TITLE: The Effectiveness of the “Stepping On” Program for Reducing the Incidence of Falls in the Elderly

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Balance and Falls SIG

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ABSTRACT BODY:

Purpose/Hypothesis: One-third of all adults over the age of 65 years fall each year. Falls cost individuals financially, physically, and emotionally. Balance and strength deficits contribute to increasing an individual's fall risk. Studies have shown the efficiency of community-based exercise and education programs on reducing the risk of falling. The Stepping On Program aims toward fall prevention through education, exercise, and shared experiences among participants. The purpose of this study was to determine whether participants in Stepping On experienced an improvement in balance and confidence following completion of the program.

Number of Subjects: 12

Materials/Methods: Twelve participants (10 females, 2 males) recruited from a local Stepping On program completed both pre- and post-testing for this study, mean age of 74 years. Participants attended the 7-week Stepping On Program between March and May of 2017 at a local senior center for a single 2-hour session/week. Participants completed pre- and post-testing surveys (demographics, CDC Fall Risk Checklist, Activities-Specific Balance Confidence Scale, and activity level), Timed Up and Go (TUG) test, Four Stage Balance Test (FSBT), 30-second Sit to Stand (30sSTS) Test, and 10-meter Walk Test (10MWT).

Results: Overall, participants showed improvements in balance assessment scores from Week 1 to Week 7, indicating a decrease in potential fall risk. Significance was p < .01 for all comparisons except FSBT single leg stance and ABC Scale scores. The TUG mean improved from 10.07 seconds to 8.2 seconds, indicating improved mobility. The FSBT tandem stance mean increased by 11 seconds showing improved static balance with a decreased base of support. The 30sSTS test improved an average of 2 repetitions in 10 of 12 participants, indicating increase in leg strength and endurance. Participants also reported increased confidence in their balance, ABC Scale score mean improved 6%; but due to high variability significance was not achieved. Post-test survey indicated that participants found the Stepping On program to be very helpful and educational. There was high attendance and exercise compliance rate among the participants.

Conclusions: Participation in a 7-week multi-faceted group fall prevention program, Stepping On, demonstrated significant positive effects on balance abilities and balance confidence.

Clinical Relevance: Fall prevention has become a hot topic in healthcare with the rapidly increasing elderly population. Stepping On has shown to be an effective method in reducing fall risk and increasing confidence by combining education and exercise. Physical therapists can take a lead role in helping to reduce falls by promoting and/or implementing fall prevention programs such as Stepping On.
Purpose/Hypothesis: The purpose of this study was to measure if alternating, low-frequency, whole body vibration (WBV) increases the results of LSVT BIG® therapy in individuals with Parkinson's disease.

Number of Subjects: The subject was a 77 year old female with idiopathic Parkinson's disease rated as Stage I on the Hoehn & Yahr scale.

Materials/Methods: A quasi-experimental single-subject design was performed that consisted of 3 (A-B-BC) interactive treatment phases lasting 4 weeks each. The baseline phase (A) was followed by a LSVT BIG® intervention phase (B) then a combined LSVT BIG® and WBV (6 Hz) intervention phase (BC). WBV was administered using the Galileo® Med L Chip Research and balance was assessed using the Sensory Organization Test (SOT) on the NeuroCom® SMART Balance Master® and the Mini-BESTest. Data was analyzed visually-graphically and with the 2-standard deviation (2SD) band method between adjacent phases.

Results: Results from the SOT indicated an upward trend with an increase in scores from the first baseline recording (Score of 45) to the last recording in the BC intervention phase (Score of 67). However, no significance was found using the 2SD band method. Mini-BESTest scores increased from the beginning of the baseline (A) phase (Score of 17) to the end of the BC intervention phase (Score of 25). The Mini-BESTest scores exceeded the minimal detectable change (MDC) of 3.5 in the period from the end of the LSVT-BIG® only (B) intervention phase to the end of the LSVT BIG® plus WBV (BC) intervention phase. Furthermore, Mini-BESTest scores improved between the LSVT BIG® only (B) and LSVT BIG® plus WBV (BC) intervention phases using the 2SD band method, with two consecutive data points falling outside of the band.

Conclusions: These results indicate that alternating, low-frequency, WBV added to LSVT BIG® therapy may improve components of balance (anticipatory, reactive postural control, sensory orientation, and dynamic gait) in individuals with Parkinson's disease as indicated by the Mini-BESTest. At the time period between the LSVT BIG® only (B) and LSVT BIG® plus WBV (BC) intervention phases, Mini-BESTest scores improved as noted by exceeding the MDC and the 2SD band method. SOT scores, however, did not have a significant change after the intervention phases.

Clinical Relevance: Though significance was not found with the addition of WBV to LSVT BIG® when measuring balance with SOT, there was significant increase in balance when using the Mini-BESTest. The results of this study indicate that by using low-frequency WBV in addition to LSVT BIG®, an individual with Parkinson's disease may improve functional balance more than with LSVT BIG® alone.
The Relationship Between Cognitive Domains and Gait Performance in People with Mild Cognitive Impairment and Alzheimer’s Disease

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Purpose/Hypothesis: While walking has traditionally been viewed as an automatic process it is becoming increasingly recognized that cognitive processes are required to move through the environment safely and efficiently. Safe and efficient gait, particularly during dual-task gait, requires use of cognitive domains including executive function, visual spatial processing, and processing speed. Importantly, these cognitive domains are susceptible to mild cognitive impairment (MCI) and Alzheimer’s Disease (AD) and may lead to increased risk of disability and/or falls while walking. However, while the implications of cognitive decline on gait are notable, gait is not traditionally a part of the clinical exam in cognitively impaired populations. The purpose of this study is to evaluate the relationship between the cognitive domains involved with dual-task gait in MCI and AD without performing a dual-task itself thus reducing the burden of clinical gait evaluations beyond a single-task gait evaluation. The hypothesis was that worse performance on cognitive domains responsible for dual-tasking would be related to decreased gait velocity during single-task gait. This information may be useful in identifying patients at increased risk for fall and/or mobility disability so that preventative therapies can be prescribed.

Number of Subjects: Forty-three community dwelling adults diagnosed with either MCI or AD.

Materials/Methods: Gait was assessed with participants walking at their usual and comfortable speed over the ProtoKinetics Movement Analysis Gait Mat. Cognition was evaluated using a cognitive battery of tests looking at global cognition as well as the cognitive domains of executive function and visual spatial processing and processing speed. Both student T-tests and correlations were used to evaluate the relationships between gait velocity and cognition.

