measured as the time it took to walk 10 meters at a comfortable pace (expressed as m/sec). FTSTS was recorded as the time it took to sit and stand five times with arms crossed. The intraclass coefficient (ICC 2.1) was computed to assess test-retest reliability of each test. Standard error of measurement (SEM), which quantifies measurement error in absolute values, was calculated as the standard deviation  $\times \sqrt{(1-ICC)}$ . MDC at a 95% confidence level (MDC95) was calculated as  $z \times SEM \times \sqrt{2}$  where  $z=1.96$ .

**Results :** Mean FTSTS was 19.0 seconds, with an ICC of 0.92 (SEM was 3.28sec, MDC95 was 9.09 sec). Measurement error and MDC95 expressed as a percentage of mean FTSTS were 17.3% and 47.8% respectively. Mean GS was 0.73m/s, with an ICC of 0.98 (SEM was 0.04m/s, MDC95 was 0.11m/s). Measurement error and MDC95 expressed as a percentage of mean GS were 5.5% and 15.1% respectively. Mean MSL (involved) was 20.86", with an ICC of 0.98 (SEM was 1.1", MDC95 was 3.05"). Measurement error and MDC95 expressed as a percentage of mean MSL (involved) were 5.2% and 14.5% respectively. Mean MSL (uninvolved) was 21.5", with an ICC of 0.98 (SEM was 1.39", MDC95 was 3.85"). Measurement error and MDC95 expressed as a percentage of mean MSL (uninvolved) were 6.5% and 17.9% respectively.

**Conclusions :** The high ICC for FTSTS, GS and MSL suggest high test-retest reliability. FTSTS has a very high MDC% (47.8%) and therefore low sensitivity to detecting real change. GS and MSL have a much lower MDC% and greater sensitivity to detect real change in performance. The low SEM% for GS, MSL (involved) and MSL (uninvolved) is suggestive of low measurement error and good absolute reliability, whereas the opposite is true for the FTSTS.

**Clinical Relevance :** In patients with chronic stroke, real change was computed to be  $>0.11$  m/s for GS,  $>3.05$ " for MSL (involved),  $>3.85$ " for MSL (uninvolved), and  $>9.09$  sec for FTSTS. These results will assist clinicians and researchers in interpreting whether real change has occurred when comparing repeated measures of FTSTS, GS and MSL.

**TITLE:** Understanding clinically important change in gait speed in people with stroke undergoing inpatient rehabilitation

**AUTHORS/INSTITUTIONS:** J. Canbek, G.D. Fulk, L. Nof, J.L. Echternach, Physical Therapy, Nova Southeastern University, Fort Lauderdale, FL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** People with subacute stroke typically have rapid and large changes in gait ability while undergoing inpatient physical therapy. There is a lack of information about how much change in gait speed is needed in hospitalized people with subacute stroke to be considered an important amount. The purpose of this study was to estimate minimal clinically important difference (MCID) for comfortable gait speed in persons who have experienced stroke and are undergoing inpatient rehabilitation using 3 different anchors of change: 1) participant rating of change in walking ability; 2) physical therapist perception of patient change in walking ability; 3) achievement of  $\geq 17$  point change on the motor domain of the Functional Independence Measure (FIM.)

**Number of Subjects :** 43

**Materials/Methods :** Participants were recruited if they had a first documented stroke and were receiving physical therapy during inpatient rehabilitation. Participants were excluded from the study if they had a history of a previous stroke, were medically unstable, were non-English speaking or were unable to walk without assistance prior to the current stroke event. Comfortable gait speed measured by a 5 meter walk test and motor FIM scores were collected at admission to and discharge from inpatient rehabilitation. Global Rating of Change (GROC) scores were collected at discharge from inpatient rehabilitation. A score of 6 ("a great deal of change") on a Global Rating of Change scale and achievement of  $\geq 17$  point change on the motor FIM was used to dichotomize participants into those who had important change in walking ability and those who did not. Receiver operating curves were constructed to estimate important change values for gait speed using the three anchors.

**Results :** Mean gait speed was 0.20 (0.20) m/s at admission to inpatient rehabilitation and 0.53 (0.31) m/s at discharge. 67% of participants experienced  $\geq 17$  point change on the motor FIM. MCID of comfortable gait speed was estimated to be 0.24 m/s (AUC= 0.644 , sn/sp=66%/64%, LR+=1.83, LR-0.54) anchored to motor FIM change scores.

**Conclusions :** MCID of gait speed for people hospitalized in inpatient rehabilitation after stroke was estimated at 0.24 m/s. For this sample, motor FIM change appears to be a better anchor to distinguish patients who have had important change than use of a GROC. More research is needed to estimate meaningful change people with subacute stroke using larger cohorts with similar characteristics.

**Clinical Relevance :** People with stroke who experience change in gait speed of 0.24 m/s or greater during inpatient rehabilitation are likely to experience an important change in functional mobility. Physical therapists can use this information as a reference value for setting goals and interpreting progress in individual patients who are undergoing inpatient rehabilitation after stroke.

**TITLE:** Exercise response in non-ambulatory individuals with Multiple Sclerosis

**AUTHORS/INSTITUTIONS:** B.J. Baker, M. Shoemaker, N. Holochwost, L. Mirakovits, B. Newell, D. Robinson, Physical Therapy, Grand Valley St Univ, Grand Rapids, MI;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this expanded follow-up study is to develop and clearly define an exercise program that will improve the function and quality of life in non-ambulatory individuals with MS. This study is a multiple single subject design study and will determine protocols and objective measures to be included in future trials.

**Number of Subjects :** 2- multiple single subject design

**Materials/Methods :** An AB research design was implemented over the course of 10 weeks with follow-up at four weeks post intervention. Phase A served as a two week control period and phase B consisted of eight weeks of exercise training with outcome measures administered weekly. Outcome measures included the Modified Fatigue Impact Scale (MFIS), Short Form-12 Questionnaire (SF-12), Patient Specific Functional Scale (PSFS), handheld grip dynamometry, submaximal upper body ergometry, and limits of stability via the Equitest System. Meaningful changes in outcome measures were determined using the two standard deviation band method.

**Results :** Participant 1 showed significant improvements in the Cognitive subscale of the MFIS from 13.0 to less than 9.54. She also demonstrated an improvement from 2 to greater than 4.3 in the self identified task of "Donning and Doffing Coat" on the PSFS. Significant improvements in both right and left grip strength from 20.25 to greater than 23.23 and 14.0 to greater than 17.26 were noted respectively. Equitest measures of directional control, end point excursion, and maximal excursion all improved.

Participant 2 showed significant improvements in the Cognitive, Physical and Psychosocial Subscales of the MFIS with improvements from 28.25 to less than 23.53, and 26.25 to less than 24.34, and 6 to less than 6 respectively, as well as an overall improvement from 60.5 to less than 53.87. A significant improvement in the Mental Composite Summary Scores of the SF-12 was found from 36 to greater than 47.38, his overall SF-12 score significantly improved from 72.8 to 82.36. He also showed significant improvements of all five self identified tasks on the PSFS with improvements from 3.5 to greater than 5.8, 2.25 to greater than 4.55, 2.5 to greater than 4.8, 2.25 to greater than 4.55, 1.5 to greater than 3.8 Task 1- Working in his Workshop, Task 2- Cleaning Garage, Task 3- Playing with Grandchildren on the Floor, Task 4- Putting in Grab Bars, and Task 5- Lawn Care respectively. Equitest measures of directional control, end point excursion and maximal excursion improved.

**Conclusions :** Meaningful impairment-based measures of dynamic sitting balance improved in both participants and arm strength improved in Participant 1. Meaningful functional improvements occurred in fatigue, quality of life measures, patient specified functional tasks and cardiovascular response for both participants.

**Clinical Relevance :** There is conclusive evidence showing the benefits of exercise in individuals minimally or moderately disabled due to multiple sclerosis (MS). However, there is lacking research on the effect of exercise in non-ambulatory individuals with MS.

**TITLE:** Dissociation of normal vs shear surface force generation during locomotion in people post-stroke.

**AUTHORS/INSTITUTIONS:** J. Liang, D.A. Brown, Physical Therapy and Human Movement Sciences, Interdepartmental Neuroscience Program., Feinberg School of Medicine, Northwestern University, Chicago, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** During bipedal locomotion, execution of a functional and coordinated gait pattern requires appropriate muscle activity phasing that adapts to varying environments. Individuals post-stroke are at a high risk for falls, particularly on slippery surfaces, potentially resulting from an inability to dissociate forces in the shear vs. normal directions. Our purpose was to test if the post-stroke nervous system can, when compared to that of the nonimpaired, appropriately dissociate normal surface force from shear force generation to interact with slippery surfaces.

**Number of Subjects :** Participants included eleven individuals with chronic post-stroke hemiplegia and eleven age-similar individuals with no prior history of stroke.

**Materials/Methods :** Nonimpaired subjects (Age=61±12yrs) and chronic (>6 months post-stroke) stroke survivors (Age=61±12yrs) were positioned on a custom-designed, motorized cycle ergometer. Subjects achieved a target normal pedal force of 40% maximum effort given visual feedback, while simultaneously assuming various pedal angle orientations during stationary and pedaling conditions, therefore causing magnitude and direction of shear force outputs to change. EMG from soleus (SOL), tibialis anterior (TA), vastus medialis (VM), rectus femoris (RF), and biceps femoris (BF), and pedal forces were collected. Multiple regression analyses were performed.

**Results :** During the stationary target force task, nonimpaired subjects generated a larger shear force range compared to post-stroke individuals (192.7N vs 98.5N;  $p<0.05$ ). In nonimpaired subjects, 75% of shear force variance was explained by a combination of SOL, TA and VM EMG amplitudes. In post-stroke individuals, 71% of shear force variance was explained by amplitude of SOL and VM EMG only, since TA did not contribute. During the pedaling condition, nonimpaired subjects generated a larger shear force range compared to post-stroke individuals (154.8N vs. 73.6N;  $p<0.05$ ). In nonimpaired subjects, 88% of shear force variance could be explained by SOL, TA and RF EMG amplitude and in post-stroke individuals, 81% of shear force variance was explained by SOL, VM and RF EMG amplitude.

**Conclusions :** Compared with nonimpaired subjects, individuals post-stroke are less capable of generating a high range of surface shear forces. In addition, people post-stroke utilized different muscle activity combinations in order to vary surface shear forces. These results demonstrate that, when interacting with potentially slippery surfaces, post-stroke individuals have less range and muscle activity activation flexibility to prevent high shear forces from resulting in a slip.

**Clinical Relevance :** The results of this study will, in the future, support the development of specific ideas for therapeutic intervention to reduce the probability of slips during locomotion in people post-stroke.

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**TITLE:** Targeting supramaximal strength in incomplete spinal cord injury: Time and intensity dependent increase in volitional torque generation

**AUTHORS/INSTITUTIONS:** C. Thompson, Kinesiology and Nutrition, University of Illinois at Chicago, Chicago, IL; A. Jayaraman, Center for Bionic Medicine, Rehabilitation Institute of Chicago, Chicago, IL; T. Hornby, Department of Physical Therapy, University of Illinois at Chicago, Chicago, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Individuals with chronic motor incomplete spinal cord injury (iSCI) suffer from profound lower extremity weakness. This is particularly devastating as volitional strength is closely associated with function and strength training programs are often ineffective in this population. Recent data in individuals with iSCI indicate that short term increases in volitional torque generation can be observed during repeated maximal volitional effort (MVE) contractions. A strength training protocol which harnesses this 'supramaximal' torque may prove to be effective at improving strength and function; however behavioral parameters which maximize the increases in volitional torque are not well defined. To this end, we hypothesize that high-intensity contractions performed at short rest intervals will elicit supramaximal torque in individuals with iSCI.

**Number of Subjects :** Eleven individuals with iSCI (AISA C and D) participated in this study.

**Materials/Methods :** Subjects performed MVE contractions of the knee extensors following various combinations of contraction intensity (% baseline MVE) and duration rest between contractions. Peak torque and surface electromyographic (EMG) activity was assessed. Single motor unit (MU) activity during supramaximal contractions was assessed in a subset of these individuals using fine-wire electrodes.

**Results :** Supramaximal volitional torque was observed when MVE contractions were preceded by contractions >50% baseline MVE and separated by rest periods <15 sec. This supramaximal torque was associated with increases in agonist EMG and in rate of torque development. A strong correlation between torque and quadriceps EMG activity throughout a wide range of torque production was observed ( $R^2=0.757$ ;  $p<0.0001$ ; range = 2.9–191.0% baseline MVE). When data was fit to a nonlinear model, a decay constant of 62% for contraction intensity and 6.5 sec for duration between MVEs was observed. Single MU recordings during repeated MVEs demonstrated increased MU recruitment and rate coding during supramaximal torque generation.

**Conclusions :** Individuals with iSCI produce supramaximal torques during high-intensity volitional contractions separated by brief periods of rest. Both surface EMG and single MU recordings suggest central mechanisms contribute to supramaximal torque. These time and intensity parameters are necessary for the clinical implementation of an volitional exercise program in human iSCI. Preliminary results from a 4-week training intervention utilizing these parameters demonstrate superior gains in strength and function as compared to conventional resistance training.

**Clinical Relevance :** Individuals with chronic iSCI suffer from profound weakness which limits function. Unfortunately strength training appears to have limited success in this population. This study quantifies the behaviors necessary to observe supramaximal volitional torque. These findings are necessary to guide future clinical trials aimed to harness this supramaximal torque generation for functional gains in individuals with chronic iSCI.

**TITLE:** Validation of the StepWatch Activity Monitor (SAM) with Observational Counts of Stepping and FIM Locomotor Scores in Individuals Post Stroke

**AUTHORS/INSTITUTIONS:** D. Straube, L. O'Donnell, Physical Therapy, University of Illinois Chicago, Chicago, IL; T. Hornby, , Rehabilitation Institute of Chicago, Chicago, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Meaningful measures of locomotor ability are important for documenting outcomes in research and clinical practice. The SAM is a portable ankle accelerometer that has been increasingly used to capture walking activity in subjects post stroke. The purpose of this study was to assess the concurrent validity of the SAM scores with observational counts of stepping activity and FIM scores.

**Number of Subjects :** Data from 50 subjects (26 males and 24 females) observed on 83 PT sessions were used for analysis. Inclusion criteria were patients post stroke receiving therapy to address motor deficits related to stroke and ability to provide consent. Exclusion criteria were therapy sessions related to non-motor deficits and sessions performed by an aide or student.

**Materials/Methods :** Observers underwent a 2.5 hour training session to achieve acceptable reliability (> 90% agreement) on step counting. SAMs were attached to each subject during therapy sessions, with the observers documenting steps with a mechanical counter within the same session. FIM scores were obtained from the subject's chart. Parametric and non-parametric statistics (SPSS) were used to assess associations among the locomotor variables.

**Results :** Mean FIM score was 4 (range 1-7) and mean age was 62 years. Correlation between the SAM values and observational counts was  $r = .98$  ( $p < .01$ ), and the association between the SAM values and FIM locomotor scores was  $r = .43$  ( $p < .01$ ). Significantly high associations between the SAM and observational counts were also found with subjects with low FIM scores (< 4) and higher FIM scores (> 5), with  $r = .96$  ( $p < .01$ ) and  $r = .97$  ( $p < .01$ ) respectively.

**Conclusions :** The data support the validity of steps measured by the SAMs in patients with stroke and either low or high levels of locomotor ability.

**Clinical Relevance :** The SAMs provide a mechanism to meaningfully assess stepping activity in individuals with stroke and various levels of locomotor impairment.

**TITLE:** Validation of a Modified Four Square Step Test (mFSST) and Development of a Quality Score (qFSST) in Community-Dwelling Elderly

**AUTHORS/INSTITUTIONS:** A. Fergus, J. Chamberlain, G. Joukar, A. Smith, Physical Therapy, Shenandoah University, Winchester, VA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this study was to modify and validate the FSST in community-dwelling elderly adults for use with individuals using assistive devices and those who cannot clear canes without touching.

**Number of Subjects :** Forty eight community-dwelling adults aged 65 and older.

**Materials/Methods :** Detailed fall and medical histories were taken. Subjects completed the FSST with or without assistive devices (mFSST), the TUG, the ABC Scale. During the mFSST, quality of performance was recorded in detail. Quantitative and qualitative data were analyzed and used to develop the quality score for the FSST (qFSST). Concurrent validity, discriminant validity and internal consistency of the mFSST and qFSST were analyzed.

**Results :** The mFSST had strong concurrent validity with the TUG (0.878,  $p < .01$ ) and poor with the ABC Scale ( $r = -0.327$ ,  $p < .01$ ); the mFSST had a sensitivity of 84% and specificity of 82% in identifying fallers with FSST times greater than 11 seconds. The qFSST had strong concurrent validity with the TUG ( $r = -0.752$ ,  $p < .01$ ) and moderate concurrent validity with the ABC Scale ( $r = 0.584$ ,  $p < .01$ ). The qFSST had discriminant validity in distinguishing fallers and non-fallers and an initial prediction model for falls was developed. Internal consistency of the qFSST was moderate with the items of number of taps, assistive device use, and FSST time Chronbach's alpha = 0.713); however, level of assistance lowered the internal consistency of the qFSST (Chronbach's alpha = 0.632). A qFSST greater than 7 had a sensitivity of 79% and a specificity of 63% in identifying fallers and non-fallers. Individual items of the qFSST also demonstrated the ability to discriminate between fallers and non-fallers.

**Conclusions :** The modified FSST is a valid and feasible tool for lower functioning ambulatory older adults with the ability to distinguish fallers from non-fallers. The qFSST can enable clinicians to identify qualitative impairments in dynamic balance that may guide interventions for the prevention of falls. Future research should examine additional qualitative aspects of mFSST performance to further strengthen the utility of the qFSST.

**Clinical Relevance :** The mFSST is a valid tool for determining fall risk in a broad population of older adults. Furthermore, the qFSST provides additional qualitative information to guide clinicians in addressing fall risk individually.

**TITLE:** Normative Data for Functional Balance and Gait Measures in Children Aged 14-18

**AUTHORS/INSTITUTIONS:** B. Alsalaheen, S.L. Whitney, P.J. Sparto, Physical Therapy, University of Pittsburgh, Pittsburgh, PA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Patients who sustain concussion are often seen for vestibular rehabilitation due to deficits in static or dynamic balance. Different functional balance and gait measures are used to track their recovery over the course of vestibular rehabilitation. However, these tests lack normative reference values for healthy adolescents between the ages of 14 to 18 years, which limits their clinical utility. The purpose of this study is to provide normative data for healthy high school children.