Results: Forty-three participants, 29 with MCI (mean age 71.55±8.58 years; 51.72% male) and 14 with AD (mean age 72.79±7.53 years; 50% male) were included in the data analysis. No statistically significant difference was found between MCI and AD for age or gait velocity. Global cognition (p<.01) and visual spatial processing (p<.05) were found to be statistically significant between MCI and AD although no statistically significant correlations were found between gait velocity and the cognitive measures/domains.

Conclusions: As expected, our cohort with AD had greater global and visual spatial cognitive deficits than people with MCI. Despite the patients with AD having greater cognitive deficits, gait velocity was statistically similar to those with MCI. These results indicate that a single-task gait evaluation may not be sensitive enough to probe the impact of decreased cognition on overall gait function (e.g. dual-tasking) in cognitive patients.

Clinical Relevance: Because patients with MCI and AD have greater falls risk and higher rates of disability than their healthy peers understanding the gait profile and its implications on falls and disability is critical.
TITLE: Fear of Falling Predicts Future Falls in Older Adults

ABSTRACT BODY:

Purpose/Hypothesis: Multiple performance-based outcome measures exist to assess balance performance and determine fall risk among older adults. Psychological factors are also associated with fall risk, yet can be difficult to assess and are often overlooked. The presence of a fear of falling can be determined by a simple yes-or-no question. The purpose of this study was to determine whether fear of falling could prospectively predict fall status at 12 months in a sample of community-dwelling older adults. A secondary purpose was to determine whether fear of falling was associated with balance performance.

Number of Subjects: Forty-five subjects participated and met the following criteria: age 65 or older and able to: provide informed consent, walk inside the home without help from another person, and live independently.

Materials/Methods: On the baseline test day, demographic and clinical characteristics were collected, including whether the subject had a fear of falling (yes/no). Subjects then completed the Tinetti, Berg Balance Scale (BBS), and Timed Up and Go (TUG). Following baseline testing, interviews were conducted every 3 months for one year to determine the number of falls experienced in the most recent 3 months. Subjects who experienced at least one fall during the 12-month follow-up period were classified as “fallers.” Subjects who reported no falls were classified as “non-fallers.” The Tinetti, BBS, and TUG were administered again after 12 months. Descriptive statistics, independent t-tests, mixed effects ANOVA and standard logistic regression analyses were calculated using SPSS v 24.0.

Results: Of 45 subjects, 16 reported a fear of falling at baseline. There were no significant differences in age (p=0.99) or fall history (p=0.16) between those with and without a fear of falling. Sixteen subjects experienced at least one fall during the 12-month follow-up period and were classified as fallers. Fear of falling significantly predicted future fall status (-2 Log likelihood=53.99, \( \chi^2=4.59, p=0.032 \)). Absence of a fear of falling decreased the likelihood of a future fall (OR=0.25, 95% CI=0.067-0.911). Subjects with a fear of falling scored worse on all 3 balance performance measures, though differences were statistically significant for the Tinetti (p=0.04) and BBS (p=0.03) only.

Conclusions: More than one-third of the community-dwelling older adults who participated in this study reported a fear of falling. Fear of falling prospectively predicted fall status. Additionally, fear of falling was associated with poorer balance performance.

Clinical Relevance: Results of this study suggest that a fear of falling can predict future falls in community-dwelling older adults. While psychological measures of fall risk should not replace those of balance performance, such factors are important components of fall risk and warrant inclusion in a comprehensive balance assessment.
Purpose/Hypothesis: Trunk sway responses following perturbations are critical to develop adequate prevention strategies. It is unclear how postural responses with a handheld task can validly be transferred to treadmill-induced slip perturbations in subjects with chronic low back pain (LBP). The purpose of this study was to investigate trunk reaction time, swing time, step time, and ankle sway measures following three consecutive treadmill-induced slips between subjects with and without recurrent LBP.

Number of Subjects: 69

Materials/Methods: There were 29 subjects with LBP and 40 control subjects who participated in the study. Each participant stood on the treadmill while he/she held a tray to produce a functional task. Three levels of consecutive treadmill-induced slip perturbations were introduced at level 1 (duration: 0.10 sec, velocity: 0.24 degree/sec, displacement: 1.20 cm), level 2 (0.12 sec, 0.72 degree/sec, 4.32 cm), and level 3 (0.12 sec, 1.37 degree/sec, 8.22 cm). The trunk reaction time, swing/step times, and heel strike/toe off angles and velocities were compared between the groups. The reaction time was determined as the time between onset of the treadmill motion and recovery step toe leaves belt. The peak trunk angle and velocity were measured following the perturbations by the inertial measurement unit.

Results: The trunk reaction times were compared at each level of perturbation, and there was a significant delay in the LBP group at level 1 (0.01 ± 0.01 in the control group vs. 0.07 ± 0.03 in the LBP group; t = -2.03, p = 0.04). There were significant delays on trunk reaction time (t = -2.03, p = 0.04), swing time (t = -2.63, p = 0.01), and step time (t = -2.53, p = 0.01) in the LBP group following the level 1 slip perturbation. The groups demonstrated a significant interaction between the levels and ankle sway angles (F = 4.72, p = 0.03), but there was no interaction between the levels and ankle sway velocities (F = 0.07, p = 0.79).

Conclusions: The LBP group was able to compensate for their balance deficits by enhancing control over the ankle strategy following the first perturbation. Only the trunk reaction, swing, and step times were significantly delayed in the LBP group at level 1 and demonstrated a negative relationship with kinematic measures. The novelty of the slip task in the LBP subjects could improve the stepping strategy following perturbation to avoid possible pain recurrence and injury.

Clinical Relevance: The improved postural corrections following low dose perturbations might enhance trunk sway in individuals with LBP. These results provide evidence for rehabilitation strategies like slip perturbation to adapt subjects’ responses to slips. A prospective design for future outcome studies might contribute to a further understanding of the effects of postural control on balance deficits in subjects with recurrent LBP. Further outcome studies with compensatory strategies might be needed to justify fall prevention and recurrence of pain.
For persons with non-vestibular balance deficits, is the Mini-Balance Evaluation Systems Test a clinically useful tool to measure fall risk.

**ABSTRACT BODY:**

**Purpose:** To determine whether the Mini-BESTest is a useful tool for measuring fall risk in persons with non-vestibular balance deficits. This test addresses several aspects of balance, including anticipatory postural adjustments, reactive postural control, sensory orientation, and dynamic gait. The multi-dimensional nature allows therapists to examine many aspects of balance with one clinical tool.