**Number of Subjects :** Sixty two high school students between the ages of 14.5 and 18.2 years old (M=15.8, SD =1.1) were recruited from local high schools. Subjects did not have previous history of self reported concussion.

**Materials/Methods :** Subjects completed the Dynamic Gait Index (DGI), Functional Gait Assessment (FGA), Timed "Up & Go" (TUG), and the Five Times Sit to Stand (FTSTS). Gait speed was measured over a course of 4 meters and 20 feet. Percentile scores were computed for all measures and correlations were computed to determine the relationship between subject demographics and the measures.

**Results :** There was no significant relationship between the measures and height or gender. The Timed "Up & Go" significantly increased in older subjects and heavier subjects. Gait speed was significantly slower in heavier subjects. The Dynamic Gait Index (DGI) was significantly higher (i.e. better) in older subjects.

**Conclusions :** Normative reference values for functional balance and gait measures were obtained for healthy children aged 14-18.

**Clinical Relevance :** These normative scores provide a reference for interpreting the performance of common functional balance and gait measures for individuals of high school age who sustain concussion. These normative scores provide end points for discharge from the vestibular rehabilitation therapy.

**TITLE:** Implementing a modified-constraint induced therapy program in a group outpatient setting

**AUTHORS/INSTITUTIONS:** E. Bryant, K.K. Cleary, Eastern Washington University, Spokane, WA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Modified constraint induced therapy (mCIT) is a therapeutic approach used to treat patients with hemiparesis post-stroke. Research has shown positive outcomes of mCIT compared to traditional therapy or no rehabilitation. However, no research surrounding mCIT delivered in a group setting has been conducted in the United States. The purpose of this pilot study was to develop a mCIT program rooted in evidence, deliver it in a group outpatient setting, and measure functional outcomes.

**Number of Subjects :** This multiple patient case report included four subjects (3 men, 1 woman) with chronic stroke (at least 6 months prior), ages 47–68 years ( $x=56.3$ ). A sample of convenience was recruited through a regional rehabilitation facility. Inclusion criteria used were consistent with benchmarks established by Page and Levine. Subjects had only one stroke, hemiparesis and disuse of the affected upper extremity (UE), and some active motion in the affected UE (20 degrees of wrist extension, 10 degrees of MCP and IP extension).

**Materials/Methods :** An evidence-based mCIT program was developed for use in a hospital-based outpatient setting, and implemented in a group format. Subjects attended for five hours per day, five days a week, for two weeks. Each subject wore a kitchen mitt on the unaffected UE and was instructed not to use that arm during the mCIT sessions. Intervention consisted of functional activities, unilateral repetitive task training, group activities, and rest breaks. The following outcome measures were used at baseline and after program completion: Arm Motor Abilities Test, Fugl-Meyer Assessment, Motor Activity Log, Berg Balance Scale (BBS), Modified Ashworth Scale, hand grip strength, Nine Hole Peg Test, Jebsen Hand Function Test, and Timed Saebo Five Ball Peg. Subjects' qualitative reports of their affected UE function and participation experiences were also recorded.

**Results :** Subjects showed improvements on fine motor, gross motor, and balance outcome measures, and provided overwhelmingly positive reports following participation. They described improved awareness of the affected UE during daily activities, return of automatic use of the affected UE, and the ability to engage in meaningful, functional tasks like tooth brushing and self-feeding. One subject returned to playing the piano following program participation.

**Conclusions :** Participation in this mCIT group program resulted in improved fine motor, gross motor and functional outcomes in all four subjects. Each subject reported personal gains following participation, expressed the opportunity to participate as an “emotional boost,” and stated that he/ she would not have been able to do this type of intensive therapy independently.

**Clinical Relevance :** This multiple patient case report demonstrated functional improvements following participation in a mCIT group program similar to evidence of outcomes following individual mCIT sessions. Implementing a group mCIT program may be a cost effective method to help patients obtain both objective and subjective functional improvements following chronic stroke.

**TITLE:** Misdiagnosis of Wernicke's Encephalopathy as Conversion Disorder: A Case Study Demonstrating the Importance of Differential Diagnosis in Physical Therapy and Communication Within the Interdisciplinary Team

**AUTHORS/INSTITUTIONS:** S. Elgelid, M. Gelder, , Nazareth College, Rochester, NY;

**ABSTRACT BODY:**

**Background & Purpose :** Wernicke's Encephalopathy (WE) is a thiamine (vitamin B1) deficiency which initiates brain tissue lesions by inhibiting metabolic processes crucial for cerebral energy use. Some common symptoms that may manifest are ataxia, mental status changes, tachycardia, peripheral neuropathy, and nystagmus or ophthalmoplegia. WE is difficult to identify, especially in the acute phase and therefore often goes misdiagnosed, prolonging treatment. There has been recent evidence regarding WE developing in post-bariatric surgery patients as a psychotic disorder. One such psychotic disorder is conversion disorder (CD) – a psychosomatic disorder presenting itself as sensory and/or motor dysfunctions. Similarly to WE, some common symptoms that may manifest with CD are hysterical paralysis, ataxia, and tremors which are often the result of an unconscious psychological conflict or need. Correct diagnosis of CD and WE is essential for proper treatment.

**Case Description :** The subject of this case was an obese 28-year-old African American female admitted with the diagnosis of CD. She presented on the cardiac unit of the acute care setting with the following findings: tachycardia, bilateral upper extremity paresis with reports of numbness and burning in her hands, bilateral lower extremity paralysis, impaired hearing, ataxia, and pseudo-seizures. Past medical history was unremarkable. Past surgical history was significant for a gastric bypass in March 2010. Findings suggested consistency with medical diagnosis of CD.

Subject was seen by PT and Occupational therapy (OT) 2x/wk for 2.5 wks. Based on recent literature regarding physical therapy treatment of CD and upon discussion with the subject's care team, the rehab staff, concurred that the subject's presented impairments would be treated via functional activities (bed mobility, transfers, pre-gait activities), while using positive reinforcement.

**Outcomes :** During this subject's course of care, there remained constant communication between the rehab staff regarding plan of care. Due to scheduling interference, nursing was the main means to relay information between the rehabilitation staff and the subject's physician. During the course of treatment the rehab staff stressed the increasing necessity of a psychiatric and neurological consult. At 2.5 wks a neurological consult was performed, re-diagnosing the subject with WE secondary to nutrient deficiency from her gastric bypass.

**Discussion :** In retrospect, it may have been beneficial for the PT to have tested deep tendon reflexes (DTRs) during the physical exam. Additionally, had the examining PT gathered more information regarding the subject's gastric bypass surgery – in conjunction with a greater awareness of the link between post-bariatric surgery and WE – then the findings during the exam could have served as integral information to relay during interdisciplinary discussion. The misdiagnosis of CD may have been identified sooner.

**TITLE:** Pediatric Hemiparesis: Synergistic treatment using repetitive transcranial magnetic stimulation and constraint induced therapy

**AUTHORS/INSTITUTIONS:** B.T. Gillick, S.T. Ellsworth, L. Elmajri, E.S. Henneman, J.R. Carey, Physical Therapy, University of Minnesota, Minneapolis, MN;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Repetitive transcranial magnetic stimulation (rTMS) is a noninvasive electrophysiologic intervention that has been shown to modulate cortical excitability and affect motor function. Constraint-induced therapy (CIT) is a behavioral treatment that can enhance movement capabilities by forcing use of the hemiparetic upper extremity while limiting use of the unaffected limb. The purpose of this study was to determine the safety and efficacy of synergistic rTMS and CIT on functional outcomes in a pediatric population with hemiparesis.

**Number of Subjects :** 15

**Materials/Methods :** Participants aged 8 to 16 years with the diagnosis of an ischemic stroke resulting in congenital hemiparesis took part in this single-blinded, randomized study. The study design included pre and post testing and a sham and real rTMS group, while all received CIT. Dependent variables included safety measures, functional outcome, and brain reorganization, as determined by fMRI and TMS testing. All children wore a uni-valve cast consistently throughout the 2-week treatment duration, except for five 1-hour rTMS sessions. Participants all received five, two-hour treatment sessions of CIT and were randomized to receive either five treatments of real or sham rTMS on days alternating with CIT. rTMS consisted of 20 minutes of 6-Hz primed, low-frequency stimulation applied to the optimal point of the contralesional primary motor area serving the nonparetic extensor digitorum muscle. Regarding data analysis, the Assisting Hand Assessment (AHA) showed a difference in baseline, and an analysis of covariance was run to explore for within-group and between-group differences. For the Canadian Occupational Performance Measure (COPM), which did not show differences in baseline, a paired t-test was used for within-group analysis, and a two-sample t-test was used for between-group analysis.

**Results :** No child experienced any serious adverse event. Improvements in the primary outcome measures, the AHA and the COPM were noted in both groups. For the AHA, all subjects improved in behavioral outcomes from pre to post testing, yet those in the real rTMS/CIT group showed significant improvements as compared to the sham rTMS/CIT group ( $p < 0.003$ ). All subjects significantly improved in the 2 subsections of the COPM: Performance and Satisfaction from pre to posttest ( $p < 0.01$ ), yet the between-group analysis did not reveal significance. Brain reorganization analysis is in process.

**Conclusions :** In this study, the combination of rTMS and CIT for use was found to be safe, with the potential to increase hand function. Further research is required with a larger sample size to determine specific improvements.

**Clinical Relevance :** The synergistic use of rTMS with conventional therapeutic techniques in children living with congenital hemiparesis has the potential to enhance motor function of the paretic limb.

**TITLE:** Unilateral vestibular hypofunction in a 60 year old patient with a childhood medical history of meningitis.

**AUTHORS/INSTITUTIONS:** A.D. Pause, Pi Beta Phi Rehabilitation Institute, Vanderbilt University Medical Center, Nashville, TN;

**ABSTRACT BODY:**

**Background & Purpose :** Peripheral vestibulopathy is a diagnosis of balance disorders in children. Children often go without complaints of symptoms related to the vestibular system and demonstrate a strong ability to compensate for loss of balance function. Because of the strong ability to compensate, deficits may go undiagnosed and therefore untreated. Understanding causes of vestibulopathy in children, such as meningitis, may help detect deficits in adulthood based on patient medical history. This case report demonstrates the importance of differential diagnosis in older patients with subjective symptoms and medical history, such as meningitis, indicating possible vestibular pathology.

**Case Description :** The case report presents a 60 year old female with lifelong balance disturbances with a medical history of meningitis and sensorineural hearing loss at age three years. Referral was made for physical therapy intervention for imbalance due to increased falls one year prior to evaluation. Her physical therapy examination results indicated possible vestibular hypofunction. Her evaluation lead to referral to appropriate medical professionals and testing.

**Outcomes :** A review of the patient's medical history through subjective examination guides the therapist to utilize the appropriate assessment tools. The patient's examination showed a positive head impulse test, significant deficits with Computerized Dynamic Posturography, and deficits with Neurocom Gaze Stabilization and Dynamic Visual Acuity testing. Dynamic Gait Index testing score indicated the patient was a high falls risk. Evaluation results, and medical history of meningitis with sensorineural hearing loss and lifelong balance disturbances, guided the referral to an otolaryngology department and for vestibular function testing. The results of vestibular function testing, consisting of Electro-Video Nystagmography, Sinusoidal Harmonic Acceleration testing, and Vestibular Evoked Myogenic Potential (VEMP) testing, indicate an eighty-one percent left unilateral peripheral vestibular system weakness.

**Discussion :** Often times, physicians rely on the expertise of physical therapists to differentially diagnosis patients. Understanding vestibular disorders and identifying possible causes in the medical history, such as childhood meningitis, helps guide the examination process. With direction of the Guide to Physical Therapist Practice to conduct the examination process, review the medical history, and evaluate current signs and symptoms, recommendations were made for diagnostic testing and referral to appropriate medical professionals. This process established a definitive diagnosis with establishment of an appropriate physical therapy treatment plan and interventions.

**TITLE:** Comparison of a Neuroprosthesis and an Ankle Foot Orthosis on Walking Speed, Energy Cost, and Balance in a Patient with Chronic Spastic Hemiplegia: A Case Report

**AUTHORS/INSTITUTIONS:** M. Eikenberry, C. Kinney, , Mayo Clinic, Phoenix, AZ;

**ABSTRACT BODY:**

**Background & Purpose :** Orthoses are routinely prescribed for management of spastic equinovarus foot in patients with hemiplegia to improve functional mobility. Neuroprosthetic devices are increasingly available, both as training tools and as an orthotic replacement. Little data exists to objectively compare functional electrical stimulation (FES) to ankle foot orthoses (AFOs), leading to difficulty with reimbursement for these newer and more costly FES devices. This case study illustrates the use of objective outcome measures for walking speed, energy cost, and balance to compare FES with a custom AFO, facilitating clinical decisions for orthotic prescription.

**Case Description :** A 48 year old female with chronic spastic right hemiplegia due to a left ischemic stroke participated in standardized testing using an FES unit and a custom AFO. The patient ambulates limited distances in the community, using a custom AFO and single point cane. The following tests were completed: 6 minute walk test (6MWT), 10 meter walk test (10MWT), Berg Balance Scale (BBS), Timed Up and Go (TUG), and functional computerized posturography. Energy cost was estimated using the Physiologic Cost Index (PCI). All tests were completed per standardized protocol by one clinician.

**Outcomes :** The patient's PCI was lower during gait while using the FES (1.37 beats/meter, and 1.55 beats/meter for the AFO). Functional computerized posturography demonstrated increased symmetry during sit to stand (STS), walking, turning, and negotiating a curb using the FES (STS 4% increased weight bearing on hemi limb with FES; step width 3 cm less with FES; turn sway 17% less with FES; curb negotiation limb asymmetry 40% less with FES). Berg Balance scores were equivalent with FES and the AFO (49/56). The difference in TUG scores were less than the established minimally detectable change for patients with chronic stroke (16.54 sec with the FES; 14.00 sec with the AFO). Walking speed showed no clinically important difference between the FES unit and the AFO (10 MWT FES 0.714 m/sec, AFO 0.752 m/sec; 6 MWT FES 220 meters at 0.62 m/sec, AFO 248 meters at 0.69 m/sec).

**Discussion :** These findings suggest a benefit with using the FES for this patient, particularly for measures of energy costs and postural symmetry. There was no clinically important difference between the FES and AFO for gait speed. Postural symmetry and energy efficiency were greater with the FES after only a few trials of use. It is possible that gait speed would improve with the FES after a longer training period, a question for further study. Clinicians contemplating FES prescription for patients with spastic hemiplegia may find measuring these objective parameters helpful to guide clinical decisions and support insurance reimbursement.

**TITLE:** Effectiveness of dance video game training in decreasing the risk of falling in subjects with Parkinson's disease

**AUTHORS/INSTITUTIONS:** R. Naik, S. Bronner, J. Noah, ADAM Center, Long Island University, Brooklyn, NY; A. Tachibana, Dept. of Physiology and Neuroscience, Kanagawa Dental College, Yokosuka, Kanagawa, JAPAN;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Falling is a common occurrence and the leading cause of accidental death in people over the age of 65 years. Individuals with Parkinson's disease (PD) are nine times more likely to fall than healthy adults of the same age due factors such as loss of balance, decrease in strength and endurance, delayed reaction time, deficits in vision, impaired attention, and lack of confidence. External cuing such as rhythmic auditory stimulation has demonstrated improvement in multiple gait parameters in subjects with PD. Additional positive benefits such as improved balance are also reported following treadmill training, tango, and ballroom dancing, which are also paced activities. We examined the effects of multi-sensory cued training on falling risk factors in subjects with PD using a dance video game, Dance Dance Revolution (DDR). Playing DDR requires cognitive processing of the visual screen, listening to the song's rhythm, reaction to quickly step onto a designated sensor, balance, force generation through the tapping foot, and weight transfer to accomplish each of the steps within a song-game. Strength and endurance are developed to sustain these components during multiple song-games. We hypothesized that DDR training would decrease the risk of falls in Parkinson's patients.

**Number of Subjects :** Pilot study with five subjects (57 – 63 yrs) with PD (Hoehn & Yahr 1 – 3).

**Materials/Methods :** Subjects trained for 30 hrs on a modified version of DDR. Pre and post training testing included single and dual reaction time (RT) step tasks, 6 min walk test (6MWT), stair climb test, Berg balance test (BBT), and the UPDRS motor section. Scores were compared using paired t-tests ( $p < 0.05$ ).

**Results :** There were improvements in the UPDRS motor section (group mean 60%,  $p = 0.03$ ). No other tests reached significance. However, improvements were seen in the single RT step task (forward stepping 26%, backward stepping 10%), dual RT step task (forward stepping 18%, backward stepping 2%), stair climb test (ascent 16%, descent 18%), 6MWT (8%), and BBT (5%). Subjects all reported that DDR game-play was challenging and fun.

**Conclusions :** Improvements in functional strength, balance, and ability to react quickly to step were seen post training. These improvements may impact favorably on decreasing the risk of falling. Retention test data are currently being collected and analyzed. This research suggests that the complex interactive environment created by DDR stimulates multiple senses and trains participants to coordinate effective sensory-motor responses that are relevant to the real world.

**Clinical Relevance :** Exer-games can be played at home and across generations. People may be more likely to stick to a physical activity that is game-like and can be played with others. Current analyses of fMRI changes are underway to understand neural mechanisms involved with DDR rhythmic training. The basal ganglia-cortical pathway may be targeted during rhythmic auditory stimulation, or an alternate cerebellum-cortical pathway may be activated as well.

**TITLE:** The feasibility and acute effects of polestriding in individuals with Parkinson's disease who exhibit freezing of gait

**AUTHORS/INSTITUTIONS:** J.V. Lynskey, K. Clark, K. Whitefield, P. Bosch, Physical Therapy, A.T. Still University, Mesa, AZ; J. Stovall, N. Krishnamurthi, J. Abbas, Center for Adaptive Neural Systems, Arizona State University, Tempe, AZ; J. Samanta, P. Manhant, , Movement Disorders Specialists, Phoenix, AZ;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Polestriding is a modified form of walking utilizing cross-country skiing type poles in both hands to emphasize large amplitude movements of the arms and legs. After polestriding, spatiotemporal, kinematic and quality of life measures of patients in early stage Parkinson's disease (Hoehn & Yahr I-III) have improved. However, little is known about the feasibility and effectiveness of implementing polestriding for individuals with more severe disease (Hoehn & Yahr II-V), who exhibit freezing of gait. Therefore, the purpose of this pilot study was to determine the feasibility and acute effects of polestriding in individuals with Parkinson's disease who exhibit freezing of gait.

**Number of Subjects :** 4 individuals with Parkinson's disease (H&Y II-IV) who exhibited freezing of gait.

**Materials/Methods :** A pretest – posttest within subject design was used. All subjects received training on polestriding (EXERSTRIDER™ Walking Poles) and performed 30 minutes of polestriding exercise. Prior to and after exercise, all subjects underwent 3D kinematic analyses of overground locomotion (with and without poles). Two comparisons of gait velocity, stride length, hip excursions, shoulder excursions were made as follows: pre exercise no poles vs. pre exercise poles, to assess potential gait changes as a result of polewalking; and pre exercise no poles vs. post exercise no poles, to assess the acute effects of polewalking exercise. Paired t-test and effect size calculations were used to analyze the data. Feasibility was assessed by documenting subject ability to learn the proper technique and safely perform 30 minutes of polewalking exercise.

**Results :** All four subjects were able to learn proper polestriding technique and perform 30 minutes of polestriding exercise. One subject, however, required close supervision during the exercise and had multiple losses of balance. Polewalking (pre-pre comparison) significantly increased hip excursion ( $p < .001$ ), and demonstrated trends towards increased shoulder excursion ( $p = .09$ ) and stride length ( $p = .05$ ). Walking speed, however, was not affected. Polestriding exercise (pre-post, no poles) resulted in significantly improved hip excursion ( $p < .05$ ), and a trend was noted for increased shoulder excursions ( $p = .06$ ). Walking speed was not affected.

**Conclusions :** Polestriding is a feasible and safe intervention in some individuals with Parkinson's disease who exhibit freezing of gait. When walking with poles, individuals with Parkinson's disease appear to walk with larger hip and shoulder movements and make larger strides. Following 30 minutes of training, these improvements in gait appear to carry over into walking without poles, at least for a short duration.

**Clinical Relevance :** The pilot data presented herein sets the stage for further investigation into the use of polestriding as an intervention for individuals with Parkinson's disease who exhibit freezing of gait.

**TITLE:** Dual task attention and interlimb coordination in Parkinson's disease

**AUTHORS/INSTITUTIONS:** T.L. McIsaac, P. Dhaliwal, B. Benjapalakorn, Biobehavioral Sciences, Teachers College, Columbia University, New York, NY;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Daily activities frequently require that we use our arms and legs to do different tasks at the same time such as shifting gears with the hand while pressing the accelerator pedal with the foot when driving. Such activities require the ability to allocate attention, prioritize multiple tasks and coordinate multiple body segments, abilities shown to be impaired in Parkinson's disease (PD). However, dual-task control of the upper and lower limbs has largely been examined in standing and walking activities wherein the arm task is influenced posturally by the leg task. The purpose of this study, therefore, was to examine the dual task effect on control of the ipsilateral arm (reaching) and foot (pedal tracking) during activities performed while seated in people with and without PD. We hypothesized that participants with PD would demonstrate greater dual task cost in performance of both the arm and foot task than healthy age-matched participants.

**Number of Subjects :** Eleven subjects with PD and eleven healthy age-matched controls.

**Materials/Methods :** Participants performed a 3-phase arm task (reach-grasp, place, return) and a target tracking task (level and ramped tracking) with an instrumented foot pedal, separately and concurrently while seated. Velocity profiles of the reach task and errors (RMSE) of the foot pedal tracking task were evaluated as indicators of upper and lower limb control, respectively.

**Results :** Repeated measures ANOVAs [within-group factors of Task (single and dual), Type (easy and hard) for foot task, Phase of reach (grasp, place, return) for the arm task] revealed that PD causes increased error of the difficult foot pedal tracking task when performed concurrently with the arm task, but with similar error on the dual-task easy foot pedal task, compared to healthy adults. Interestingly, the first phase of the reach task was similarly impacted by the concurrent foot task as for controls, but the second and third phases of the reach task were more affected by concurrent performance than for control participants.

**Conclusions :** PD impacts the ability to perform two simultaneous tasks of the ipsilateral upper and lower limbs when they are not posturally linked. Specifically, while seated the arm and foot tasks are affected by dual task interference such that the easier foot task and the first phase of reaching are less impacted. This may imply a task prioritization strategy related to task complexity (reach phases) and difficulty.

**Clinical Relevance :** Individuals with mild to moderate PD are involved in 5 times more car accidents than healthy adults of similar age. Focusing therapeutic strategies on seated dual task training with more complex and difficult activities of the arm and leg may prolong the period of independence and community mobility in patients with PD.

**TITLE:** Assessing balance in geriatric orthopedic and neurologic populations using two standard measures

**AUTHORS/INSTITUTIONS:** K.A. Butera, S.Z. George, Physical Therapy, University of Florida, Gainesville, FL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The primary purpose of this study was to compare two geriatric populations—orthopedic and neurologic—and the application of the Brunel Balance Assessment (BBA) and the Berg Balance Scale (BBS) within these two populations. In addition, the relationships between individuals' scores on these two balance assessments and the SF-36 measures of physical functioning and general health, as well as fall risk were also examined.

**Number of Subjects :** Twenty participants were recruited from an outpatient physical therapy clinic and then sub-categorized into orthopedic (n=12) and neurologic (n=8) populations based on primary diagnosis.

**Materials/Methods :** Participants completed an SF-36 and falls history report and also underwent balance assessments using the BBA and BBS.

**Results :** The orthopedic population performed at a significantly higher level than the neurologic population on both the BBA ( $p=.04$ ) and BBS ( $p=.01$ ). The two balance assessments were found to be significantly associated for the orthopedic population only ( $r=.68$ ;  $p=.01$ ). The two balance assessments were also moderately correlated (approaching significance) with the general health portion of the SF-36 (BBA  $r=.45$ ;  $p=.08$  and BBS  $r=.48$ ;  $p=.06$ ). Within this sample, fall risk appeared to be associated with those who did not fall, but not with those who did.

**Conclusions :** There was no association between measures in the neurologic population suggesting that selecting the appropriate balance measure may be more essential when evaluating these patients. Physical functioning may have less association with these balance assessments due to geriatric patients having an inaccurate perception of functional performance.

**Clinical Relevance :** While balance is a large contributor to functional mobility, including locomotion and ADLs, there has been limited research regarding recommendations for selection of balance measures in the clinic. This study further demonstrates the need for more specific selection of appropriate balance measures based on patient population. Future research should focus on establishing criteria for selecting an ideal measure that is psychometrically robust, clinically feasible, and appropriate for the population that is being examined.

**TITLE:** The relationship between trunk position sense and postural control deficits in people post stroke

**AUTHORS/INSTITUTIONS:** S. Ryerson, J. Hidler, , National Rehabilitation Hospital, Washington, DC;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To quantify the accuracy of trunk position sense during a frontal plane task in people with post stroke hemiplegia and to assess its relationship with sit to stand (STS) performance.

**Number of Subjects :** Twenty-four subjects with chronic stroke and 25 age-matched controls

**Materials/Methods :** Trunk repositioning error (TRE)during sitting lateral flexion movements was assessed using an electromagnetic movement analysis system while STS performance was determined using force plates under each foot. STS metrics used to evaluate performance included time to peak vertical force and weight bearing symmetry. Steadiness and balance were quantified as the time to reach and stay within 3% of the final force (settling time) and Berg Balance Scale (BSS)scores.

**Results :** There were significant differences in absolute TRE during a frontal target movement between both affected and unaffected sides of people post stroke and the control group (unaffected side/controls  $p=0.0009$ ; affected side/controls  $p=0.0006$ ; and in the sagittal plane between the unaffected side of people post stroke and controls  $p=0.0016$ ). Mean frontal plane error post stroke (unaffected side)  $3.21\pm 2.08$ , controls (left side default)  $1.54\pm 0.99$ .

STS performance of people post stroke and controls differed significantly in the following areas: time to peak ( $p=0.0001$ ), settling times ( $p=0.0001$ ), and between leg weight symmetry ( $p=0.0001$ ). Mean time to peak (sec): post stroke(2.86), controls (.97); settling time (sec)(excluding the 5 post stroke subjects who did not 'settle'):post stroke (7.78), controls (2.78); weight symmetry: post stroke (0.75), controls (1.04).

There were no significant correlations between TRE and STS or balance performance measures. However, the five people who did not 'settle' in standing had greater TRE, greater weight asymmetries, and lower BBS scores than the mean scores of the post stroke group.

**Conclusions :** Frontal plane trunk repositioning error is greater in people post stroke than in non-neurologically impaired age matched controls. Subjects with an inability to establish standing postural steadiness had higher TRE, lower weight symmetry and lower BBS scores.

**Clinical Relevance :** Performance of daily activities depends upon good trunk postural control. Components of postural control include position sense, steadiness, and symmetry. The findings of this study, along with our earlier findings of a deficit in TRE during a sagittal target movement, continue to identify altered trunk position sense as an impairment post stroke and could provide important insight into the mechanisms responsible for altered postural control post stroke. The results support the inclusion of position sense retraining as an important postural control intervention strategy to improve balance and functional activities.

**TITLE:** Quantitative Evaluation of Parkinson's Rigidity Progression over Time

**AUTHORS/INSTITUTIONS:** L. Kremer, L. Wagner, A. Muthumani, D.W. Powell, A.J. Threlkeld, R. Xia, Physical Therapy, Creighton University, Omaha, NE;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Parkinson's disease (PD) is a relentlessly progressive neurodegenerative movement disorder. Rigidity is one of the cardinal motor symptoms of PD, and is defined as a uniform increase in resistance to passive movement throughout the range of motion. Evidence has indicated that both increased neural reflex and altered non-neural mechanical components contribute to parkinsonian rigidity. The purpose of this study was to quantify the progressive changes in neural and non-neural components and in overall rigidity in PD over a multi-year period.

**Number of Subjects :** 7 (4 Male; 3 Female)

**Materials/Methods :** Seven people with idiopathic PD have participated in this study. Each participant completed two testing sessions with a between-test interval of 12 to 48 months. Participants were tested after an overnight withdrawal from their anti-PD medication. Torque resistance of the more affected wrist joint was measured during passive flexion and extension movements in patterns of a small amplitude pseudorandom binary sequence. To quantify the neural and non-neural contributions to rigidity, a parallel-cascaded system identification technique was applied. A repeated measures analysis of variance was used to determine if changes in neural and non-neural contributions to overall rigidity were statistically significant.

**Results :** Neural (Test 1:  $0.133 \text{ Nm} \pm 0.081 \text{ Nm}$ ; Test 2:  $0.189 \text{ Nm} \pm 0.104 \text{ Nm}$ ;  $p = 0.025$ ) and non-neural (Test 1:  $0.081 \text{ Nm} \pm 0.077 \text{ Nm}$ ; Test 2:  $0.146 \text{ Nm} \pm 0.065 \text{ Nm}$ ;  $p = 0.010$ ) contributions to overall rigidity significantly increased over time.

**Conclusions :** Rigidity became worse over the course of study examination. Neural and non-neural components contributed to the enhancement of rigidity. The findings are consistent with clinical reports of disease progression.

**Clinical Relevance :** The progressive increase in non-neural contributions to parkinsonian rigidity can be targeted with interventions used by physical therapists. The alterations in intrinsic muscle and connective tissue properties may be delayed by passive accessory movements, manual stretching, and indicated modalities. Clinical studies are warranted to determine whether such interventions are effective in managing the non-neural progression of rigidity.

**TITLE:** Manual Wheelchair Wheelie Training by Physical Therapists in Inpatient Spinal Cord Injury Rehabilitation

**AUTHORS/INSTITUTIONS:** K.M. Casperson, L.M. Teeter, , Shepherd Center, Atlanta, GA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Describe manual wheelchair wheelie training conducted by physical therapists during inpatient rehabilitation for patients with spinal cord injury (SCI).

**Number of Subjects :** 600 patients with traumatic SCI enrolled in the multi-site study, **SCIR rehab**.

**Materials/Methods :** Physical Therapists providing care to patients with acute SCI documented the content of each physical therapy (PT) session using portable electronic devices featuring customized software. Session type (group vs. individual), session activities, and time spent on each activity were documented. Injury characteristics were obtained via chart review. Level and completeness of SCI were determined using the International Standards of Neurological Classification of SCI.

**Results :** 509 of the 600 patients practiced manual wheelchair skills in 4375 individual and group PT sessions. 51% of these patients participated in wheelie training during 1348 sessions (30.8% of all manual wheelchair skill sessions) and most sessions were in group format (69% of sessions for patients with tetraplegia and 65% for patients with paraplegia). Patients with motor incomplete injuries above C7 spent a higher percentage of their PT sessions practicing wheelies than those with motor complete injuries above C7 (5.1% v. 4.0% respectively). Patients with motor complete injuries at C7 and below spent a higher percentage of their PT sessions practicing wheelies than those with motor incomplete injuries at those levels (10.7% v. 6.8% respectively). However, for patients with motor complete injuries at C7 or below, regardless of injury level, there was no significant difference in the percentage of their PT sessions that included wheelie training. Wheelie training sessions were conducted on level surfaces (90.5%), inclines (5.2%), and rough terrain (4.3%). At discharge from inpatient rehabilitation, patients with C1-4 injuries were dependent with wheelies, patients with C5-8 injuries required minimal-moderate assistance, and those with paraplegia (T1-S4) required supervision-minimal assistance to perform the wheelie skill.

**Conclusions :** Wheelie skill practice comprises a large component of PT sessions during inpatient SCI rehabilitation and group format was used frequently. Most practice took place on level surfaces, even though the wheelie is required for negotiating steep declines and rough terrain.

**Clinical Relevance :** The wheelie is a fundamental manual wheelchair skill and a component of more advanced skills that support community reintegration. Trends from the **SCIR rehab** study regarding the practice of the manual wheelchair wheelie with patients with SCI could be used to contribute to the creation of a clinical framework. This tool could be utilized by general neurological clinicians who work less frequently with this unique patient population.

**TITLE:** REHABILITATION OF THE UPPER LIMB POST STROKE: RANDOMIZED CONTROLLED PILOT INVESTIGATION EVALUATING EXTERNAL AUDITORY FEEDBACK FOR TRUNK CONTROL DURING TWO NEW TRAINING METHODS.

**AUTHORS/INSTITUTIONS:** G.T. Thielman, Physical Therapy , University of the Sciences, Philadelphia , PA; P. Bonsall , Physical Therapy , University of the Sciences , Philadelphia , PA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Auditory feedback for trunk control from an external device is a novel concept that eliminates the need for tactile or verbal cueing. Training in the virtual environment is being established as a new approach for neurorehabilitation. ReoTherapy (REO) introduces a robot-assisted program for the upper extremity, based on the understanding that numerous repetitions of functionally oriented movements can stimulate cortical reorganization. Recent work utilizing robotic therapy suggests benefits for moderate to severely impaired individuals post stroke; achievement of repetitive task practice and decreased need for constant supervision. However, trunk stabilization has been shown to be necessary with REO, and literature is lacking to support this for long-term functional changes of the impaired arm. The purpose of this randomized controlled pilot investigation was to compare REO with real-world task-related training (TRT), measuring the amount of changes evident during external trunk sensor feedback, for the moderate to severely impaired individual post stroke. Based on prior work it was expected that greater changes would be apparent post training for TRT.

**Number of Subjects :** Sixteen individuals post stroke, discharged from all rehabilitative services at least 6 months prior, with no receptive aphasia, apraxia or other cognitive deficits. Individuals scored between 20 and 44 on the Upper-Arm subsection of the Fugl-Meyer Scale, and demonstrated some trunk movement during the pretest reaching performance measures.

**Materials/Methods :** Rehabilitative sessions lasted between 50 and 65 minutes, 2-3 times a week for 4-6 weeks. Both groups performed reaching activities at varied locations across the workspace using the paretic upper-limb. Auditory trunk sensor feedback was systematically and equally faded throughout the training. Using a pretest/posttest design, rehabilitative effects were determined using scales at each level of the ICF model. Kinematic changes of arm reaching ability, using the Polhemus electromagnetic tracking device, were recorded. Neural activation utilizing fMRI was used to demonstrate neuroplastic changes.

**Results :** A 2 (Training Group) x 2 (Pre-/Posttests) ANOVA was used to reveal clinically relevant improvements for both techniques on the Motor Activity Log, the Wolf Motor Function Test, elbow extension and the Reaching Performance Scale. Detailed kinematic and fMRI analyses will also be presented.

**Conclusions :** Fading external auditory feedback during extended REO and TRT reaching/grasping practice generally led to equal changes. Due to limitations with the REO device for this protocol, using TRT with an auditory feedback signal can be a more effective approach.

**Clinical Relevance :** Both protocols used environmental feedback as a means to enhance motor learning. However, the degree of changes evident varied per protocol and may be due to the appropriateness of one technique for certain participation levels, and the other technique for others.

**TITLE:** Lower extremity weakness better predicts walking limitations in people with multiple sclerosis than lower extremity strength asymmetry.

**AUTHORS/INSTITUTIONS:** A.C. Tigges, J.M. Wagner, Physical Therapy and Athletic Training, Saint Louis University, St. Louis, MO; R.T. Naismith, Neurology, Washington University School of Medicine, St. Louis, MO;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** To determine whether lower extremity (LE) weakness or the presence of LE strength asymmetry better predicts limitations in walking speed and endurance in people with multiple sclerosis (pwMS), and if a particular muscle group best predicts these limitations in walking.

**Number of Subjects :** 33 pwMS (19 female, 14 male; age  $43.6 \pm 10.2$  years) and moderate clinical disability (EDSS  $3.8 \pm 1.6$ ).

**Materials/Methods :** Bilateral hamstring and plantarflexor maximal isometric voluntary torque (MVIT) was assessed using an isokinetic dynamometer. Bilateral hip flexor maximal isometric voluntary force (MVIF) was assessed using a hand-held dynamometer. Hamstring MVIT was evaluated with the subject seated and the knee in  $60^\circ$  of flexion. Ankle plantarflexion MVIT was evaluated with the subject supine and the leg in  $0^\circ$  of dorsiflexion and knee in  $0^\circ$  of knee extension. Hip flexor MVIF was evaluated with the subject supine and hip and knee in  $90^\circ$  flexion. Each subject performed three 5-sec trials of MVIT(F) for each muscle group. All strength data were normalized to body weight (%BW). The lowest MVIT(F) for each muscle group was identified and used as measures of LE weakness. The percent difference in MVIT(F) between the right and left side for each muscle group was calculated and used as measures of LE strength asymmetry. The mean time to complete two trials of the Timed 25-Foot Walk Test was used to assess walking speed. The total distance walked during the Six Minute Walk Test was used to assess walking endurance. Forward stepwise multiple linear regression analyses were used to determine whether LE weakness or LE strength asymmetry better predicts limitations in walking, and if a particular muscle group best predicts limitations in walking.