**Description:** Critical appraisal framed by a question was performed. General search for the Mini Balance Evaluation Systems Test was performed to obtain patient populations. Key words were selected to search the following diagnostic groups: non-vestibular balance deficits, Parkinson's Disease, Multiple Sclerosis, Older Adults, End Stage Renal Disease, Cancer Survivors, Cervical Spondylotic Myelopathy, Diabetes, Peripheral Neuropathy, Stroke, Knee Replacement, COPD and Spinal Cord Injury. To be included, articles had to include psychometric data on the Mini-BESTest, data on falls, and subjects with a non-vestibular diagnosis. Exclusion criteria were persons younger than 18 years old, and studies utilizing only the Brief-B Est or BESTest.

**Summary of Use:** Twelve articles met the inclusion criteria. Their levels of evidence varied from 2b-2c. Each study had a population older than 18, and different non-vestibular conditions that affected balance. There were 6 studies involving subjects with neurologic conditions, and 6 studies on subjects with non-neurologic conditions. All studies included both genders. Psychometric data was appraised, including validity, reliability, sensitivity, specificity, minimal detectable change, and cutoff scores. The Mini-BESTest was administered on two different occasions in most of the populations in order to determine the interrater and test-retest reliability. In each study population, psychometric data indicated that the Mini-BESTest was able to determine the presence of balance impairment, but there was limited evidence that the Mini-BESTest could be utilized to predict future fall risk in persons with non-vestibular balance deficits. Only in persons with Parkinson's Disease has the Mini-BESTest been validated as a future fall predictor. However, it has been shown to be useful as a balance measure and for predicting history of falls in other populations, including patients with Stroke, Cervical Myelopathy, Spinal Cord Injury, Multiple Sclerosis, Type 2 Diabetes, COPD, ESRD, and Community Dwelling Older Adults.

**Importance to Members:** The Mini-BESTest can be used to predict future falls in persons with Parkinson's Disease. Cut-off scores to indicate balance impairment have been established for multiple neurologic and non-neurologic diagnoses, but at this time, these scores cannot be translated for use as scores to indicate fall risk. The core measures CPG recently noted that clinically useful variables have been established for the Mini-BESTest, but future research is needed to determine whether the test can be recommended for use across neurologic populations.
Assessing Balance Changes Following an Exercise Program among Middle-Aged Adults

Rana Almarzouki1, Gurinder Bains1, Bruce D. Bradley1, Todd C. Nelson1, Everett B. Lohman1, Noha S. Daher1

Purpose/Hypothesis: Balance is a state that is needed for every human being in order to live independently and safely. Impaired balance can become a serious problem especially when one ages and can lead to falls. A recent study found that approximately 18% of adults aged 45–64 years had fallen in the previous 3 months. The purpose of this study was to examine balance changes in middle-aged adults using the Y Balance Test (YBT) following a home-based exercise program.

Number of Subjects: 52

Materials/Methods: Fifty-two participants with mean age of 54.4±5.4 years and body mass index of 27.7±5.7 kg/m² volunteered for this randomized controlled trial. Participants were randomly assigned to exercise or non-exercise groups at baseline. Participants in the exercise group received an exercise packet with the exercise instructions provided in both written form and DVDs along with log sheets and thera-bands. The exercise program consisted of a combination of balance and strengthening exercises. At weeks four and eight, participants’ balance was measured on the YBT for right and left anterior (RA & LA), posteromedial (RPM & LPM), and posterolateral (RPL & LPL) directions.

Results: Twenty-five participants (48.1%) were in the exercise group and 27 (51.9%) in the non-exercise group. Results showed that there was a significant improvement over time and a significant group by time interaction in all directions (p<0.01). In the exercise group, there was a significant improvement over time in all directions (p<0.001). Bonferroni post hoc comparisons revealed that the improvement was significant between 4 weeks and baseline (p<0.001), 8 weeks and baseline (<0.001), and 8 weeks and 4 weeks (p<0.01). However, there were no significant changes in the non-exercise group (p>0.05). The percent (%) change (8 weeks versus baseline) was significantly higher in the exercise group than in the non-exercise group in the RA (7.7 versus 2.2), LA (8.0 versus 1.9), RPM (11.0 versus 4.1), LPM (12.2 versus 1.8), RPL (13.1 versus 2.0), and LPL (13.1 versus 5.1) directions; p<0.05.

Conclusions: The exercise program, containing a combination of strength and balance exercises, improved balance scores in the exercise group.

Clinical Relevance: A properly designed exercise program that includes strength and balance training can improve balance in middle-aged adults.

ABSTRACT BODY:

Materials/Methods: Fifty-two participants with mean age of 54.4±5.4 years and body mass index of 27.7±5.7 kg/m² volunteered for this randomized controlled trial. Participants were randomly assigned to exercise or non-exercise groups at baseline. Participants in the exercise group received an exercise packet with the exercise instructions provided in both written form and DVDs along with log sheets and thera-bands. The exercise program consisted of a combination of balance and strengthening exercises. At weeks four and eight, participants’ balance was measured on the YBT for right and left anterior (RA & LA), posteromedial (RPM & LPM), and posterolateral (RPL & LPL) directions.

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Conclusions: The exercise program, containing a combination of strength and balance exercises, improved balance scores in the exercise group.

Clinical Relevance: A properly designed exercise program that includes strength and balance training can improve balance in middle-aged adults.
TITLE: Validity and Clinical Utility of the Adult Myopathy Assessment Tool in GNE Myopathy

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Balance and Falls SIG

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ABSTRACT BODY:

Purpose/Hypothesis: GNE myopathy, a rare genetic muscle disease, presents with progressive and skeletal muscle atrophy and weakness, leading to frequent falls, gait aid use, and declining functional performance. The disease progresses to involve all skeletal muscles, but the quadriceps are relatively spared. Outcome measures are needed for clinical assessment and research trials in GNE myopathy. The Adult Myopathy Assessment Tool (AMAT) is a 13-item functional performance test scored 0-45, validated in Spinal Bulbar Muscular Atrophy that provides insights into muscle strength and endurance. The AMAT correlates with several patient-reported outcomes in GNE myopathy, but requires validation compared with objective physical measures. We analyzed natural history data with three objectives: [1] to establish AMAT construct validity with performance and strength measures, [2] to determine if AMAT cut scores discriminate performance when subjects are divided into high, moderate, and low functional groups, and [3] to identify if a relationship exists between gait aid use and AMAT score.

Number of Subjects: 38

Materials/Methods: Thirty-eight participants, 16 male and 22 female, mean age of 40.2 years (±11.0 SD), completed the AMAT, 13 bilateral muscle group quantitative muscle assessment (QMA), timed 6-minute walk test (6MWT), and activities-specific balance confidence (ABC) scale. Functional groups were formed by separating the sample into tertiles, based on AMAT cut scores of 35 and 22. All measures were compared amongst functional groups through ANOVA and Kruskal-Wallis analyses. AMAT score was also analyzed by a receiver-operating characteristic curve to predict gait aid use.

Results: AMAT scores correlated significantly (p < .001) with QMA, 6MWT, and ABC (r = .64 to .78). All performance and strength measures of the high functional group were significantly different from the low and moderate groups, however low and moderate groups were not different. Although total body strength averaged 46.4% of predicted, quadriceps strength averaged 65.4% of predicted and had no association with functional groups. We found high sensitivity of 0.875 and specificity of 0.818 in recommending gait aid use for individuals with an AMAT score below 28.

Conclusions: We established good construct validity and clinical utility of the AMAT for patients with GNE myopathy. Functional performance, walking distance, strength and balance confidence are all impaired in individuals with GNE myopathy. However, when AMAT dropped below 35, a sharp decline in all parameters was evident.

Clinical Relevance: Irrespective of an individual's age or disease duration GNE myopathy can lead to significant functional challenges. We speculate that quadriceps muscle sparing leads to relative preservation of upright mobility as seen on the AMAT sit-to-stand and step-up tasks. This, however, creates a precarious upright mobility safety profile in those scoring < 35 on the AMAT. The Adult Myopathy Assessment Tool may prove useful to identify patients who require gait aide use and more comprehensive rehabilitative care.
Characterizing Functional Challenges in Spinal and Bulbar Muscular Atrophy with the Adult Myopathy Assessment Tool

ABSTRACT

Purpose/Hypothesis: Spinal and bulbar muscular atrophy (SBMA) is a rare progressive neuromuscular disease that affects approximately 1 in 50,000 men. Skeletal muscle weakness leads to frequent falls, gait aid use, increased caregiver support and declining functional task performance and perceived quality of life. The Adult Myopathy Assessment Tool (AMAT) has been validated to assess physical function and muscle endurance in adults with SBMA. This retrospective study had three aims to better characterize functional challenges faced by those with SBMA and determine additional clinical utility of the AMAT. Objectives include (1) identifying the most difficult performance tasks and determining if AMAT cut scores discriminate quality of life and strength in men with relative high, moderate, and low functional performance, (2) determine if an AMAT cut score can predict the need for a gait aid, and (3) explore if the ability to perform a single limb heel raise (SLHR), the most challenging AMAT task in SBMA, discriminates quality of life, strength and gait aid use.

Number of Subjects: 93

Materials/Methods: Ninety-three male participants, mean age of 53.8 years (±11.0 SD), completed the AMAT, Quantitative Muscle Assessment (QMA), and Short Form 36-item quality of life Physical Component Summary (PCS). Low, moderate, and high functional groups were formed by separating the sample using previously published AMAT cut scores. QMA and PCS were compared amongst functional groups through ANOVA analysis. AMAT score was also analyzed by a receiver-operator characteristic (ROC) curve to predict gait aid use. Lastly, QMA, PCS, and gait aid use of those able and unable to perform a SLHR were compared via pair-wise parametric T test, Mann Whitney U test, and chi-square test.

Results: The most challenging AMAT tasks were SLHR, sit-up, and repeated push-ups. AMAT cut scores of 35 and 25 detected significant differences in total strength, however, the lower cut score did not differentiate quality of life. ROC analysis identified a cut score of 30 optimized sensitivity of 0.822 and specificity of 0.750 to predict whether a man with SBMA needs a gait aid. Men who could not perform one repetition of SLHR had significantly weaker ankle plantar flexion, lower extremity and total body strength, required gait aid use more frequently and reported reduced quality of life.

Conclusions: This study characterizes the functional challenges of men with SBMA. The AMAT appears to have clinical utility as cut scores predict gait aid use and discriminate differences in strength and quality of life. Clinical Relevance: AMAT testing can be readily administered in the clinic. A score of less than 30 or the inability to perform a SLHR may indicate a need for gait aid use. Men scoring 35 or greater were significantly stronger and reported greater quality of life scores. Based on functional difficulties, early rehabilitative interventions aimed at maintaining distal leg, core, and upper body strength may be helpful for men with SBMA.
Purpose/Hypothesis: The purpose of this research study is to determine if a short-term personalized intervention program based on a new outcome measure would affect the ability to rise from the floor.

Number of Subjects: Twenty-two participants with various neurological disorders, movement disorders, and/or a history of falls participated in four structured physical therapy sessions; nineteen participants completed the study with three unable to complete the study due to scheduling and health issues.

Materials/Methods: Participants attended four one-on-one sessions at a university based physical therapy clinic. At the initial visit, the participant's efficiency in rising from the floor was measured by a newly developed outcome measure, the Timed Up From the Floor (TUFF), and fall concern was measured with the Falls Efficacy Scale-International (FES-I). Based on observations during the TUFF administration, an individualized program was developed; the participant was instructed in the exercise program for the next three sessions, and the TUFF and FES-I was reassessed at the fourth session.

Results: Analysis of the TUFF and FES-I scores pre to post-intervention revealed strong correlations ($r = 0.883$ and $r = 0.850$, respectively, $p<.001$). A Pearson correlation was also conducted to determine the relationship between the TUFF and FES-I outcome measure changes, which resulted in a moderately strong, inverse correlation with statistical significance ($r = -0.532$, $p = 0.028$).

Conclusions: Though significant improvements were made in most participants' scores on the TUFF and FES-I from pre-intervention to post-intervention, the results showed a moderately strong, inverse correlation between the TUFF and FES-I outcome measures. This indicates that while TUFF scores decreased and participants were quicker to rise from the floor, FES-I scores increased and indicated a higher fear of falling during activities of daily living (ADL). While most participants improved their scores on both the TUFF test and FES-I, a few had significant increased FES-I scores. Participants who did not improve on either their TUFF or FES-I stated without solicitation that they felt, "more cognizant of balance," are "noticing a decrease in falls", and "feel more confident in being able to get up from the floor [independently]" at the final session. The interventions provided to each participant were significant in that they were conducted in only three sessions, resulted in statistically significant data, and participant feedback indicated a change in both their physical and psychosocial well-being.