**Results :** LE weakness and LE strength asymmetry were predictive of walking speed ( $R^2 = 0.32$ ,  $p < 0.01$ ;  $R^2 = 0.26$ ,  $p < 0.03$ , respectively). LE weakness was more predictive of walking endurance ( $R^2 = 0.53$ ,  $p < 0.001$ ) than strength asymmetry ( $R^2 = 0.27$ ,  $p < 0.01$ ). Plantarflexor MVIT predicted the greatest amount of variance in walking speed (weakness:  $R^2 = 0.28$ ,  $p = 0.03$ ; asymmetry:  $R^2 = 0.20$ ,  $p = 0.03$ ). Hip flexor MVIF predicted the greatest amount of variance in walking endurance (weakness:  $R^2 = 0.43$ ,  $p < 0.01$ ; asymmetry:  $R^2 = 0.21$ ,  $p = 0.05$ ).

**Conclusions :** LE weakness better predicted limitations in walking speed and endurance than LE strength asymmetry. Of the muscles tested, plantarflexors best predicted limitations in walking speed, whereas hip flexors best predicted limitations in walking endurance.

**Clinical Relevance :** pwMS often present with LE weakness yet little is known about side-to-side strength asymmetry and its impact on limitations in ambulation in this patient population. These preliminary data suggest that LE strength assessment, as directed by the type of ambulatory limitation experienced by the individual, may serve as an important component in the evaluation and treatment of pwMS.

**TITLE:** Mechanical and Neurophysiological Manifestations of Fatigue in Parkinson's Disease

**AUTHORS/INSTITUTIONS:** D. Powell, A. Benes, M. Konor, K.L. Kerschen, A. Gustafson, R. Xia, A.J. Threlkeld, Physical Therapy, Creighton University, Omaha, NE; N.J. Hanson, College of Education and Human Ecology, The Ohio State University, Columbus, OH;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Fatigue is one of the foremost complaints of people with Parkinson's disease (PD) and has been described as "an overwhelming feeling of tiredness". Mechanically, fatigue is defined as a reduced ability to produce force. In healthy adults, mechanical fatigue of muscle results from depletion of chemical substrates required for contraction. Fatigue may also have a central origin including diminished spinal or supraspinal neural drive. Fundamental questions remain unanswered regarding the sources of fatigue associated with aging and PD. The purpose of this study was to investigate the changes in torque generation and neuromuscular activation thigh muscles after a fatiguing protocol. To assess contributions of aging and PD. we compared healthy young adults (YAC) to healthy older adults (OAC) and individuals with PD (PDF). We hypothesized that elderly adults and people with PD would have greater declines in muscle activation in response to a fatiguing protocol.

**Number of Subjects :** 16 (6 PDF, 5 OAC, 5 YAC)

**Materials/Methods :** Surface EMG electrodes were placed over the vastus lateralis, vastus medialis, biceps femoris and semimembranosus muscles. Utilizing a Biodex System 3 dynamometer, each participant performed maximal voluntary isometric contractions (MVIC) at 60° of knee flexion before (pre-) followed by repeated isokinetic knee extension contractions (60°/s) until peak knee extension torque fell below 50% peak pre-fatigue MVIC torque for three consecutive contractions (fatigue). After isokinetic fatigue was reached, isometric MVIC was measured again (post-). Torque and surface EMG data were captured using Datapac 2K2 software (1000 Hz, RunTech, Inc.).

EMG signals were smoothed using the root mean squared with a 20 ms window. Mean EMG data were calculated during a 200 ms window (100 ms pre- and post-) surrounding the peak knee extension torque. EMG amplitude was normalized to peak mean EMG during the MVIC contraction.

Paired sample t-tests were used to determine the effect of fatigue on torque, quadriceps activation, hamstrings activation and coactivation ratio (CAR) within each group. Alpha level was set at  $p < 0.05$ .

**Results :** The YAC group demonstrated a significant change in torque ( $p=0.040$ ). YAC quadriceps activation and hamstring activation were reduced following fatigue but not significantly ( $p=0.096$  and  $p=0.086$  respectively). Neither the OAC nor the PDF exhibited significant changes in torque production or muscle activation. Mean post- CAR increased slightly in all subjects but the increase was not significant.

**Conclusions :** These data suggest that young adults experience greater muscular fatigue following repeated isokinetic contractions than older adults or individuals with PD. Alternatively, older adults and people with PD may not have fully activated their musculature, resulting in less muscular or central fatigue compared to the young adults.

**Clinical Relevance :** These findings may aid in the development of evidence-based interventions specific to PD-related fatigue.

**TITLE:** Can Changes in Hand Position Favorably Alter Shoulder Kinematics during Circuit Resistance Training in Individuals with Paraplegia?

**AUTHORS/INSTITUTIONS:** L.M. Riek, , University of Rochester, Rochester, NY; J. Tome, D.A. Nawoczenski, , Ithaca College, Rochester, NY; P.M. Ludewig, , University of Minnesota, Minneapolis, MN;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Shoulder impingement pain following paraplegia can be disabling, affecting both function and quality of life. Shoulder exercises, particularly circuit resistance training (CRT), offer numerous health benefits. However, the kinematic patterns associated with certain exercises and hand positions may contribute to increased impingement risk (subacromial or internal). The purpose of this study was to determine if altering hand position can favorably modify scapular and glenohumeral kinematic patterns. Hypotheses: Modified hand positions will result in increased scapular posterior tilt, upward rotation, external rotation (ER) and/or glenohumeral ER.

**Number of Subjects :** 19 individuals (14 men, 5 women; 25-76 years) with paraplegia and no shoulder pain were recruited.

**Materials/Methods :** The Flock of Birds™ electromagnetic tracking system acquired three dimensional position and orientation data from the trunk, scapula, and humerus during five CRT exercises (row, chest press, lat pulldown, overhead press and rickshaw). Procedure: Subjects performed exercises in two hand positions: traditional and modified. Analysis: Descriptive statistics and two-way repeated measures ANOVA was used to evaluate the effect of modifications and exercises on kinematic variables. Significance was set at 0.05 for all analyses.

**Results :** The traditional rickshaw produced the most detrimental kinematic patterns: scapular anterior tilt (24 degrees), scapular internal rotation (IR) (47 degrees), glenohumeral IR (31 degrees) and scapular upward rotation (15 degrees). Modifying rickshaw hand position resulted in improved kinematic patterns: increased glenohumeral ( $p=.016$ ) and scapular ER ( $p<.001$ ) of 5 degrees. Favorable increases in glenohumeral ER ( $p<.001$ ) of 18 degrees were also found with the modified lat pulldown. For the overhead press, traditional position was preferred as shown by greater glenohumeral ER of 9 degrees ( $p=.001$ ) and scapular ER of 6 degrees ( $p=.004$ ). There was no difference between traditional and modified positions for the row and chest press.

**Conclusions :** The outcomes of this study guide recommendations related to specific positioning for CRT exercises that emphasize healthy shoulder mechanics. If given an option, hand positions should be chosen that minimize shoulder impingement risk. Kinematic patterns were favorably altered with modified hand positions during the lat pulldown and rickshaw. The traditional overhead press was the preferred position. The rickshaw is of greatest concern with detrimental kinematic patterns corresponding to increased subacromial impingement risk.

**Clinical Relevance :** During CRT, even simple changes in hand positions may minimize shoulder impingement risk. The rickshaw should be used sparingly when needed to meet essential functional goals. The modified position should be used for the lat pulldown and rickshaw and the traditional position should be used for the overhead press.

**TITLE:** Gross Motor Coordination Patterns Differ between Seated and Standing Cycling

**AUTHORS/INSTITUTIONS:** N. Carlson, J. Karlson, B. Lemon, J. Rolf, A. Schleeper, B. Stoppel, D.L. Hoover, , Rockhurst University, Kansas City, MO;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Studies show that measures of power output (W) are usually greater when persons cycle in a seated position, rather than in a standing position. Yet, little is known about how measures of gross motor performance (GMP) differ between these two positions, or how they may contribute to the differences typically seen in power output. Deeper understanding of these issues has clinical implications, as factors such as body position during gross motor activity may influence the quality of exercise during training or rehabilitation. Cycling is a continuous motor task that may be used to assess GMP, and it is well suited for laboratory studies. The goal of this study was to explore the effects of riding position on GMP during high intensity cycling.

**Number of Subjects :** Thirty two women ( $24.14 \pm 1.62$  yr,  $167.77 \pm 7.52$  cm,  $64.13 \pm 8.55$  kg) completed this study. Criteria was used to 1) include subjects who exercise at least 30 minutes 3 or more days per week and 2) exclude individuals a) who possess any type of pathology which would, by itself, alter GMP, or b) who regularly cycle.

**Materials/Methods :** The trial order (seated vs. standing) was randomized, and participants visited the laboratory on two occasions. Following a standardized warm up, subjects rode an electronically-braked cycle ergometer at maximal intensity for 30 seconds. Conditions were controlled and measured by computer. The following variables were assessed during each trial: speed, watts, cadence, and measures of cycling efficiency (SpinScan™, and average torque angle (ATA) throughout the 360° of pedal travel). A repeated measures within-subjects ANOVA was used for statistical analysis.

**Results :** Significant differences were found between conditions for speed ( $F(1,31)=89.55, p=0.000$ ), watts ( $F(1,31)=75.02, p=0.000$ ), cadence ( $F(1,31)=146.10, p=0.000$ ), SpinScan ( $F(1,31)=54.215, p=0.000$ ), left ATA ( $F(1,31)=28.92, p=0.000$ ) and right ATA ( $F(1,31)=47.38, p=0.000$ ). Significant interactions ( $F(5,27)=7.82, p=0.000$ ) were found for both conditions over time.

**Conclusions :** The findings suggest that two separate attractor states may control seated and standing cycling, as the subjects responded to the different riding positions by 1) altering their gross motor coordination patterns while cycling and 2) showing differing fatigue patterns under the two conditions. The results support other studies suggesting that power output is typically greater in a seated position, yet the present findings may help to explain the source of the differences, by addressing the differences in GMP seen when cycling in these two positions.

**Clinical Relevance :** The GMP of the subjects was clearly influenced by the cycling positions used in this study. The participants in this study appeared to self-organize in very different ways the motor activities included in the conditions in this study. These findings suggest physical therapists should be mindful of even the most subtle changes in exercising posture when creating clinical interventions for their patients.

**TITLE:** Community Walking Is Similar in Healthy Older Adults and People with Parkinson's Disease

**AUTHORS/INSTITUTIONS:** J.S. Delavan, B.P. Simonsen, R. Xia, A.J. Threlkeld, D. Powell, Physical Therapy, Creighton University, Omaha, NE;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Many people with Parkinson's disease (PD) report excessive fatigue. Described as "an overwhelming feeling of tiredness" and commonly measured using psychometric methods, the relationship between the perception of tiredness and physical fatigue has not been well established. However, the influence of PD-related fatigue on activity has not been objectively assessed. Two common physical manifestations of fatigue include diminished level and intensity of activity. The purpose of this pilot research was to compare objective measures of physical activity (total steps /day and step intensity) between people with PD that reported fatigue (PDF) versus older adult controls (OAC) and younger adult controls (YAC). We hypothesized that PDF would have fewer total steps and lower step intensity than YAC and healthy older controls OAC.

**Number of Subjects :** 11 (4 PDF, 4 OAC, 3 YAC)

**Materials/Methods :** After informed consent, participants were asked to perform normal daily activities while wearing an ankle-mounted accelerometer (Orthocare Innovations) positioned immediately proximal to the lateral malleolus for four days. Accelerometer data were extracted using StepWatch Analysis Software (3.1.0, Orthocare Innovations). Variables included total steps and distribution of step intensities categorized as low (<15 steps/min), moderate (15-40 steps/min), or high (>40 steps/min). Subjects with PD completed the Parkinson's Fatigue Scale (PFS) survey instrument to determine his or her subjective perception of fatigue. Student's t-tests were used to detect significant differences between the PD, OAC and YAC groups. Alpha level was set at  $p < 0.05$ .

**Results :** PFS scores (mean  $44 \pm 8.83$ ) confirmed that fatigue was present in the PDF group. Average steps/day approached the recommended value of 10,000/day in the PDF ( $10381 \pm 3887$ ), OAC ( $9818 \pm 2140$ ) and YAC groups ( $11520 \pm 2395$ ). T-test comparisons of steps/day showed no difference between groups: OAC vs PDF ( $t=0.808$ ), YAC vs PDF ( $t=0.676$ ), and OAC vs YAC ( $t=0.366$ ). T-tests comparing step intensity between groups revealed significant differences between the PDF vs YAC: low ( $t=0.018$ ), medium ( $t=0.041$ ), and high ( $t=0.012$ ). There was no significant differences in step intensity between PDF vs OAC: low ( $t=0.715$ ), medium ( $t=0.486$ ), and high ( $t=0.454$ ), as well as OAC vs YAC: low ( $t=0.254$ ), medium ( $t=0.171$ ), and high ( $t=0.145$ ).

**Conclusions :** All subjects took about the same number of steps/day. Step intensity varied by age but people with PD-related fatigue were not different than older controls. Young adults walked with greater vigor than either healthy older adults or people with PD-related fatigue.

**Clinical Relevance :** Objective measures of activity demonstrated that people with self-reported PD-related fatigue had activity levels similar to older control subjects. This may be due to the method used to identify PD-related fatigue or may indicate that activity limitation does not include our measures of ambulation. These data are gathered from a small population and will require corroboration.

**TITLE:** Predicting discharge placement after rehabilitation for a stroke: the role of demographics and clinical presentation

**AUTHORS/INSTITUTIONS:** S. Billinger, A.A. Lentz, B.J. Gajewski, , KUMC, Kansas City , KS; P. Pohl, , The Sage Colleges, Troy, NY;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The majority of older adults return home after rehabilitation for stroke. The relationship between functional ability at admission and return to home is evident, with high functional ability scores at admit associated with home placement. The literature is less clear if demographics such as age, sex, and marital status aid in predicting placement. The purpose of this study was to determine if functional status, age, sex and marital status predict discharge to residential care versus home after inpatient rehabilitation post-stroke. We anticipated that being older, female and single, in addition to having a lower functional ability at admission, would predict placement to residential care.

**Number of Subjects :** 31,912

**Materials/Methods :** Using a national data base of rehabilitation hospitals provided by the Allied Health Research Institute, we examined the records of 31,912 adults 65 years of age and older who were admitted for inpatient rehabilitation post-stroke between the years of 2002 and 2008. Inclusion criteria included those living at home prior to admission, a diagnosis of stroke, and discharge to home or residential care. Descriptive analysis was followed by binary logistic regression with the outcome of placement to home versus residential care. Measures of interest included admission scores on the Functional Independent Measure (FIM), age, sex, and whether or not the individual was married or had a partner.

**Results :** The mean age of our sample was  $77.7 \pm 7.3$  years. About half of the patients were married (48%) with none identified as having a partner; 57% of the sample was female. The average FIM score on admission was  $60.0 \pm 19.6$  out of the maximum of 126; the average FIM at discharge was  $84.8 \pm 22.3$ . Three-quarters of the patients (75%) were discharged to home, and one-quarter (25%) was discharged to residential care. The admission FIM ( $<0.001$ ), age ( $<0.002$ ), marital status ( $<0.001$ ), and sex ( $< 0.032$ ) were significant predictors of placement to residential care. After rehabilitation, the individual is more likely to be discharged to residential care if they have a low admission FIM, are older, not married, and are female. The model has moderate predictive power with 71.9% sensitivity and 72.1% specificity.

**Conclusions :** Consistent with previous reports, the majority of patients in this sample returned to home after inpatient rehabilitation for stroke. The results of this study suggest that in addition to the admission FIM, demographic information, specifically age, sex and marital status, can contribute to the prediction of discharge placement.

**Clinical Relevance :** To anticipate discharge placement after inpatient rehabilitation, the therapist should consider the age, sex and marital support system of the patient, as well as the clinical presentation at admission. Results of this study provide useful information to guide the clinician in predicting discharge placement after inpatient rehabilitation for stroke.

**TITLE:** In-phase and anti-phasic postural coordination modes during sensory re-weighting conditions.

**AUTHORS/INSTITUTIONS:** G. Antal, L. Allison, D. Williams, Physical Therapy, East Carolina University, Greenville, NC;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Bilateral quiet stance is maintained using in-phase ('ankle strategy') and anti-phasic ('hip strategy') coordination modes. These modes occur concurrently but at separate frequencies. In general, anti-phasic motion occurs when body segments move at frequencies above 1 Hz, while in-phase motion occurs at frequencies below 1 Hz. The purpose of this study was to determine whether sensory re-weighting influences postural motor strategies during quiet bilateral stance. Does sensory re-weighting drive postural motor strategy selection or are these postural coordination modes based primarily on pendulum dynamics?

**Number of Subjects :** Eight healthy young adults (age range 20-30 years).

**Materials/Methods :** Participants stood on either a firm or 5-inch foam surface in front of a large screen that displayed a visual field image representing an inner hemisphere of dots. The sphere was either static or translated forward and backward sinusoidally at a frequency of 0.18 Hz. Sensory up-weighting to vision occurs when the visual display is stable, but the compliant foam surface is unstable. Sensory up-weighting to somatosensation occurs when the surface is stable but the moving visual display is unstable. Postural sway was measured via forceplate recording. Both postural sway and body segmental motions (trunk, legs) were measured by motion analysis. Analysis: A 2x2 (vision x surface) research design was used to investigate the effects and interactions between surface and visual conditions. Power spectral density (PSD) and cross spectral density (CSD) were calculated for the trunk and leg segments. Coherence and co-phase between trunk and leg segments were calculated to determine the relative response strength and strategy used with respect to the spectrum of postural sway response frequencies.

**Results :** A significant increase in PSD at 0.18 Hz in the Moving vision-Foam surface condition indicates sensory up-weighting toward vision. Greater overall power is seen when either sensory input is less reliable. The trunk segment exhibits a greater PSD than the leg segments. Visual motion increased the coherence of the segments, and was associated with a stronger in-phase coordination mode.