Clinical Relevance: Many people avoid activity for fear of falling and inability to rise from the floor independently. Interventions should be tailored based on specific deficits noted during administration of the an outcome measure. The TUFF outcome measure provides such information. With appropriate education and fall-rise technique training, and a thorough HEP, improvements can be made in strength, coordination, and confidence, to decrease fear of falling even with limited intervention.
ABSTRACT BODY:

Purpose/Hypothesis: Injurious and fatal falls are concerning in older adults. Exercise programs to improve balance are effective for fall prevention. Balance training prescription includes mode, frequency and duration, but the intensity of balance tasks is rarely measured. We developed the rate of perceived stability (RPS), a self-rated, balance intensity scale, to allow safer, more effective balance exercise prescription. Reducing fall risk depends on responding to perturbations, and avoiding tasks outside of one’s balance capacity. This study’s purpose was to examine the degree to which people can accurately predict the difficulty of specific balance tasks. We hypothesized that people would be less accurate in predicting their ability with activities not performed daily.

Number of Subjects: 22, seven males, 50–79 years of age (mean = 59 years)

Materials/Methods: Subjects sequentially filled out the ABC scale, were taught to use the RPS scale, then completed the Berg. The ABC was adapted to include numbers 17-20, corresponding to activities 11-14 on the Berg. Subjects rated each Berg item 11-14 using the RPS scale. After data collection, the average score for each ABC item and corresponding averaged Berg item RPS score were calculated. Additionally, Pearson correlations (SPSS) were calculated for each item between the ABC and RPS scores for the corresponding activities.

Results: There was a moderate but significant Pearson correlation of 0.521 (p< .05) between the RPS score for Berg item 11 and adapted ABC scale item 17. The other three activities were not significantly correlated.

Conclusions: Subjects estimated their difficulty with balance tasks then rated their actual difficulty while performing the task. The only task in which the prediction was correlated with the actual was turning around left then right. This activity may have been more predictable due to familiarity; one might easily imagine turning around in standing versus standing in tandem, standing on one leg, or doing repeated toe-taps. These last three activities are components of functional activities, such as stairs, single leg stance for dressing, stepping over objects, tandem stance for moving in confined spaces; however, subjects were less able to predict their balance ability accurately on these activities. This inability may impact safety in making choices of how and what activities to perform.

Clinical Relevance: Physical Therapy for balance and falls should address individualized, appropriate, high intensity balance training and fall prevention education. This study shows that people may overestimate their balance abilities during daily activities. The relationship between people’s estimations of balance abilities and actual difficulties should be studied further as an avenue for targeted balance intervention, both therapeutic exercise based and educational.
TITLE: Impact of an information processing task on balance in young adults with autism, a preliminary study

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Balance and Falls SIG

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ABSTRACT BODY:

Purpose/Hypothesis: Postural control is dependent on central sensory integration of visual, vestibular, and proprioceptive cues. The Sensory Organization Test (SOT) has been used to document balance impairments in children and young adults with Autism Spectrum Disorders (ASD), especially when visual and proprioceptive inputs are conflicting. Balance and sensory integration abilities are dependent on attention requirements of a given task as well as attention capacity of the individual. In certain populations, sensory integration processes may be affected when attention is split. The purpose of this preliminary study was to identify the impact of performing an auditory information processing task, specifically a simple reaction time task (IP-SRT) and a choice reaction time task (IP-CRT) on balance in three young adults with ASD.

Number of Subjects: Three adults (1 female, 29.3(6.1) years) meeting criteria for ASD based on the Autism Diagnostic Observation Schedule.

Materials/Methods: This repeated measures design used a well-established dual-task protocol which required participants to perform an auditory IP-CRT/SRT task while exposed to sensory perturbations in the SOT. Testing consisted of 3 IP conditions: no IP task, IP-CRT, and IP-SRT. Balance was studied under 4 SOT conditions: fixed floor and visual scene (SOT1), fixed floor and sway-referenced visual scene (SOT3), sway-referenced floor and fixed visual scene (SOT4), and sway-referenced floor and visual scene (SOT6). Percent change in mean sway velocity in the anterior-posterior direction (MV-AP) was calculated to assess balance.

Results: Under the no IP task condition, mean MV-AP scores were 1.25, 1.38, 1.58, and 2.36 cm/s for SOT1, SOT3, SOT4, and SOT6 respectively. Under SOT1, there was a 0.43 cm/s (34%) and 0.45 cm/s (36%) decrease in MV-AP with IP-CRT and IP-SRT respectively. Under SOT3, there was a 0.18 cm/s (13%) and 0.37 cm/s (27%) decrease in MV-AP with IP-CRT and IP-SRT respectively. Under SOT4, there was a 0.03 cm/s (2%) and 0.29 cm/s (19%) decrease in MV-AP with IP-CRT and IP-SRT respectively. Under SOT6, there was a 0.17 cm/s (7%) and 0.26 cm/s (11%) decrease in MV-AP with IP-CRT and IP-SRT respectively.

Conclusions: In summary, performing an auditory IP task appears to reduce sway velocity in adults with ASD. As a preliminary study with a small sample size, interpretation of the results is limited. Data collection in a larger sample is being conducted to confirm these trends, and to understand differences compared to young adults without ASD. The preliminary data presented here are part of a larger study collecting data for participants with ASD and age-, sex-, and IQ-matched controls.

Clinical Relevance: We were able to demonstrate the feasibility of the experimental methods in this population. Participants were able to control their balance on the Equitest posture platform and perform the dual-task. This preliminary analysis is a step toward understanding attention-balance interference in adults with ASD.
Does Guarding Experience Influence Performance on the Functional Gait Assessment?

Barbara S. Robinson, Jason L. Shaw, Marcia K. Himes, Anna-Grace Eubanks, Taylor Anding, Boaz Beard, Todd E. Daniel

PURPOSE/HYPOTHESIS: The purpose of this study was to determine if guarding experience affects Functional Gait Assessment (FGA) scores when used with community-dwelling older adults. We hypothesized that there would be no significant difference in FGA scores regardless of whether an Expert Physical Therapist (PT) guarded or a Novice Student Physical Therapist (SPT) guarded the participants.

NUMBER OF SUBJECTS: Seventeen community dwelling older adults (mean age = 74.4 ± 9.0, Male = 3, Female = 14) who were 55 years or older, with no reported history of neurological disorders, and well controlled chronic medical conditions participated. Participants were excluded from the study if they were taking medications that might affect balance, unable to follow directions and perform test procedures, could not stand independently for 20 minutes with or without an assistive device, or had a history of an orthopedic injury, surgery, or fracture in the past six months.

MATERIALS/METHODS: All participants completed two trials of the FGA with contact guard assistance and were video recorded. Each participant’s first trial was randomly assigned to be guarded by either an Expert PT or a Novice SPT. Participants were given a two minute rest break between each trial. Two experienced PTs evaluated and scored the FGA videos. Evaluators and participants were blinded from the purpose of the study. Participants were asked to describe any difference noted between the two trials.

RESULTS: The intraclass correlation (ICC) used to assess interrater reliability indicated very high internal agreement between scores (Expert PT Guarder: ICC = .934, Novice SPT Guarder: ICC = .891). Further analysis was conducted by averaging the scores to determine if there were differences between FGA scores when guarded by an Expert PT or a Novice SPT. A paired samples t-test was used to compare the sum of Expert PT with the sum of Novice SPT (based on average scores of two raters that were summed to create totals). Expert PT ratings did not differ from Novice SPT ratings, t(16) = -0.33, p = .848, corrected d = -0.05, 95% C.I. [-1.946, 1.416]. The majority of participants (16/17) indicated that they did not perceive a difference between the two FGA trials.

CONCLUSIONS: Upon initial examination, it may be difficult to determine the amount of guarding assistance required for safety during balance and gait assessments. Some physical therapists or student physical therapists may provide either too much or too little assistance based on guarding experience. With this group of participants, guarding experience did not have a significant effect on total FGA scores for community-dwelling older adults.

CLINICAL RELEVANCE: The FGA is a commonly used measure of balance and postural stability for older adults and individuals with vestibular disorders. Regardless of guarding experience, FGA total scores did not differ significantly.
Purpose/Hypothesis: The purpose of this study was to determine if rater experience affects Functional Gait Assessment (FGA) scores when testing community-dwelling older adults. We hypothesized that there will be a significant difference between CGA FGA scores as scored by experienced physical therapists (PT Rater) and novice physical therapist students (SPT Rater).

Number of Subjects: Twenty-three individuals (mean age = 73.6 ± 6.2, Male = 6, Female = 17) who were 55 years or older, with no reported history of neurological disorders, and well controlled chronic medical conditions participated. Individuals were excluded from the study if they were using of medications that might affect balance, were unable to follow directions and perform test procedures or could not stand independently for 20 minutes with or without an assistive device, or had a history of an orthopedic injury, surgery, or fracture in the past six months.

Materials/Methods: All participants completed two trials of the FGA, guarded with Contact Guard Assistance (CGA) during one trial and Standby Assistance (SBA) during the other trial. They were guarded by an experienced physical therapist and were video recorded. Participants were given a two minute rest break between each trial. Two experienced physical therapists (Expert PT Raters) and three physical therapist students (Novice SPT Raters) scored only the videos with contact guard assistance (CGA). The SPT Raters with no previous experience with the FGA, received 10 minutes of training on the scoring instructions of the FGA. All raters were blinded from the purpose of the study.

Results: The correlation between each rater pair was good to excellent with a range of r = .809 to r = .939. A paired samples t-test was used to compare the sum of Expert PT Raters with the sum of Novice SPT Raters (average scores of each rater group were summed to create totals). Expert PT Raters were not significantly different from Novice SPT Raters, t(22) = -1.79, p = .087, corrected d = -0.13, 95% C.I. [-1.66, 0.122].

Conclusions: The FGA was previously found to be a reliable and valid test of balance when scored by experienced physical therapists and physical therapist students with training in evaluation and management of individuals with vestibular disorders. When used with this population of community-dwelling older adults, rater experience did not significantly affect the FGA total score.

Clinical Relevance: The FGA is a commonly used measure of balance and postural stability for older adults and individuals with vestibular disorders. It appears that minimal instruction in the use of the FGA is sufficient to obtain a reliable total score.
Purpose/Hypothesis: Postural control occurs via multisensory processing by visual, somatosensory and vestibular systems. Vestibular decline is 70% more prevalent in persons with diabetes compared to age matched norms. Vestibular dysfunction is a newly emerging diabetes-related complication which has a significant impact on poor balance and fall risk. The purpose of this study was to analyze the extent to which physical therapists screen for vestibular deficits in patients with T2DM. A secondary aim was to identify the outcome measures most often used by those who are screening for vestibular deficits in T2DM.

Number of Subjects: 1000 surveys were mailed to APTA members with clinical specializations in geriatrics and neurology. 328 survey responses were received, from which 294 were used for data analysis. 34 incomplete surveys were excluded.

Materials/Methods: A 20-question survey was created with four questions asking about the percentage of patients seen with a primary or secondary diagnosis of T2DM. Two questions explored screening frequency for vestibular deficits. One question examined the frequency of use of 17 common fall risk and vestibular outcomes measures. Remaining questions explored demographic characteristics of the sample population.

Results: Descriptive and chi square statistics were performed. Preliminary findings note that of the 294 respondents, 170 (57.8%) do not specifically screen for vestibular deficits in patients with a primary diagnosis of T2DM. For patients with a secondary diagnosis of T2DM, 144 respondents (49.1%) did not screen for vestibular deficits. 52.3% with GCS and 63.8% with NCS do not screen for vestibular deficits. Most frequently used outcomes measures to examine patients with T2DM included the Timed Up and Go (85.1%), Berg Balance Scale (79.2%), Dynamic Gait Index (70.2%), Sharpened Romberg (69.0%), and Dix-Hallpike Test (66.7%). Additional statistical findings will be available at the time of the presentation.

Conclusions: Based on preliminary findings, there is a gap in the body of knowledge regarding preventative screening for vestibular deficits in patients with T2DM. With a significant number of respondents reporting that they do not routinely use an outcome measure that has a vestibular component, it is likely that the fall risk of persons with T2DM may be underestimated. The findings of this study offer additional information to be used in standardizing examination and treatment approaches for individuals with T2DM.

Clinical Relevance: Previous studies report that 13.9% of the outpatient population in physical therapy has a secondary diagnosis of T2DM. 30% of adults over 65 years of age with diabetes repeatedly fall. Currently, there seems to be no consistency in practice guidelines for assessing vestibular deficits in persons with T2DM. An evidence-based screening protocol for vestibular dysfunction, used in conjunction with visual and somatosensory testing would be beneficial to standardize practice, to improve treatment outcomes, and to reduce fall risks for patients with T2DM.
CONTROL ID: 3040914
TITLE: Stabilization of center of mass during quiet stance is preserved in individuals with mild multiple sclerosis
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Balance and Falls SIG
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ABSTRACT BODY:
Purpose/Hypothesis: Quiet stance requires complex integration of somatosensory, vision, and vestibular information for postural control. Healthy individuals depend primarily upon somatosensory information to control postural sway when standing on a stable surface with vision available. However, in multiple sclerosis (MS) subjects, somatosensation, especially in the feet, is impaired due to demyelination and axonal degeneration of spinal and supraspinal axons in sensory pathways. Thus, MS individuals increase their reliance on vision for postural control. In order to remain upright, the nervous system controls the position and motion of the body’s center of mass (CoM). Coordination of several joints is required to stabilize position of the CoM. We investigated the coordination among body segments with respect to the stabilization of the CoM during a quiet stance task and the effects of vision on CoM stability in people with MS and healthy individuals. We hypothesized that individuals with MS will have impaired coordination leading to reduced stability of the CoM, more so for the eyes closed condition than the eyes open condition.