**Conclusions :** Visual display motion had greater influence over trunk segment motion, while surface compliance had greater influence over leg segment motion. Sinusoidal visual display motion at 0.18 Hz influences postural coordination modes according to pendulum dynamics. Both visual and somatosensory cues affect the characteristics and frequencies of postural coordination modes.

**Clinical Relevance :** These findings imply that the systematic manipulation of visual and surface conditions during the evaluation and treatment of individuals with impaired balance is critical, even for 'simple' quiet standing balance activities.

**TITLE:** Power versus Manual? Wheelchair Intervention Trends For Individuals With Low Level Tetraplegia: Findings From The SCIRehab Study

**AUTHORS/INSTITUTIONS:** J. LaBarbera, , Carolinas Rehabilitation, Charlotte, NC; A. Natale, , Craig Hospital, Englewood, CO; J. Gassaway, , Institute for Clinical Outcomes Research, Salt Lake City, UT;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Describe physical therapy (PT) and occupational therapy (OT) interventions for manual and power wheelchair (WC) training during acute rehabilitation for individuals with C5, C6, and C7/8 motor complete spinal cord injuries (SCI).

**Number of Subjects :** 110

**Materials/Methods :** PTs and OTs providing regular care to 600 patients with SCI documented the content and duration of each session using portable electronic devices featuring customized software. Injury characteristics were obtained via chart review. Level and completeness of SCI were determined using International Standards of Neurological Classification of SCI. Minutes of treatment per week was calculated and compared among groups using Chi-square tests and ANOVA.

**Results :** 110 of 600 study patients had motor complete C5-C8 SCI. 83 of these 110 patients received a combination of power and manual WC training spending 26.1 minutes/week (mean) on manual training and 24.1 minutes/week on power training. 7 patients received 68.5 minutes/week of power training only and 20 patients received 74.3 minutes/week of manual training only. A mean of 5.6 total manual training sessions per patient were conducted as compared with 9.3 for power training. Much variability in time spent was seen between and within injury levels. Onset of manual WC training from day of injury varied from a mean of 21 days for patients with C7 injuries (n=12) receiving only manual training to a mean of 60 days for patients with C5 injuries (n=49) receiving both manual and power training. Onset of power WC training varied from 33 days for patients with C6 injuries (n=2) to 53 days for patients with C5 injuries (n=5).

Workers compensation (payer type) is associated with recommendation for both manual and power WCs; other variables associated with recommendation for both types of WCs include C6 AB injury group, and discharge location-home. Lower admission motor FIM score is associated with fewer recommendations for both types of WCs. Higher admission FIM motor score is associated with recommendation of manual only; longer time from injury to rehabilitation admission, older age, and race-black are associated with less recommendation of manual only. For power only WC recommendation, C5-6 AB injury group, higher admission cognitive FIM score, and race-black are associated with more; student status is associated with less.

**Conclusions :** Most patients with C5-8 SCI receive both manual and power WC training. Patients spend slightly more time on manual training but in fewer overall sessions than for power training. Patients with higher level injuries begin their WC training later in admission compared with those of lower injury level. Patients with C5-6 injuries are more likely to receive power equipment.

**Clinical Relevance :** It is reasonable to address both manual and power WC training with individuals that have C5-C8 tetraplegia. There are multiple factors associated with ultimate prescription decision. Future outcome data analysis will be helpful in determining optimal equipment utilization and client satisfaction.

**TITLE:** Effects of Ventriculoperitoneal Shunt on Gait Performance in People with Normal Pressure Hydrocephalus

**AUTHORS/INSTITUTIONS:** S. Kim, J.B. Stephenson, School of Physical Therapy & Rehabilitation Sciences, University of South Florida, Tampa, FL; S. Agazzi, N. Abel, Department of Neurosurgery, University of South Florida, Tampa, FL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Individuals with normal pressure hydrocephalus (NPH) commonly experience gait disturbance, urinary incontinence, and memory loss. Ventriculoperitoneal shunt (VPS) surgery which drains cerebrospinal fluid away from the ventricles is used to treat these symptoms. Although benefits of the surgery are reported, objective results of gait performance to identify the effects of the surgery are very limited. The literature suggests that objective gait measures would provide important knowledge to better understand the nature of NPH gait, as well as changes in gait pattern after intervention. Therefore, the purpose of this study was to identify the effect of VPS surgery on gait performance in people with NPH by performing systematic gait assessments using the GAITRite Walkway System.

**Number of Subjects :** Ten individuals (68-94 years old) clinically suspected of NPH participated in this study.

**Materials/Methods :** All subjects underwent high volume cerebrospinal fluid drainage (40 ml) via lumbar puncture. Six subjects had a VPS surgery based on magnetic resonance imaging, neuropsychological tests, and gait assessments before (baseline) and immediately after lumbar puncture. Additional gait assessments were performed during comfortable walking at 1, 4, and 9 months after VPS surgery using the GAITRite Walkway System. No statistical analysis was conducted due to the limited number of subjects who completed the follow-up tests.

**Results :** The subjects showed noticeable increases in gait velocity and cadence at the 1 month follow-up test compared to baseline (from 0.51 to 0.67 m/s and from 94.4 to 98.2 step/min, respectively). Their stride length and step length also increased compared to baseline (from 65.3 to 82.2 cm and from 32.6 to 41.0 cm, respectively). Their double support time decreased compared to baseline (from 42.6 to 36.7% of gait cycle). The subjects showed further improvements at the 4 month follow-up test. Their gait velocity, cadence, stride length, step length, and double support time were 0.76 m/s, 103.1 step/min, 89.1 cm, 44.4 cm, and 32.5% of gait cycle, respectively. The subject who completed all three follow-up tests showed even more improvement in gait velocity (0.85 m/s) and cadence (112.6 step/min) at the 9 month follow-up test and maintained the other gait variables.

**Conclusions :** Our preliminary results show that VPS surgery can help improve gait performance in people with NPH. The results suggest that instrumented gait assessment using the GAITRite Walkway System can provide an objective measure of gait improvement after VPS surgery.

**Clinical Relevance :** Objective gait assessment will help clinicians more accurately identify changes in gait performance after intervention in people with NPH.

**TITLE:** Predicting functional recovery in persons with chronic stroke using navigated transcranial magnetic stimulation  
**AUTHORS/INSTITUTIONS:** K. Dunning, V. Hill, E. Schaefer, C. Spinner, S. Page, Rehabilitation Sciences, University of Cincinnati, Cincinnati, OH; S. Israel, Neuroscience Graduate Program, University of Cincinnati, Cincinnati, OH; P. Boyne, J. Wilkerson, K. Fisher, Drake Center, Cincinnati, OH; J. Laine, Nexstim Ltd, Helsinki, FINLAND; J. Karhu, University of Kuopio, Kuopio, FINLAND; B. Kissela, Department of Neurology, University of Cincinnati, Cincinnati, OH;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Previous studies suggest recovery after stroke is associated with corticospinal tract (CST) integrity. CST integrity can be assessed using transcranial magnetic stimulation (TMS). The purpose of this study is to determine the validity of TMS to predict recovery potential in response to rehabilitation among persons with moderate to severely affected upper extremity (UE). This study is ongoing and will enroll 20 subjects. This analysis consists of 7 subjects enrolled to date.

**Number of Subjects :** 7 subjects, average age 64.9 years old, average 3.5 years post stroke (range, 1.8 to 7.4 years), 4 females.

**Materials/Methods :** Eligible subjects had action research arm test <10. A brain MRI for each subject was obtained for use with the navigated TMS system. Three hand/wrist muscles were tested for motor evoked potential (MEP): Abductor Pollicis Brevis (APB), First dorsal interosseous (FDI), and Extensor Digitorum Communis (EDC). CST integrity was defined as having at least 1 MEP in any of these 3 muscles. All subjects participated in UE task specific training using an electrical stimulation neuroprosthesis 3 hr/dy, 5 dy/wk for 3 wks. Outcomes were measured before and after the intervention by a blinded rater: the UE Fugl Meyer (FM), Stroke Impact Scale (SIS) hand sub-scale and kinematics. Video kinematics measured degrees of wrist and finger (digit two) extension during 2 active movements: 1) wrist extension with closed hand and; 2) wrist extension with an open grasp. Wilcoxon rank exact test was used to compare changes in outcomes between groups. Statistical significance was set at  $p < .05$ .

**Results :** Among the 7 subjects, 3 had MEPs: 1 subject with EDC; 1 with APB and FDI; and 1 with EDC, APB and FDI. FM increased more in subjects with MEPs (17.3 to 20) compared with the non-MEP group (15 to 15.5) [ $p = .40$ ]. SIS hand subscale increased in subjects with MEPs (8.3 to 16.7) and decreased in subjects without MEPs (11.3 to 8.8) [ $p = .20$ ]. Wrist extension with closed hand increased more in subjects with MEPs ( $12.3^\circ$  to  $17.4^\circ$ ) compared with subjects without MEPs ( $6.2^\circ$  to  $9.6^\circ$ ) [ $p = 0.31$ ]. Wrist extension with open grasp increased among subjects with MEPs ( $12.9^\circ$  to  $17.6^\circ$ ) and decreased among subjects without MEPs ( $4.0^\circ$  to  $3.0^\circ$ ) [ $p = .03$ ]. Finger extension with closed hand increased more in subjects with MEPs ( $7.1^\circ$  to  $10.7^\circ$ ) compared with subjects without MEPs ( $11.7^\circ$  to  $12.3^\circ$ ) [ $p = .43$ ]. Finger extension with open grasp increased among subjects with MEPs ( $7.4^\circ$  to  $7.6^\circ$ ) and decreased among subjects without MEPs ( $5.5^\circ$  to  $3.6^\circ$ ) [ $p = .43$ ].

**Conclusions :** Although this study is limited by small sample size, it suggests that subjects with hand/wrist MEPs demonstrated greater increases in active wrist extension (especially with an open grasp) from this 3 week therapy intervention.

**Clinical Relevance :** Clinical Relevance: The ability to predict response to specific types of rehabilitation treatments may be helpful in selecting the most appropriate treatments for persons with stroke.

**TITLE:** Home Balance Exercises for Locomotor and Balance Performance in Adults with Cerebellar Ataxia: A Pilot Study.

**AUTHORS/INSTITUTIONS:** J.L. Keller, Motion Analysis Lab, Kennedy Krieger Institute, Baltimore, MD; A. Bastian, Neuroscience, Johns Hopkins University School of Medicine, Baltimore, MD;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Physical therapy intervention is the primary treatment for gait ataxia and imbalance in individuals with cerebellar damage. Our aim was to determine if a home balance exercise program is feasible for improving locomotor and balance abilities in these individuals.

**Number of Subjects :** Ten subjects with cerebellar ataxia.

**Materials/Methods :** Paradigm: All subjects performed a home-based balance exercise program for 6 weeks. Two sets of baseline measures were taken two weeks apart to assess repeatability of our measures. One mid-training visit was used to re-evaluate the program progression. Subjects logged their exercise performance both in frequency and degree of balance challenge. Subjects were retested after the 6 weeks of training and again 4 weeks later to assess retention. Assessment tools: Both laboratory and clinical measures were taken. Our primary outcome measure was walking speed. In the laboratory, subjects performed static standing on a force plate and joint motion was recorded in 3-D as they walked as fast as possible over ground(Optotrak). Clinical tests included: 1) the dynamic gait index (DGI), 2) the timed up and go test (TUG), 3) the functional reach test (FR), and 4) the activities specific balance confidence scale (ABC). The neurological exam included the international cooperative ataxia rating scale (ICARS).

**Results :** Ten subjects, mean age 50.7 (SD 13.1, 4 women) participated. ICC for most of our measures was high: Walk speed 0.92, Stride Length 0.85, Static standing 0.99, ICARS (total) 0.94, DGI 0.67; TUG 0.85; FR 0.97; ABC 0.98. Using repeated measures ANOVA, the group showed a significant improvement across baseline, 6 week and 10 week visits in walk speed ( $P<0.01$ ), stride length ( $P<0.05$ ) and DGI ( $P<0.001$ ). Post-hoc comparison in these three measures revealed that significant rehabilitation effects occurred in the 6 week training period and were retained one month later. There was not a significant change across the other measures for the group, though there were individual subjects who improved on the various measures. Regression analysis indicated that walk speed change in the group was affected significantly only by the extent of balance challenge, and not by age, ataxia severity, or duration of exercise.

**Conclusions :** Improvement in locomotor performance in people with cerebellar ataxia is observable after a six-week home balance exercise program. The exercise program must be designed to provide a significant challenge to the person's balance.

**Clinical Relevance :** Physical therapy intervention directed at improving locomotor performance via balance exercise in people with cerebellar ataxia is appropriate. These preliminary results suggest the intervention must challenge the patient's balance to show a measurable change. Some individuals may require direct therapy services, rather than a home program, to provide a safe means to challenge their balance effectively.

**TITLE:** Determining clinically important difference on the Tinetti Performance Mobility Assessment (POMA) in people with stroke

**AUTHORS/INSTITUTIONS:** J. Canbek, G.D. Fulk, L. Nof, J.L. Echternach, , Nova Southeastern University, Fort Lauderdale, FL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** People with subacute stroke typically have rapid and large changes in ability to maintain balance while undergoing inpatient physical therapy. The Tinetti POMA is a valid and reliable tool to measure balance ability in people with subacute stroke. However, there is no information about how much change on the Tinetti POMA represents a clinically important amount. The purpose of this study was to estimate minimal clinically important difference (MCID) on the Tinetti POMA in persons who have experienced stroke and are undergoing inpatient rehabilitation using 3 different anchors of change: 1) participant rating of change in balance ability; 2) physical therapist perception of patient change in balance ability; 3) achievement of  $\geq 17$  point change on the motor domain of the Functional Independence Measure (FIM.)

**Number of Subjects :** 43

**Materials/Methods :** Participants were recruited if they had a first documented stroke and were receiving physical therapy during inpatient rehabilitation. Participants were excluded from the study if they had a history of a previous stroke, were medically unstable, were non-English speaking or were unable to walk without assistance prior to the current stroke event. Tinetti POMA and motor FIM scores were collected at admission to and discharge from inpatient rehabilitation. Global Rating of Change (GROC) scores were collected at discharge from inpatient rehabilitation. A score of 6 ("a great deal of change") on a Global Rating of Change scale and achievement of  $\geq 17$  point change on the motor FIM were used to dichotomize participants into those who had important change in walking ability and those who did not. Receiver operating curves were constructed to estimate important change values for Tinetti POMA using the three anchors.

**Results :** The mean Tinetti POMA score for the cohort was 6.6 (5.5) points. 67% of the participants experienced  $\geq 17$  point change on the motor FIM. MCID of the Tinetti POMA was estimated to be 7 points (AUC=0.743, sn/sp=79%/64%, LR+=2.18, LR-=0.32) anchored to motor FIM change. MCID of the balance domain was estimated as 4 points (AUC=0.653, sn/sp=83%/57%, LR+=1.93, LR-=0.30) and MCID of the gait domain was estimated as 3 points (AUC=0.701, sn/sp=79%/64%, LR+=2.20, LR-=0.32.)

**Conclusions :** MCID of the Tinetti POMA was estimated to be 7 points. For this sample, motor FIM change appears to be a better anchor to distinguish patients who have had important change in balance ability than use of a GROC.

**Clinical Relevance :** People with stroke who experience change on the Tinetti POMA of 7 points or greater during inpatient rehabilitation are likely to experience an important change in functional mobility. Physical therapists can use this information as a reference value for setting goals and interpreting progress in individual patients who are undergoing inpatient rehabilitation after stroke.

**TITLE:** Sleep Parameters Associated With Off-line Learning in Individuals with Stroke: A Preliminary Report

**AUTHORS/INSTITUTIONS:** C.F. Siengsukon, A.J. Sharman, Physical Therapy and Rehabilitation Science, University of Kansas Medical Center, Kansas City, KS; S. Stevens, Neurology, University of Kansas Medical Center, Kansas City, KS;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Recent studies have demonstrated sleep promote motor skill learning in individuals following stroke. However, the mechanisms driving sleep-dependent off-line motor skill learning in individuals with stroke remains unknown. Certain sleep parameters have been associated with sleep-dependent off-line motor skill learning in young healthy individuals, including stage 2 non-REM sleep. We hypothesize that stage 2 non-REM sleep will be associated with sleep-dependent off-line motor skill learning in individuals following stroke.

**Number of Subjects :** Two individuals with stroke (average age 65.5 year old) slept for three nights in the sleep laboratory for polysomnographic recording.

**Materials/Methods :** The first night of polysomnographic recording in the sleep laboratory served as an acclimation night. The second night served as a baseline night. The morning of the third day, participants practiced a continuous tracking task. The night after practice, they returned to sleep in the sleep laboratory for polysomnographic recording. The morning of the fourth day, participants underwent a retention test. An off-line learning score was calculated from the last practice block to the retention block.

**Results :** Both subjects demonstrated an improvement in performance on the tracking task following a night of sleep as demonstrated by a reduction in tracking error (average reduction in RMSE 1.5 degrees). Contrary to our hypothesis, the participants demonstrated a reduction in the amount of time spent in stage 2 non-REM sleep (average reduction 6%), but demonstrated an increase in the amount of time spent in slow wave sleep (average increase 8%).

**Conclusions :** These findings confirm that individuals with stroke benefit from sleep to promote motor skill learning. Furthermore, results suggest slow wave sleep may be associated with sleep-dependent off-line motor learning in individuals with stroke. Further testing is warranted to confirm these preliminary findings.

**Clinical Relevance :** Understanding which sleep parameters promote off-line motor skill learning in individuals with stroke could lead to the manipulation of sleep parameters to enhance motor learning and possibility recovery following stroke.

**TITLE:** Intensive Locomotor Training and Changes in Non-Locomotor Activity in Two Individuals Post Stroke

**AUTHORS/INSTITUTIONS:** D. Straube, T. Hornby, Physical Therapy, University of Illinois Chicago, Chicago, IL; C. Kinnaird, C. Holleran, A. Echaz, E. Wagner, K. Rodriguez, E. Narducci, , Rehabilitation Institute of Chicago, Chicago, IL;

**ABSTRACT BODY:**

**Background & Purpose :** Despite data to suggest improvements in walking ability in patients with stroke following intensive locomotor training (LT), observational studies of therapy suggest significant time is dedicated to non-ambulation activities. Further, recent data suggest that non-locomotor activities such as static balance and strength may be improved with LT strategies. Few studies have explicitly investigated the effects of LT on these non-walking tasks. The aim of the present case report was to describe the effects of high intensity LT on balance and sit-to-stand performance in two individuals post-stroke.

**Case Description :** Two subjects with chronic stroke (> 6 mo duration) with moderate to severe gait impairments (gait speeds were 0.12 m/s and 0.45 m/s) completed the protocol. Subjects completed 40 sessions of LT over 8 weeks, with a focus on achieving 70-80% of heart rate reserve. LT over the 1st two weeks focused on treadmill stepping with no weight support or therapist assistance. LT during the last 6 weeks focused on multidirectional walking and obstacle avoidance while stepping continuously on a treadmill or overground, as well as continuous reciprocal stair training. Non-locomotor activities (balance training, sit to stand) were intentionally not a focus of practice over the 8 weeks. Repeated baseline outcome measures were performed prior to LT and following 4 and 8 weeks including the Berg Balance Scale (BBS) and time (seconds) to complete the 5-times sit-to-stand (5XSTS) test. Secondary measures of the 5XSTS included assessment of lower extremity kinematics, kinetics, and electromyographic activity (vastus lateralis).

**Outcomes :** Both subjects tolerated the LT well, with no adverse events occurring. Performance on the BBS improved from 30 to 36 pts and 43 to 46 pts in the two subjects. For the 5X STS testing, subjects performed the task 33%-50% faster than pre-testing (63 to 31 s and 19 to 13 sec). Peak velocities during sit to stand ascent and descent increased by 6%-10% following training, with increased normalized EMG and knee power observed in the paretic knee.

**Discussion :** Dynamic, high intensity LT, an arguably high level skill, may appear to provide benefit in increased lower extremity strength, balance and sit to stand task performance. The findings suggest the need for further studies with larger samples sizes and more rigorous design.

**TITLE:** Quantification of Gait Performance in People with Friedreich Ataxia

**AUTHORS/INSTITUTIONS:** J. Stephenson, S. Kim, School of Physical Therapy & Rehabilitation Sciences, University of South Florida, Tampa, FL; T. Zesiewicz, Department of Neurology, University of South Florida, Tampa, FL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Damage to the cerebellum causes walking impairment with inability to control the timing, force and quality of movement. People with cerebellar ataxia experience a gait pattern characterized by unsteadiness, widened stance, lateral veering and uncoordinated steps. This gait pattern, a hallmark of cerebellar ataxia, has been widely studied. Friedreich Ataxia (FA) is the most common inherited degenerative disease of the cerebellum, however, to our knowledge, no studies have thoroughly examined gait performance in people with FA. To better understand functional impairments in people with FA, it is necessary to systematically examine their gait patterns. The purpose of our study was to identify whether the gait pattern of people with FA is significantly different from that of healthy people matched for age, gender, height, and weight.

**Number of Subjects :** Four people diagnosed with FA (26±6 years) and 4 age-, gender-, height- and weight-matched healthy controls (26±7 years) participated in this study.

**Materials/Methods :** All subjects underwent gait assessment using the GAITRite Walkway System. Spatiotemporal gait variables including gait velocity, stride length, double support time, and gait variability (defined as standard deviation of stride length) were assessed to compare gait performance of the two groups. Paired t-test was conducted to identify group differences.

**Results :** Gait velocity in the FA group (0.46 m/s) during comfortable walking was significantly slower than that in the control group (1.35 m/s) ( $p < 0.01$ ). The FA group also showed significantly shortened stride length (79.0 cm) compared to the control group (136.4 cm) ( $p < 0.01$ ). The FA group had a prolonged double support time (35% of gait cycle) compared to the control group (22.5% of gait cycle) ( $p < 0.05$ ). In addition, variability of stride length in the FA group (12.34cm) was notably greater than that in the control group (2.73 cm) ( $p < 0.01$ ).

**Conclusions :** Our preliminary results show that people with FA have significantly impaired gait patterns which include decreased gait velocity, shortened stride length, and increased variability of stride length. The results suggest that systematic gait measurement and analysis are important to properly understand gait impairment in people with FA.

**Clinical Relevance :** Systematic gait assessment can provide an accurate understanding of gait impairment in people with FA.

**TITLE:** Relationship between personal factors and behavioral outcomes after locomotor rehabilitation intervention post-stroke.

**AUTHORS/INSTITUTIONS:** A.E. Embry, S.A. Kautz, , Medical University of South Carolina, Charleston, SC; M.G. Bowden, C.M. Gregory, , Veterans Affairs, Ralph H. Johnson Medical Center, Charleston, SC; A.L. Behrman, , Department of Physical Therapy, University of Florida, Gainesville, FL; R.R. Neptune, , Department of Mechanical Engineering, University of Texas, Austin, TX;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Post-stroke locomotor rehabilitation programs are effective in improving ambulatory behavioral outcomes. However, little is known about the effect of training on quality of life (QOL) measurements or how QOL relates to different levels of outcomes (body structure/function, activities, and participation). The Stroke Impact Scale (SIS) is a measure of perceived function and QOL specific to those post-stroke. Our purpose is to determine if different elements of perceived health status (personal factors) relate differently to body structure and function-based, activity-based, or participation-based outcome measures as defined by the ICF model. We hypothesize relationships between physical domain measures and body structure/function (Fugl-Meyer), recovery measures with activity scores (walking speed), and participation measures and amount of home and community walking (steps/day).

**Number of Subjects :** Thirty-two individuals with chronic hemiparesis (22 males; 58.5±12.8 (SD) years of age; 18 with left hemiparesis) participated in the study.

**Materials/Methods :** Each individual participated in a 12-week intervention comprised of 36 sessions of locomotor training including step training on a treadmill with body-weight support and assistance from manual trainers as well as overground training. Primary variables of interest were the Stroke Impact Scale (SIS); a nine domain questionnaire using a 1-5 Likert scale for domains 1-8 and 0-100% for domain 9: self-selected gait speed, lower extremity Fugl-Meyer, and steps/day. Pre-post data were analyzed utilizing paired t-tests across all domains and outcome measures and Pearson Correlations compared domains of the SIS to gait speed, FM, and steps/day.

**Results :** Paired t-tests reveal no significant differences in any individual item of the SIS, the FM, or steps/day. Self-selected walking speed increased significantly from pre (0.47 m/s) to post (0.69 m/s) ( $p<0.001$ ). Pre-training, the strength domain of the SIS had the highest correlation with the FM ( $r=0.561$ ,  $p=0.001$ ), participation had the highest correlation with steps/day ( $r=0.668$ ,  $p<0.001$ ), and percent recovery had the highest correlation with walking speed ( $r=0.407$ ,  $p=0.025$ ). Post-training, percent recovery had the highest correlation with all three measures ( $r> 0.541$ ,  $p<0.004$ ), implying that perceived percentage recovery is a critical factor in rehabilitation outcomes.

**Conclusions :** Individuals that undergo a locomotor rehabilitation program demonstrate large correlations between perceived recovery and measures of body structure and function, activity, and participation implying that locomotor rehabilitation includes a component of psychological wellbeing that is that is missed in traditional outcome measures.

**Clinical Relevance :** Personal factors are inconsistently measured in the clinic, and may be a critical element of locomotor recovery. Addressing personal factors as an adjunctive treatment with locomotor rehabilitation may improve overall locomotor outcomes.

**TITLE:** Flexor carpi radialis H-reflex inhibition correlates with impaired grip strength post-stroke

**AUTHORS/INSTITUTIONS:** C.P. Phadke, Spasticity Research Program, West Park Healthcare Centre, Toronto, Ontario, CANADA; C.T. Robertson, Sport and Exercise, Jacksonville University, Jacksonville, FL; E.G. Condliffe, Physical Medicine and Rehabilitation, University of Alberta, Edmonton, Alberta, CANADA; C. Patten, Physical Therapy, University of Florida, Gainesville, FL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Grip strength is frequently used clinically as a proxy for global assessment of motor function, including severity of hemiparesis post-stroke. Effective force production involves integration of descending neural drive with afferent signals in the spinal circuitry. Position-specific tasks, such as power grip, involve an optimal degree of spinal inhibition to maintain an appropriate position and effective muscle length-tension relationships. While it is known that stroke impairs both grip strength and spinal inhibition, their mutual relationship has not yet been explored. Moreover, the reliability of assessing spinal inhibition in the upper-extremity is unknown. Here we: 1) investigated the correlation between flexor carpi radialis (FCR) H-reflex inhibition and grip strength after 2) establishing the reliability of FCR H-reflex inhibition in non-disabled and stroke participants.

**Number of Subjects :** Eighteen persons post-stroke (mean +/- SD: age 63 +/- 13 years; 6 +/- 5 years post-stroke; 13 males) and sixteen non-disabled individuals (age: 60 +/- 13 years) participated.

**Materials/Methods :** FCR H-reflexes were tested on two separate days by stimulating the median nerve and recording responses via surface electromyography. Inhibition was tested by conditioning the FCR H-reflex (H) with radial nerve stimulation at two different inter-stimulus intervals: 13 ms (presynaptic Ia inhibition-PSI) and 0 ms (reciprocal Ia inhibition-RI). Reflex inhibition was expressed as the reduction in conditioned relative to unconditioned H-reflex amplitude. Pearson's correlation coefficient, intraclass correlation coefficients [two-way mixed model-ICC (1, 2)], and standard error of measurement (SEM) were calculated.

**Results :** A strong positive correlation ( $r = 0.70$ ;  $p < 0.05$ ) was revealed between paretic grip strength and PSI, while a strong negative correlation ( $r = -0.60$ ,  $p < 0.05$ ) was revealed between paretic grip strength and PSI on the unimpaired side. RI and paretic grip strength were not correlated. Relative reliability (ICCs) ranged from good to excellent ranging from 0.61-0.78 in both stroke and non-disabled participants. SEM was low ranging from 10-19% (stroke) and 15-20% (non-disabled).

**Conclusions :** H-reflex techniques provide a non-invasive approach to study modulation of spinal inhibitory mechanisms, which are impaired post-stroke. Our results establish the reliability of two forms of reflex inhibition in post-stroke and non-disabled individuals enabling us to assess neurophysiological changes pre- and post-therapy.

**Clinical Relevance :** The correlation between reduced PSI and impaired grip strength reveals the potential contribution of PSI to force production and particularly, position-specific control of force. Our findings motivate further research to understand recovery of force production mechanisms following neurorehabilitation.

**TITLE:** Evaluation of an MS Educational Track for Physical Therapy Students

**AUTHORS/INSTITUTIONS:** A. Rosenberg, C.M. Eicher, A. Fay, K. Gore, M. Mahon, K. Thomas, L. Johnston, Physical Therapy, UNC-Chapel Hill, Cary, NC; D. Meyer, Physical Therapy, UNC Hospitals, Chapel Hill, NC; K. Gooch, Eastern Chapter, National Multiple Sclerosis Society, Raleigh, NC; E. Byrne Gaskins, , Raleigh Neurology, Raleigh, NC;

**ABSTRACT BODY:**

**Purpose :** The Education and Scholarship Track in Multiple Sclerosis (MS) is a unique collaboration between the University of North Carolina (UNC), Division of Physical Therapy (PT) and the Eastern North Carolina Chapter of the National MS Society. The curriculum was created in response to a local need for PTs who have expertise in the management of the neurological and psychosocial needs of patients living with MS.

The goal is to enhance the MS-related competencies of an annual cohort of Doctor of Physical Therapy (DPT) students. The desired outcome is to graduate DPT students who have a skill competency base specific to MS and to expand the current evaluation format to include a report of an advanced outreach level of scholarship-related activities.

**Description :** This 2-year track focuses on 5 elements: didactic learning, clinical experiences, service, advocacy, and education/training instruction. Scholars tailor class projects and readings to focus on MS. Clinical experiences provide opportunities to work with PTs, neurologists, and researchers who have a focus on this population. Scholars participate in community service opportunities including MS Society events, board meetings, and educational presentations for support groups. The track is evaluated using qualitative and quantitative measures including: The MS Competencies Rating Scale\*, MS Activity Tracking Form, and qualitative feedback from MS/DPT Scholars and graduates, patients, and interdisciplinary preceptors.

**Summary of Use :** Evaluation outcomes indicate increased student competencies in MS specific knowledge and skills. Student competencies indicate a change from a pre-program likert scale rating of “below average” to a mid-program rating of “average” to “above average” in several domains. Evaluation findings reflect program expansion beyond eastern NC as evidenced through scholar and graduate delivery of web-based modules, teleconferences, and workshops.

**Importance to Members:** It is our goal that this curriculum will serve as a national education model for other universities seeking to advance the competencies of DPTs to provide services for individuals with MS.

**TITLE:** Home discharge from inpatient rehabilitation with a peroneal functional electrical stimulation orthosis post-stroke

**AUTHORS/INSTITUTIONS:** P. Boyne, E. Patton Wasik, , Drake Center, Cincinnati, OH; K. Fisher, K. Dunning, , University of Cincinnati, Cincinnati, OH; K. McBride, , Bioness, Valencia, CA;

**ABSTRACT BODY:**

**Background & Purpose :** Peroneal functional electrical stimulation (pFES) improves gait for persons with chronic hemiparesis, yet there is little research examining the effects of pFES early after onset, when restorative interventions may have the greatest potential for impact. Theoretically, discharge from inpatient rehabilitation with pFES may facilitate continued motor return, but the feasibility of this strategy has not been previously reported. The purpose of this clinical case report was to describe the outcomes and feasibility of home discharge with a pFES orthosis for a person with recent stroke.

**Case Description :** A 65 year old male presented to inpatient rehabilitation with left hemiparesis 4 days post brainstem decompression and clipping for a carotid aneurysm. At post op day (POD) 19, the patient was thought to be a good candidate for a pFES orthosis (including home discharge): he had foot drop but good stance phase knee control and medio-lateral ankle stability; he had a good response to pFES; he had strong family support and; he was able to follow instructions. pFES use was incorporated into gait training and non-therapy time (cyclic stimulation, training mode) during his inpatient stay and was continued after discharge home. Gait speed (10m walk test), Timed Up and Go (TUG) and the Six Minute Walk Test (6MWT) were assessed with and without pFES. Feasibility of home discharge with the pFES orthosis was assessed by monitoring amount of use (internal to the pFES device) and by documenting patient/spouse education, satisfaction and adverse reactions.

**Outcomes :** On POD 18, the patient had no active dorsiflexion and outcomes without pFES were: gait speed 0.18m/s; TUG 56s; 6MWT 64m. On POD 19, he was fitted with a pFES orthosis (Bioness L300). On POD 20, outcomes increased nearly two-fold using pFES: gait speed 0.37m/s; TUG 31s; 6MWT 146m. On POD 27 (discharge date) outcomes had improved both without pFES (gait speed 0.66m/s, TUG 22s, 6MWT 234m) and with pFES (gait speed 0.75m/s, TUG 19s, 6MWT 266m). Education was provided to the patient and his wife on POD 20. His wife demonstrated independent pFES donning/doffing and operation after 20 min of training. She underwent an additional 35 min of training before discharge on skin care, device maintenance and a conditioning protocol. No formal education has been needed since discharge. The patient and his wife reported high satisfaction during inpatient and after discharge. According to the device monitoring system, the patient followed the conditioning protocol as instructed during inpatient and after discharge. To date, the patient has been home for 1 month. He attends outpatient PT 2x/wk so is being monitored for skin condition and amount of use. No adverse reactions were experienced.

**Discussion :** Inpatient use and home discharge with a pFES orthosis is a promising strategy that appears to be feasible for select persons with hemiparesis. Future study is needed to evaluate feasibility and efficacy with a larger sample.

**TITLE:** Comparison of Short-Bursts of Body Weight Supported Treadmill Training and Overground Walking Training on Gait Symmetry in Persons with Chronic Stroke

**AUTHORS/INSTITUTIONS:** S.A. Combs, A. Kalpathi Parameswaran, T. Poole, A. Harmeyer, D. Colburn, L. Brower, Krannert School of Physical Therapy, University of Indianapolis, Indianapolis, IN; A.A. Schmid, , Roudebush VA Medical Center, Indianapolis, IN;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** The purpose of this pilot study was to examine gait symmetry immediately after a short-burst of body weight supported treadmill training (BWSTT) or overground walking training (OWT) with persons with chronic stroke.

**Number of Subjects :** Twenty participants with chronic stroke who walked  $\leq 8$ m/s participated in this single-blind trial and were randomized to either BWSTT or OWT (11 male; mean age  $60.9 \pm 8.3$  years;  $61.2 \pm 48.9$  months post stroke; 8 right hemiparesis).

**Materials/Methods :** Intervention sessions were administered 5 times a week for 2 consecutive weeks, for 30 minutes of walking each session. Both groups followed standardized protocols: BWSTT increased treadmill speed and decreased body weight support; OWT increased speed/distance walked over a level indoor track. Manual and verbal cues were provided for both groups as needed. Using the Borg Rating of Perceived Exertion Scale (RPE) a moderate walking intensity (ratings of 11-14) was maintained throughout intervention sessions, measured at 5 minute increments. Participants were evaluated the week before (pre-test) and after intervention (post-test) by a masked examiner. Outcome measures included: Step length symmetry, stance time symmetry, swing time symmetry, lower extremity section of the Fugl-Meyer Assessment (FMA), and comfortable 10-meter walk test (CWT). Spatiotemporal symmetry was calculated as a ratio of paretic to non-paretic variables. Results were analyzed with a 2X2 mixed model ANOVA,  $p < .05$ . A Bonferroni correction was employed to control for multiple comparisons.

**Results :** No statistically significant differences were found between groups for all measures at pre-test and post-test ( $p > .05$ ). No statistically significant main effects for time were found for step length symmetry or stance time symmetry ( $p > .05$ ). Only the OWT group significantly improved swing time symmetry at post-test ( $p < .05$ ). Both groups increased their FMA scores, but only the BWSTT group demonstrated a significant change ( $p < .05$ ). Both groups demonstrated statistically significant increases in self-selected gait speed on the CWT ( $p < .05$ ).

**Conclusions :** Neither intervention resulted in significant improvements in gait symmetry except the improved swing time symmetry by the OWT group. Although both groups demonstrated improvements in lower extremity motor impairments and gait speed, these changes did not necessarily translate to improvements in gait symmetry. Based on the results of this study, it appears that compensatory walking patterns were reinforced at increased gait speeds, despite providing manual and verbal cues to improve gait quality.

**Clinical Relevance :** BWSTT and OWT at moderate training intensities increased gait speed in these participants with chronic stroke. However, the 2-week duration of the short-burst training dose may not have been long enough to result in substantial changes in the well established gait patterns of the participants with chronic stroke.