Number of Subjects: Kinematic data for 17 MS subjects (EDSS: 2-4) and 10 control subjects was analyzed.

Materials/Methods: Subjects were asked to stand quietly with either eyes open (EO) or closed (EC) on separate trials. We analyzed the structure of postural sway variance in joint space using the uncontrolled manifold (UCM) approach. The UCM is a statistical tool to analyze the structure of variance in a multi-dimensional set of data. It is based on the idea that the CNS stabilizes those aspects of the motor system that are relevant for a task, while leaving other aspects uncontrolled.

Results: Overall, joint configuration variance was higher for the MS group compared to the control group (F(1,25)=5.02, P<0.05). However, the component of joint configuration variance that affects the CoM position was found to be substantially lower than joint configuration variability leaving the CoM position stable (F(1,25)=12.46, P<0.01) irrespective of whether eyes were open or closed for both the MS and control groups. This result indicates that while the variance of joint configurations led to some variation in the CoM position, most of the joint variance was consistent with joint configurations that stabilized the CoM position.

Conclusions: Our findings indicate that joint configuration is more variable for mildly impaired subjects with MS, as compared to the healthy individuals. However, the structure of variance is not different from healthy individuals, indicating that the active coordination between different body segments remains intact.

Clinical Relevance: It is important to assess the structuring of joint variance towards stabilization of a task variable, i.e. CoM during quiet standing rather than investigating just the overall joint variance. Investigation of the structuring of joint variance in the context of task stabilization can serve as a better marker of postural instability rather than identifying the postural sway alone.
Purpose/Hypothesis: To use wearable inertial measurement units (IMUs) to compare single task and dual task differences in total time and rotational head velocity during the initial turn of the instrumented timed up and go (ITUG) in balance impaired (BI) and healthy young (HY) individuals. It was hypothesized that the BI participants would demonstrate lower dual and single task peak rotational head velocities and a higher dual task cost compared with HY participants.

Number of Subjects: 9 healthy young, neurologically intact adults (mean age 26.4, 55% female) and 5 balance impaired adults with neurologic impairment (mean age 52.2, 60% female) with a history of falling >/=2 times within the last year.

Materials/Methods: Wearable 3D IMUs (APDM inc. Opal monitors) were placed over the head, trunk, and lumbar spine. Following instrumentation, participants performed two trials each of the 3m ITUG in single task and dual task scenarios. Dual task ITUG involved counting backward by 3 from a number between 40 and 80 while completing the trial. ITUG total time for both dual and single task ITUGs were calculated using the APDM software suite. Raw inertial sensor data was processed with a custom written Matlab algorithm which identified peak rotational head velocity during the initial turn of the ITUG. Dual task cost metrics were calculated as the difference in single task and dual task total ITUG time and peak rotational head velocity. Peak rotational head velocity, and dual task cost metrics were compared between BI and HY individuals using two sample Mann-Whitney U tests for non-normally distributed data.

Results: Preliminary results suggest lower peak rotational velocity of the head in BI participants when compared with HY participants (182.1±13.1 m/s vs 238.5±29.8 m/s; p=0.001) during dual task ITUG. Differences in peak head rotational velocity during single task ITUG were found between the groups, but did not reach statistical significance (182.9±40.8 m/s vs 220.0±35.6 m/s; p=0.15). Observable, but non-significant, differences in dual task cost were observed between BI and HY individuals for total ITUG time (2.73±4.79 sec. vs 0.13±0.47 sec.; p=0.29) and peak head rotational velocity (0.81±35.6 m/s vs -18.5±37.2 m/s; p=0.35).

Conclusions: BI participants rotate their heads at lower velocities than HY participants while turning during dual task performance of TUG. Interestingly, while BI individuals experience a greater dual task cost when considering total ITUG time, HY individuals experience a larger dual task cost on head turn velocity. This should be explored further, as people with balance impairment may not demonstrate dual task cost in head turn velocity, despite the overall reduction in ITUG performance, because they have already reduced overall turning velocity during single task performance.

Clinical Relevance: Analysis of head-trunk kinematics during rotational tasks such as the ITUG may provide additional insight into postural coordination in individuals at risk for falls.
Purpose/Hypothesis: Single leg stance (SLS), the amount of time an individual can maintain balance on one foot before falling or having to resume two-legged stance, is often used as an assessment of balance. Single leg stance with eyes open (SLS-EO) has been shown to be an effective predictor of falls in community dwelling older adults and in active senior athletes. Both SLS-EO and SLS with eyes closed (SLS-EC) have excellent interrater reliability. Special Olympics (SO) provides FUNfitness (FF) physical therapy (PT) screenings at state games, which includes SLS assessment. Elements of the FF screens have been investigated, such as grip strength, physical fitness, and FRT scores. The SLS times of SO athletes as related to falls have not been examined. The purpose of this study is to determine if there is a relationship between SLS times of Special Olympic athletes and number of falls reported by participants in the last year.

Number of Subjects: 178

Materials/Methods: Special Olympic athletes completed the FF screenings during the May 2018 Arizona games. As a routine part of FF screens, each athlete completed SLS-EO and SLS-EC testing on the right and left legs. Participants were assessed by a licensed PT. Each athlete was asked how many falls they have had in the past year. The SLS and falls data were recorded on a data sheet using a unique participant number. The average age of the SO athletes was 24.5 years with 70 females (40%) and 108 males (60%) completing the screens. A Spearman Rho test was used to determine relationship between number of falls falls and SLS.

Results: Data analysis revealed little to no relationship between falls and SLS-EO (R LE: r = -.175, p = .027; L LE: r = -.175, p = .027) and little to no relationship between falls and SLS-EC (R LE: r = -.172, p = .030; L LE: r = -.181, p = .023). Of the 178 athletes who completed the SLS-EO test, 122 (69%) were labeled as needing education for balance however of these, 36 (28%) reported actual falls in the past year. The SLS-EC test labeled 155 (87%) as needing education for balance, however of these, 42 (27%) reported actual falls.

Conclusions: SLS test with eyes open and eyes closed is used as part of the standard set of screens conducted for the FUNfitness program. For this study, a history of falls was used an evidenced-based and convenient way of assessing functional balance in this population. However, the results of this study showed no relationship between the number of falls experienced in a year and SLS times, either with eyes open or closed. These results indicate that SLS testing may not be an effective way to identify balance deficits in SO athletes.