**TITLE:** Predictors of sedentary behavior in people with Parkinson disease.

**AUTHORS/INSTITUTIONS:** C. Swank, , Baylor Institute for Rehabilitation, Dallas, TX; M. Peiser, R. Zimmerman, A. Medley, M. Thompson, E. Trudelle-Jackson, , Texas Woman's University, Dallas, TX;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Parkinson disease (PD) progressively robs individuals of physical function and cognitive capacity potentially promoting sedentary behavior. Decreased physical activity (PA) may contribute to neurochemical loss in the nigrostriatal system. The purposes of this study were to assess the PA level in people with PD and the relationship between PA and motor function, cognitive performance, depression and ADL function.

**Number of Subjects :** 20 people with PD (15 male/5 female), average age of 68.45 (range=54-80) years and average duration of PD 8.5 years participated in the study. Hoehn & Yahr (HY) stages ranged from 1-4.

**Materials/Methods :** PA was assessed using a Step Watch™ (Cymatech, Seattle, WA, USA) step activity monitor that participants wore for 3 consecutive 24-hour periods. HY and Unified Parkinson's Disease Rating Scale (UPDRS) were used to assess motor variables, such as rigidity, tremors, gait disturbances, and balance impairments. ADL function was measured by the Schwab & England (SE) scale. Timed Up & Go (TUGalone, TUGmotor, & TUGcognitive) assessed functional performance in single and dual task gait. The Beck Depression Inventory (BDI-II) quantified depression and the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) assessed executive dysfunction. Stepwise multiple regression analysis determined the best predictor of steps/day as well as peak activity index.

**Results :** The mean total UPDRS was 41.7+/-19.0 while the SE scale mean for ADLs was 77%+/-17.2. Functional gait times for TUGalone, TUGmotor, and TUGcognitive were 11.46+/-9.34, 15.08+/-13.81, and 16.63+/-13.72 seconds respectively. While the mean BDI-II score (10.05+/-7.59) fell in the normal range, RBANS mean total scaled score of 88.85+/-19.34 reflected executive function in the 29th percentile. Mean number of steps/day was 3691.3+/-2124.2 (range=832-8259) and mean peak activity index was 34.47+/-10.77. Regression analysis revealed TUGcognitive score ( $R^2=0.54$ ,  $R^2_{adj}=0.51$ ,  $p<0.001$ ) as the only predictor of steps/day. Regression also indicated an overall model ( $R^2=0.77$ ,  $R^2_{adj}=0.74$ ,  $p=0.04$ ) accounting for 77% of the variance with TUGcognitive ( $R^2=0.70$ ,  $R^2$  change=0.70,  $p<0.001$ ) and HY stage ( $R^2=0.77$ ,  $R^2$  change=0.07,  $p=0.035$ ) as significant predictors of peak activity.

**Conclusions :** PA guidelines call for 10,000 steps/day to promote health benefits for an average person. When compared to this recommendation, people with PD are very sedentary. Though PD progression on the HY scale moderates intensity of PA, the ability to perform cognitive dual tasks appears to be predictive of both overall participation and peak activity performance in PA accounting for nearly 54% and 77% of the variance respectively.

**Clinical Relevance :** Mobility in the "real world" is complex and requires cognitive flexibility. Barriers to PA in people with PD are many. However, the capacity to dual task appears to play a significant role in the sedentary behavior of people with PD. Physical therapists should consider integrating dual tasks to decrease barriers and promote participation in PA.

**TITLE:** Task prioritization during dual-task walking in people with Parkinson's disease: testing the "posture second" hypothesis

**AUTHORS/INSTITUTIONS:** V.E. Kelly, A.J. Eusterbrock, A. Shumway-Cook, Rehabilitation Medicine, Univ Washington, Seattle, WA;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** People with Parkinson's disease (PD) have gait impairments that are exacerbated by the performance of a concurrent task. It is not known how people with PD prioritize when walking under such dual task conditions, but it has been proposed that people with PD prioritize "posture-second," putting them at increased risk for falls. The purpose of this study was to examine task prioritization when walking and performing a cognitive task with instructions to focus equally on both tasks. We hypothesized that people with PD would show greater declines in performance of walking compared to the cognitive task under these conditions, supporting the posture-second hypothesis.

**Number of Subjects :** Ten individuals with PD participated (mean [SD] age = 71 [6] years, Hoehn & Yahr stage = 2.0 [0.5]) while in the on-medication state. Data are compared to 5 healthy older adults (HOA; age = 67 [14] years).

**Materials/Methods :** Participants walked under single-task (ST; walking only) and dual-task (while performing an auditory Stroop task) conditions. In dual-task conditions, three different instructions were provided: "perform both tasks as best as you can" (DTequal) versus "prioritize walking" (DTwalk) or "prioritize the cognitive task" (DTcog). Gait speed was the primary outcome for walking. Cognitive task outcomes were response latency and accuracy. Dual task costs (DTCs) for each variable were calculated as the difference between single and dual task performance expressed as a percentage of single task performance. Prioritization was assessed using repeated measure ANOVAs with a between-group factor (PD, HOA) and within-group factors to compare differences between 1) ST and DTequal performance; 2) DTCs for walking and the cognitive task, and 3) all DT conditions (DTcog, DTequal, DTwalk).

**Results :** For both people with PD and HOA, gait speed was slower and response latency was longer under DTequal compared to ST conditions. Cognitive task response accuracy did not change under DTequal compared to ST conditions for either group. There was no difference between DTCs for walking and the cognitive task for either group. For people with PD, walking DTCs were similar under the DTequal and the DTcog conditions, and both conditions had greater DTCs than the DTwalk condition. Instructions did not affect walking DTCs for HOA.

**Conclusions :** There was partial evidence for a posture-second prioritization in people with PD. In people with PD but not HOA, declines in walking performance (measured by DTCs) were comparable under equal focus and cognitive focus instructions, suggesting support for the posture-second hypothesis. However, both groups demonstrated comparable dual-task declines in walking and the cognitive task, which did not support the posture-second hypothesis.

**Clinical Relevance :** Inappropriate prioritization in people with PD may contribute to falls under dual-task walking conditions. Further research is needed to understand factors that influence dual-task prioritization in people with PD and whether prioritization can be modified in this population.

**TITLE:** Intensive Task Specific Locomotor Training: Intensity versus Amount of Practice

**AUTHORS/INSTITUTIONS:** K.R. Nance, , Rehabilitation Institute of Chicago, Chicago, IL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Current literature supports the use of intensive task specific locomotor training in patients following stroke. The amount of daily stepping practice and, more directly, the amount of practice during therapy sessions, appear to contribute substantially to improvements in ambulatory function in the laboratory setting and in the community. In many published reports, the independent effects of the amount vs. intensity (workload or power) of practice on walking recovery are unclear. Namely, in able-bodied individuals, intensity of aerobic (i.e., running) training is thought to be a primary factor contributing to improvements in running performance. The goal of this project was to evaluate the relative contributions of amount vs intensity of walking training on improvements in walking ability in individuals post-stroke.

**Number of Subjects :** 4

**Materials/Methods :** Using a randomized crossover design, 4 individuals with chronic (> 6 mo) stroke participated in two separate, locomotor training (LT) programs. The low-intensity intervention consisted of 4 weeks of LT performed on a treadmill and overground while achieving 30-40% of heart rate reserve. In this arm, large amounts of stepping practice were obtained, yet speed was kept low. At matched speeds, the high-intensity intervention focused on a "resistive" walking environment with the use of weighted vests, leg weights and resistive elastic bands during treadmill and overground walking, with a goal to achieve 70-80% of heart rate reserve. Each intervention was performed 3X/week for 4 weeks, with a 1 month wash-out period between training protocols. Primary dependent variables included self-selected velocity over short distance, distance walked over six minutes, Berg Balance Scale (BBS) and peak treadmill speed.

**Results :** After the first 4 weeks of training, individuals in the low-intensity training group showed minimal changes in clinical measures including Berg balance scale (3-9%), 6 minute walk test (0.5-0.09%), peak treadmill speed (20%). During high-intensity training, similar changes in short distance walking speed and BBS were observed, with greater improvements in distance walked over 6 minutes (17-21%) and peak treadmill speed (33%).

**Conclusions :** Preliminary data suggests that high-intensity training may contribute to larger improvements in walking function as compared to low-intensity training. These findings lend support to the hypothesis that intensity of gait training may be an important variable to facilitate improvements in walking function.

**Clinical Relevance :** The early results of this study indicate that intensity of training, rather than simply amount of walking practice, may be an important parameter to consider when goals of therapy sessions are to improve ambulatory function post-stroke.

**TITLE:** Is the relationship of performance-based measures with self-report measures in persons with multiple sclerosis dependent on level of clinical disability?

**AUTHORS/INSTITUTIONS:** J.M. Wagner, R.A. Norris, Physical Therapy and Athletic Training, Saint Louis University, St. Louis, MO; R.T. Naismith, Neurology, Washington University School of Medicine, St. Louis, MO;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Performance-based measures of standing balance and ambulation have been shown to be related to self-reported balance confidence and walking limitations in persons with multiple sclerosis (pwMS). However, it is unknown if these relationships hold true across different levels of overall clinical disability. The aim of this study was to determine if the level of clinical disability impacts the relationship of performance-based measures with self-report measures in pwMS.

**Number of Subjects :** 43 pwMS (16 m, 27 female; age =  $42.6 \pm 10.4$  years) with mild to severe clinical disability (median Expanded Disability Status Scale (EDSS) score = 3.5) divided into 3 groups based on clinical disability level: mild (EDSS 0-2.5, n = 9), moderate (EDSS 3.0-4.0, n = 22), and severe (EDSS 4.5-6.0, n = 12).

**Materials/Methods :** Subjects completed standardized clinical measures of standing balance (Dynamic Gait Index (DGI) and Four Square Step Test (FSST)), walking capacity (Timed 25-Foot Walk Test (T25FWT) and Six Minute Walk Test(6MWT)), and self-report measures of balance confidence (Activities-Specific Balance Confidence Scale (ABC)) and walking limitations due to multiple sclerosis (12-item Multiple Sclerosis Walking Scale (MSWS-12)). Spearman correlations were used to determine the relation of performance-based to self-report measures for the total sample and for each sub-group.

**Results :** For the total sample, performance-based measures were moderately correlated to self-report measures ( $r = -0.72$  to  $0.74$ ,  $p < 0.05$ ). For the mild clinical disability group, the T25FWT and 6MWT were moderately correlated to self-reported balance confidence (T25FWT vs ABC:  $r = -0.70$ ,  $p < 0.05$ ; 6MWT vs ABC:  $r = 0.60$ ,  $p > 0.05$ ). All other measures had a low to fair relationship with self-report measures. For the moderate clinical disability group, most performance-based measures of standing balance were moderately correlated to self-report measures ( $r = -0.76$  to  $0.61$ ,  $p < 0.05$ ). Performance-based measures of walking capacity had a low correlation to self-reported walking limitations (T25FWT vs MSWS-12:  $r = 0.21$ ; 6MWT vs MSWS-12:  $r = -0.30$ ,  $p > 0.05$ ). For the severe disability group, the performance-based measures had a low to fair correlation to self-reported balance confidence ( $r = -0.04$  to  $0.39$ ,  $p > 0.05$ ). Two performance-based measures were moderately correlated to self-reported limitations in walking (DGI vs MSWS-12:  $r = -0.63$ ; T25FWT vs MSWS-12:  $r = 0.44$ ,  $p < 0.05$ ). All other measures had a low to fair correlation to self-reported walking limitations.

**Conclusions :** The relationship of performance-based measures of standing balance and walking capacity with self-report measures of balance confidence and walking limitations in pwMS is dependent on overall level of clinical disability.

**Clinical Relevance :** These data suggest that some well-established performance-based measures of standing balance and walking capacity may not predict self-perceived balance confidence and walking limitations in pwMS with mild or severe clinical disability.

**TITLE:** Development of evidence-based decision making algorithms for balance and gait outcome measures

**AUTHORS/INSTITUTIONS:** C.L. Szot, E. Tseng, A.L. de Joya, Neurologic Physical Therapy Residency Program, TIRR Memorial Hermann, Houston, TX; J. Seale, Physical Therapy, University of Texas Medical Branch at Galveston, Galveston, TX;

**ABSTRACT BODY:**

**Purpose :** Utilizing standardized outcome measures (OMs) is essential in assessing the effectiveness of PT interventions. Despite the need for quantifying patient outcomes, use of OMs in PT practice continues to be limited. The purpose of this project was to develop decision making algorithms to guide physical therapists (PTs) across all settings in OM selection for balance and gait.

**Description :** A questionnaire was developed and administered to PTs in acute, inpatient, and outpatient neurologic rehabilitation settings to determine factors that impact use and selection of OMs. The questionnaire (n=28) revealed that 64% of PTs reported difficulty selecting an appropriate OM for a patient's functional status, with time and ease of use identified as major influences on OM selection. The majority of PTs surveyed identified gait and balance (86% and 67%, respectively) as high priorities in the patient's plan of care. A literature review of balance and gait outcome measures was performed. Once measures were identified, they were ranked based on psychometric properties and clinical utility using the StrokEDGE Taskforce rating scale. A balance algorithm and a gait algorithm were constructed with these selected OMs based on the patient's current functional status. To assess practical utility of the algorithms, PTs from each clinical setting (n=10) were chosen to participate in a one-month trial. Therapists tracked algorithm usage and completed a survey to evaluate the algorithms. The algorithms were revised based on the results of this trial data.

**Summary of Use :** During the trial the balance algorithm and the gait algorithm were utilized 55 times and 41 times, respectively. Time to complete the algorithms ranged from 5 seconds to 10 minutes (mean=113 seconds). Impaired cognition, medical instability, and functional inappropriateness were reported as barriers to use. All participants agreed that both algorithms were effective in guiding their decision making in OM selection, and 94% reported increased confidence in their choices of outcome measures. Participants agreed that the balance algorithm (100%) and the gait algorithm (78%) were useful for the majority of their patients. Those who were neutral (11%) or disagreed (11%) reported limited ability to use the gait algorithm due to their patients being non-ambulatory. However, it was reported that with improvements in medical stability and function, the ability to use the gait algorithm increased. Eighty-nine percent agreed that both algorithms prompted them to select OMs not used previously.

**Importance to Members:** Literature indicates that PTs believe OMs assist in developing the plan of care and monitoring effectiveness of treatment; however, time constraints, lack of familiarity of measures, and difficulty with OM selection result in inconsistent use. Decision making frameworks have been used in neurologic PT practice to guide clinical judgment. Therefore, an evidence-based, decision making algorithm will aid PTs in selection of OMs with sound psychometric properties and clinical utility.

**TITLE:** Whole-body Vibration as a Conditioning Intervention Prior to Locomotor Training in Individuals with Incomplete Spinal Cord Injury.

**AUTHORS/INSTITUTIONS:** J. Fenton, A. Foster, A. Mills, K. Taylor, Physical Therapy, University of Miami Miller School of Medicine, Miami, FL; E.C. Field-Fote, The Miami Project to Cure Paralysis, University of Miami Miller School of Medicine, Miami, FL;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Prior studies have suggested that afferent input in the form of whole-body vibration (WBV) may influence spinal locomotor and reflex circuits. WBV may be of value as a means to condition the excitability of spinal circuits and “prime” the nervous system in preparation for locomotor training (LT). The purpose of the study was to compare the effects of WBV to a sham stimulation intervention, and to assess the value of WBV as a pre-training conditioning (or “priming”) intervention as an adjunct to locomotor training.

**Number of Subjects :** Six individuals with chronic, incomplete spinal cord injury (>1 year) participated

**Materials/Methods :** Participants were randomly assigned to either a WBV/WBV+LT or sham/sham+LT group. Testing was the same for both groups and was performed on 4 occasions: baseline, after 10 sessions of WBV or sham stimulation intervention, following 12 sessions of either WBV+LT or sham+LT, and follow-up testing 4 weeks after the end of training. This testing schedule allowed us to assess: 1) the effects of WBV compared to sham, 2) WBV vs sham effects as an adjunct to locomotor training, and 3) retention of any effects. Our primary outcome measure was walking speed. We also assessed mobility using the Timed-Up and Go (TUG). We assessed the correlation between walking speed and variables that might influence potential to influence this measure. Spasticity was evaluated using the first swing excursion of the Pendulum Test, and the Spinal Cord Assessment Tool for Spastic reflexes (SCATS) was used to assess clonus, flexor and extensor spastic responses.

**Results :** Relative to baseline values, following the combined intervention mean walking speed decreased for the WBV group while it increased for the sham group (WBV:  $-0.03 \pm 0.04$  m/s, sham:  $0.02 \pm 0.04$  m/s). Baseline levels of spasticity as measured by the Pendulum Test were higher in the WBV group (WBV: 37.05 deg, sham 50.25 deg) and remained higher after locomotor training (WBV: 38.68 deg, Sham: 56.95 deg), and at follow up (WBV: 35.43 deg, Sham: 51.18 deg). There was a moderate correlation between change in walking speed and baseline Pendulum Test values suggesting greater levels of spasticity were associated with smaller improvements in walking speed.

**Conclusions :** Walking speed outcomes in the three participants assigned to the WBV group were different than prior studies in our lab wherein we found improvements in walking speed associated with 12-session course of WBV. In the present study all three individuals in the WBV group had high levels of spasticity, and this may influence responses to locomotor training.

**Clinical Relevance :** Further study is needed to assess the value of WBV as a means of priming spinal circuits in preparation for locomotor training. It is possible that individuals with SCI who have higher levels of spasticity may be less responsive to locomotor training.

**TITLE:** The Scale for the Assessment and Rating of Ataxia gait sub-scale is a valid measure of gait and dynamic balance in persons with multiple sclerosis

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

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Tandem gait is used by physical therapists and physicians as a measure of gait and dynamic balance, yet few standardized clinical scales are available to assess tandem gait. The Scale for the Assessment and Rating of Ataxia (SARA), a validated standardized outcome measure composed of 8 items testing postural control, kinetic limb function and speech, includes an appraisal of tandem gait (SARA-gait). The SARA-gait rates walking on a 0-8 scale with the ability to perform tandem gait as its highest score = 0. The SARA-gait may be a useful clinical tool for examining gait and dynamic balance in persons with multiple sclerosis (pwMS) however this sub-scale has not been validated in this population. The need to do so is strong as ataxia is prevalent in MS and is assessed by various health professionals. The aim of this study is to determine if tandem gait as measured by the SARA-gait demonstrates concurrent validity with standardized clinical measures of gait and dynamic balance in pwMS.

**Number of Subjects :** 39 adults with MS (23 female, 16 male; age  $40.8 \pm 11.4$  years, range 22-62) and minimal to moderate clinical disability (Expanded Disability Severity Scale (EDSS):  $3.5 \pm 1.7$ , range 0-6).

**Materials/Methods :** SARA-gait scores were compared to validated measures of gait and dynamic balance: the Timed 25 Foot Walk Test (T25FWT), Six Minute Walk Test (6MWT), Dynamic Gait Index (DGI), Four Square Step Test (FSST), Multiple Sclerosis Walking Scale-12 (MSWS-12), and Activities-specific Balance Confidence Scale (ABC). Comparison was also made to the EDSS, the standard disability measure in MS.

**Results :** Tandem gait as measured by SARA-gait correlated with all measures of gait and dynamic balance (presented in descending order: DGI:  $r = -.83$ ; FSST:  $r = .72$ ; 6MWT:  $r = -.69$ ; T25FWT:  $r = .69$ ; MSWS-12:  $r = .54$ ; ABC:  $r = -.44$ ,  $p < 0.01$  for all). Additionally SARA-gait correlated with the EDSS:  $r = .70$ ,  $p < 0.01$ .

**Conclusions :** Tandem gait as measured by SARA-gait is supported as a valid measure of gait and dynamic balance in pwMS. SARA-gait can be utilized as a quick clinical assessment tool in MS.

**Clinical Relevance :** Understanding relationships between interdisciplinary tools can enhance coordinated care across professions. SARA-gait is a short, simple test requiring no equipment and little training or space to administer. It demonstrates concurrent validity with more time demanding outcome measures. The SARA-gait has context within a larger ataxia measure that could be employed to expand the assessment of ataxia.

**TITLE:** Comparison of acute rehabilitation outcomes in stroke survivors before and after implementation of a clinical practice guideline for walking recovery

**AUTHORS/INSTITUTIONS:** A.M. Devers, M. Banta, A. Chan, J. Vaught, M. Wilks, Inpatient Rehabilitation, Sheltering Arms Physical Rehabilitation Centers, Mechanicsville, VA;

**ABSTRACT BODY:**

**Purpose :** To describe functional outcomes for stroke survivors in a 40-bed rehabilitation hospital both before and after the implementation of a comprehensive program for walking recovery using advanced technology.

**Description :** Less than half of stroke survivors progress to independent community ambulation, yet walking recovery remains a relevant goal months to years after the initial brain injury. Furthermore, walking ability is known to be related to health outcomes such as risk for heart disease, discharge to nursing homes, and risk for osteoporosis. Even though there are an extraordinary number of research studies investigating walking recovery after stroke, the interventions delivered often focus on one particular technique or piece of equipment in order to produce a controlled experimental environment. These studies have produced no comprehensive practice guideline(s) for gait training for individuals who have sustained a stroke. This facility implemented a clinical program for walking recovery using advanced technology that follows a clinical practice guideline for assessment and intervention decisions. Comparing functional outcomes both before and after the new clinical program was implemented may help determine the effectiveness of the program. The five measures used were Timed Up and Go (TUG), Berg Balance Assessment, Modified Functional Reach (MFR), Six Minute Walk Test (6MWT), and the Dynamic Gait Index (DGI).

**Summary of Use :** This facility has been collecting functional outcomes on patients with a diagnosis of stroke even prior to implementation of this novel program. A small study completed earlier showed that therapists could comply with collecting outcome measures on patients during the rehabilitation process. Studying the change in outcomes from admission to discharge demonstrates improvements in various activities related to walking over the course of inpatient rehabilitation. After a new program for walking recovery was implemented, the change in outcomes was studied again and then compared to the trends in the previous data.

**Importance to Members:** The comparison of outcomes presented informs best practice in physical therapy. The effectiveness of key gait training techniques, often using a particular technology to augment the intervention, have been presented in the literature. This novel approach looks at the systematic application of a combination of techniques to reach the best functional outcomes. Our data will aid in the clinical decision making process for other physical therapists seeking to improve walking recovery in stroke survivors.

**TITLE:** Successful implementation of a modified treatment protocol for an individual with spinocerebellar ataxia: A case report

**AUTHORS/INSTITUTIONS:** L.J. Haack, Pi Beta Phi Rehabilitation Institute, Vanderbilt University Medical Center, Nashville, TN;

**ABSTRACT BODY:**

**Background & Purpose :** Spinocerebellar ataxia is a genetic disorder characterized by progressive incoordination of gait, extremity function, speech and eye movements typical with cerebellar atrophy. The purpose of this case report is to present the successful implementation of a tailored treatment protocol for an individual with spinocerebellar ataxia treated on two separate occasions, three years apart. Protocol adaptation incorporated progressively narrower bases of support, balance on various support surfaces, utilization of sensory re-weighting techniques and gait training on various terrains utilizing compensatory strategies. The limited selections of protocols lead to the modification of the available research to meet the specific needs of this individual.

**Case Description :** A 50-year-old male with spinocerebellar ataxia participated in an eight week specific intensive coordination, balance and gait training program modified from an existing protocol. He presented with impaired dynamic balance during gait with head turns and full body turns along with impaired latency of reaction to surface perturbations by Neurocom computerized testing. This individual demonstrated impaired limits of stability forwards, backwards and rightward correlating with risk for falls. One hour treatment interventions were provided at a frequency of two times per week for two month duration.

**Outcomes :** Outcomes measures noted significant progression to a reduced falls risk score of >19/24 on the Dynamic Gait Index Test ; progression of preferred gait speed to above age matched norms; Neurocom computerized Motor Control Test reactions times to above age matched norms; and Neurocom computerized Limits of Stability Test measures recorded improvement on all conditions. Skilled physical therapy intervention yielded subjective reports of no falls at discharge as compared to multiple falls reported at both rehabilitation admissions.

**Discussion :** An intensively designed coordination training program, designed by Ilg et al, was modified for the specific needs of this individual diagnosed with spinocerebellar ataxia. Provided modifications incorporated various foot positions, support surfaces and facilitation of compensatory techniques not included in the original protocol. Preliminary evidence of a modified therapeutic protocol is offered in a patient diagnosed with degenerative cerebellar disease. Positive outcomes measures indicate the need for continued contributions to the literature regarding effective interventions for patients with this diagnosis.

**TITLE:** Quantification of the flexion and extension synergies at the wrist and fingers of individuals with chronic hemiparetic stroke

**AUTHORS/INSTITUTIONS:** J.P. Dewald, Physical Therapy and Human Movement Sciences, Northwestern University, Chicago, IL; L. Miller, Biomedical Engineering, Northwestern University, Evanston, IL;

**ABSTRACT BODY:**

**Purpose :** The expression of flexion and extension synergies in the paretic upper limb of moderately to severely impaired hemiparetic stroke survivors has been well quantified at the shoulder and elbow. Elbow flexion (EF) and extension (EE) torques and electromyograms (EMG) increase with shoulder abduction (SABD) and adduction (SADD) loads, respectively.

The hand is typically the most impaired of the paretic upper extremity; however, it has been examined most frequently in isolation from proximal joints. The expression of flexion synergy at the hand has been described clinically as wrist (WF) and finger flexion (FF) and has recently been quantified by the authors during a dynamic task performed at 7 SABD loads. The expression of extension synergy at the hand has been described clinically as variable, but may include wrist extension (WE) and FF.

**Description :** The primary goal of this study was to quantify the involuntary behavior of paretic wrist and fingers during SADD torque generation. We hypothesized that increases in SADD torque would lessen WF and FF torque compared to those produced with SABD torques.

We also quantified these synergies elicited by distal activation, examining the effect of performing maximal WF and WE on shoulder and elbow torques. We hypothesized that WF would produce SABD/EF and WE would produce SADD/EE.

2 participants with chronic hemiparetic stroke and 1 control were included. Participants were seated in an experimental chair. The paretic forearm was casted to a 6 degree-of-freedom load cell, and the hand was secured to a wrist and finger torque-sensing device. The limb was positioned in 75° SABD, 90° EF, 40° shoulder flexion, and mid pro-supination. Intramuscular fine-wire EMG were placed into 8 forearm, elbow, and shoulder muscles.

Isometric maximum voluntary torques (MVTs) were generated in eight directions. Subsequently, participants performed 10 trials of submaximal SABD and SADD at each of 16.67, 33.33, and 50% MVT.

**Summary of Use :** WF and WE MVTs produced SABD/EF and SADD/EE, respectively, despite no volitional WE torque achieved by these participants (WF torque was produced for both directions). Interestingly, more WF torque was produced during WE than WF MVT. During submaximal efforts, WF and FF torque increased with both SABD and SADD torques; however WF and FF torques were smaller on average with SADD. The decrease in WF and FF torques were due to lessening of wrist/finger flexor EMG rather than increased extensor EMG.

These preliminary results extend previous work showing the effect of shoulder activation on hand behavior and reveal that SABD and SADD affect torque coupling at the hand differently. Additionally, intent to extend the wrist has an opposite effect on the shoulder and elbow compared to wrist flexion, regardless of wrist torque direction actually produced.

**Importance to Members:** These results quantify the extension synergy at the paretic hand/wrist for the first time, and suggest that studies examining the these joints in isolation may be limited.

**TITLE:** Facial Rehabilitation in a patient with Neurofibromatosis Type II following facial reanimation

**AUTHORS/INSTITUTIONS:** C.P. Norton, Physical Therapy, Pi Beta Phi Rehabilitation Institute At Vanderbilt Bill Wilkerson Center, Nashville , TN;

**ABSTRACT BODY:**

**Background & Purpose :** Neurofibromatosis Type II is an inherited condition characterized by benign tumors of the nervous system. The most common types of tumors are vestibular schwannomas or acoustic neuromas. These tumors are often diagnosed in young adults prior to age thirty and can lead to hearing loss, imbalance and facial weakness or paralysis. With new procedures to restore facial muscle and nerve function, many patients are now able to regain significant facial symmetry and muscle function. This restoration of facial function greatly enhances the quality of life and social interaction of these patients.

**Case Description :** This case presents a 19 year old male college student with cortical blindness and Neurofibromatosis Type II with bilateral internal auditory canal vestibular schwannomas. This represents a more challenging rehabilitation scenario due to the fact that the patient's cortical blindness prevented the use of visual feedback for neuromuscular reeducation of facial muscles. He exhibited preexisting facial weakness since age 5, but at age 18 underwent debulking of the tumor in the right internal auditory canal with a subsequent facial reanimation procedure to restore some facial function. Physical therapy consisted of facial muscle strengthening, scar mobilization, stretching and neuromuscular reeducation with auditory feedback from surface electromyography. The patient participated in a facial rehabilitation program over a 6 month period

**Outcomes :** This individual presented with flaccid facial paralysis on the right following his facial reanimation procedure. He exhibited facial asymmetry at rest and was unable to voluntarily produce a muscular contraction. He also displayed significant soft tissue restrictions at the site of a surgical incision near his mouth. The patient utilized compensatory contractions of the tongue to activate the muscles on the right side of the face and, with auditory feedback provided by SEMG monitoring, eventually he was able to voluntarily produce a smile. His SEMG measures improved from 3 -4 microvolts using compensatory strategies produced by tongue movements to 5 microvolts for voluntary movement to produce a smile. He demonstrated improved facial symmetry at rest and improved ability to use the right sided facial muscles for facial expression, speech and eating.

**Discussion :** SEMG feedback retraining has been utilized for many years to retrain weak muscles. The principal obstacle with this patient was his inability to use visual feedback for muscular retraining. This case study utilizes SEMG with auditory feedback beginning with the production of compensatory movements, progressing to voluntary contractions for strengthening to improve functional use of the facial muscles.

**TITLE:** Brief Clinical Tests Predict 2-year decline in Activities of Daily Living in Early-stage AD

**AUTHORS/INSTITUTIONS:** E.D. Vidoni, J.M. Burns, Neurology, Univ. of Kansas Med Center, Kansas City, KS; S. Billinger, , University of Kansas Medical Center, Kansas City, KS;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Alzheimer's disease (AD) now affects 1 in 10 individuals over 65. Declining independence and changing physical function is a prominent feature of the disease that Physical Therapists may be able to address. However, individuals with AD experience varying rates of decline. The purpose of this study was to identify simple clinical test to identify those individuals with AD who are likely to experience significant functional decline over a 2 year time frame.

**Number of Subjects :** 66 individuals with early-stage AD from the Brain Aging Project, a 2-year observational study of individuals with early-stage Ad.

**Materials/Methods :** Mini-mental State Exam (MMSE) and mini Physical Performance Test (mini-PPT) data were measured at baseline and used a predictor variables in a logistic regression. Change of 9 or more points on the Alzheimer's Disease Cooperative Study Activities of Daily Living Scale (ADCS-MCI-ADL) over 2 years was used as the dependent variable. 9 points reflects an increase in assistance needed on half the measured items.

**Results :** We found that MMSE and mini-PPT could predict decline on the ADCS-MCI-ADL with 80% accuracy (model chi square 9.9 [2], p=0.007)

**Conclusions :** Simple clinical measures, MMSE and mini-PPT, can be used to predict increased functional dependence over the next 2 years.

**Clinical Relevance :** Clinicians who use the MMSE and mini-PPT as part of their regular evaluation of individuals in the earliest-stages of AD can use these tools predict rapid functional decline in the years to come

**TITLE:** Pattern of Nystagmus Predicts Successful Outcome of Canalith Repositioning Procedure: A Case Report

**AUTHORS/INSTITUTIONS:** J.O. Helminski, Physical Therapy Program, Midwestern University, Downers Grove, IL;

**ABSTRACT BODY:**

**Abstract Body :** Background and Purpose: The mechanism of benign paroxysmal positional vertigo involving the posterior canal (PC-BPPV) may be canalithiasis or cupulolithiasis. Canalithiasis may be successfully treated with the canalith repositioning procedure (CRP). During the first 3 positions of the CPR, the particles settle within the PC creating a drag on the endolymph resulting in fluid pressure on the cupula. This results in excitation of the primary afferent and a burst of upbeating and torsional nystagmus in the same direction in the first 3 positions of the CRP. This pattern of nystagmus during the CRP suggests treatment success. If during the 2nd position of the CRP, the particles move toward the ampulla or are stuck on the cupula, the flow of endolymph reverses direction towards the ampulla causing inhibition of the primary afferent and a reversal in the direction of the nystagmus. This reversal suggests treatment failure. The purpose of this case report is to: (1) discuss the application of fluid dynamics associated with PC-BPPV in the prediction of the outcome of the treatment of PC-BPPV based on the ocular nystagmus pattern during the CRP and (2) illustrate the ability to predict the outcome of the CRP with 2 cases.

Case Description: The first patient was a 40 year old female diagnosed with right PC-BPPV based on history and findings on positional testing using video oculography. The patient was treated with 3 cycles of the CRP. During the 1st cycle of the CRP an upbeating and counter clockwise nystagmus was observed in the first, second, and third position of the CRP. The nystagmus was associated with complaints of vertigo. During the 2nd and 3rd cycle, no nystagmus was observed and the patient experienced no vertigo. The second patient was a 45 year old female diagnosed with right PC-BPPV based on history and findings on positional testing using video oculography. The patient was treated with 3 cycles of the CRP. During the all 3 cycles of the CRP an upbeating and counter clockwise nystagmus was observed in the first position of the CRP. In the 2nd and 3rd position a reversal of nystagmus was observed. The nystagmus was associated with vertigo.

Outcomes: At 1 week follow-up, both patients were evaluated with the Dix-Hallpike Test. The first patient had complete resolution of BPPV. The second patient's treatment was a failure and required further treatment.

Discussion: The pattern of ocular nystagmus during the CRP may predict the outcome of the CRP. A pattern of orthotropic nystagmus observed during the first 3 positions of the CRP predicts successful resolution of BPPV. A reversal of the direction of the nystagmus during the 2nd and 3rd position predicts treatment failure based on fluid dynamics within the PC.

**TITLE:** A survey of primary care fall prevention practice for older adults.

**AUTHORS/INSTITUTIONS:** L. Allison, Physical Therapy, East Carolina University, Greenville, NC; J. Painter, Occupational Therapy, East Carolina University, Greenville, NC;

**ABSTRACT BODY:**

**Purpose/Hypothesis :** Physical therapy is an effective intervention to reduce falls in older adults. Physical therapy utilization to decrease falls in older adults is dependent on physician referral practice patterns. The purpose of this study was to explore current primary care provider practice related to fall prevention in older adults.

**Number of Subjects :** Seventy-seven of the 525 surveys were returned, a response rate of 14.7%.

**Materials/Methods :** A list of physicians was acquired from a regional office of continuing medical education. All physicians in non-primary care specialties, and in any specialty unlikely to have a large proportion of older adult patients (e.g., pediatrics, etc.) were excluded. The final list included 525 physicians. A questionnaire was developed by a physical therapist and occupational therapist with expertise in fall prevention. The original survey was subsequently refined following review and feedback from professionals in continuing medical education and survey design/implementation. A written copy of the survey was mailed to the primary care providers; the survey was also posted online. Providers were able to respond anonymously by mail or online according to individual preference.

**Results :** Seventy-seven of the 525 surveys were returned, a response rate of 14.7%. Participants underestimated the percentage of patients age 65 and older who are likely to have actually fallen. Only 28% of respondents routinely screen older adults for fall risk at least annually. The top 'triggers' that cause these primary care providers to initiate a fall risk screen were dizziness (40%), leg weakness (40%), unsteadiness/poor balance (35%), and history of stroke (35%). The most typical fall risk screening processes were verbal questioning (43%) and informal observation (30%), and took less than 5 minutes to perform. The most common follow-up for patients at high risk for falls included a more detailed examination (48%), discussion of a more supportive living situation (47%), prescription of an assistive device for mobility (44%), and prescription for exercise through physical therapy (44%). The great majority (80%) of participants considered fall risk screening to be cost-effective.

**Conclusions :** Primary care providers may underestimate fall rates in individuals over the age of 65. This may be because they do not routinely screen for falls/fall risk, and when they do, their screening process is sub-standard. One of the four most commonly reported follow-up interventions for older adults at high risk for falls was referral to physical therapy, albeit in less than half of the respondents. It is likely that many fall-prone older adults who might benefit from physical therapy services are not referred.

**Clinical Relevance :** The results of this study indicate that physician education is needed, and change in the routine primary care of older adults is required, to improve fall prevention outcomes in primary care practice. One probable consequence of these positive changes would be an increase in appropriate referrals of fall-prone older adults to physical therapy.