Clinical Relevance: When SO athletes’ SLS scores are below 20 seconds for EO and 10 seconds for EC, balance education is provided and an assessment by a PT may be recommended. However, there is little indication these cut off scores indicate a fall risk for this population. This may result in improper education and/or referrals for this population. Further studies may be needed in order to determine the most valid and reliable measures for this population.
**TITLE:** A virtual-reality dance based dance training to increase physical function and cardiovascular fitness in chronic stroke

**CURRENT SECTION:** Neurology

**CURRENT SUB-CATEGORY:** Balance and Falls SIG

**AUTHORS (FIRST NAME, LAST NAME):** Savitha Subramaniam1, Gonzalo Varas2, Tanvi Bhatt1

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**ABSTRACT BODY:**

**Purpose/Hypothesis:** To examine the effect of a multidimensional, virtual reality-based dance (VRBD) training on improving postural stability, walking function, cardiac autonomic modulation and to further assess if these improvements would be carried over to community-based activity profiles.

**Number of Subjects:** 15

**Materials/Methods:** Community-dwelling individuals with hemiparetic stroke (N = 15) received a VRBD training paradigm for 6 weeks using the commercially available Kinect dance gaming “Just Dance 2014” for one hour and thirty minutes. Change in balance control was evaluated by the Limits of Stability test (Neurocom Inc.). The post-training changes in self-initiated center of pressure response time (RT), the movement velocity (MV), the maximum excursion (MXE) were examined. Heart rate variability was determined for pre- and post-intervention for 10 minutes in (1) supine resting position; (2) quiet standing. High-frequency (HF), low-frequency (LF) and LF/HF were evaluated. Maximum workload and oxygen consumption were determined by indirect calorimetry during peak exercise (VO2 peak) with submaximal cycle ergometer. Gait speed and cadence were recorded using an electronic walkway. Changes in PA during community ambulation (CA) (one week before and after intervention) were assessed using Omran HJ-321 Tri-Axis Pedometer. To determine if the changes in functional measures assessing mobility (Berg Balance Scale [BERG]), endurance (six-minute walk test [6MWT]), and gait (speed and cadence) correlated with improved CA, the difference in clinical measures and gait performance from pre- to post-intervention was linearly regressed with the changes in CA.

**Results:** Post-training the RT was significantly reduced (p<0.05). Similarly, post-training, MV, and MXE were significantly higher (p<0.05). Post-training there was a significant improvement in autonomic modulation in the supine position, indicating an improvement in LF, HF and LF/HF (p<0.05). Maximum work load and maximum oxygen uptake increased significantly post-training (p<0.05). Community PA showed a mean of 2898.1 ± 1312.3 steps per day pre-intervention and 3876 ± 171 post-intervention. The change in the number of steps recorded in daily living from pre-to post-intervention correlated with the pre-post change scores for functional measures BERG, 6MWT, gait speed, and cadence (p<0.05).

**Conclusions:** The current study results provide a benchmark for the VRBD training for incorporating long-term adherent PA regimen in chronic stroke survivors, which along with improving cardiovascular functioning and walking function, improves community-based activity profiles.

**Clinical Relevance:** The results from this study support the feasibility and effectiveness of a virtual reality-based dance training paradigm in improving physical function along with physical activity levels. Future studies could integrate dance as an alternative therapy into the clinical treatment program and evaluate its long-term efficacy for translation into community ambulation.
Purpose/Hypothesis: Maintaining lateral stability during walking is a particularly challenging task after a stroke. Typical stabilization strategies, such as modulation of foot placement and generation of frontal plane hip and ankle torque, may be partially disrupted or entirely unavailable to individuals with a stroke. Additional neural constraints, such as abnormal joint torque coupling patterns, may limit the ability of individuals with a stroke. We hypothesized [1] that individuals with a stroke have a reduced ability to actively control lateral stability and [2] that expression of abnormal coupling leads to increased lateral instability. We analyzed spatiotemporal, kinematic, and muscle activity metrics of post-stroke gait in environments where the requirements to generate hip extension and/or abduction torque was altered through the application of force fields at the waist.

Number of Subjects: 9

Materials/Methods: 2 females and 7 males, mean age 58 years (± 7.7 SD), BBS 52.1 (± 2.6), 10 MWT-SS 10.1 s (± 2.2), 10 MWT-FV 7.3 s (± 1.9), FMA-LE 20.4 (± 2.4), performed walking trials in three force field environments and a baseline null field. To create the force fields, a cable-driven robotic device applied forces in the sagittal and frontal planes as subjects walked on a treadmill. The first field provided frontal plane stabilization, which we hypothesized would reduce lateral instability. The second field created a constant backward directed force in the sagittal plane, which we hypothesized would exacerbate the post-stroke extensor synergy. The third field was a combination of the previous two, which we hypothesized would also lead to reduced stability.

Results: Individuals with a stroke did not significantly change their step width, step width variability, step length, or step length variability when walking with force fields compared to baseline. Subjects did significantly reduce center of mass excursion and minimum lateral margin of stability when walking with external stabilization and the combination fields.

Conclusions: That individuals with a stroke do not reduce their step width or step width variability in response to novel environments suggest that individuals with a stroke have a reduced ability to actively control lateral stability and suggests that post-stroke gait behaves invariant of environmental constraints.

Clinical Relevance: Increased incidence of falling suggests that gait stability is substantially impaired after a stroke. This study serves as the first step in improving our understanding of the underlying mechanism controlling lateral stability in the stroke population, which may lead to improvements in therapeutic practice related to balance and stability during gait.
CONTROL ID: 3041610

TITLE: Does playing sound exacerbate effect of the virtual reality environment on postural steadiness?

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Balance and Falls SIG

AUTHORS (FIRST NAME, LAST NAME): Adam DeToni¹, Jordan VanDyke¹, Bradley Johnson¹, Sean Miller¹, Andrzej Remiasz¹, Jenna Tarran¹, Daniel Wheeler¹, Hamid Bateni¹


ABSTRACT BODY:

Purpose/Hypothesis: The severe consequences of accidental falls are well documented. Recent trend in the field is toward use of virtual reality (VR) systems both for assessment¹ and training²,³ of static and dynamic postural control. The knowledge gap however exist on the importance of delivery and quality of sound combined with the VR systems. Studies have shown significant benefits and impact of audio cues during training⁴. This study aims to determine whether use of sound in combination with VR system could exacerbate the impact of VR on postural steadiness.

Number of Subjects: Number of Subjects: 5 healthy young adults

Materials/Methods: Data from 5 healthy young adults (age 25.4±1.1) was analyzed. Participants were instructed to stand (bare feet - heels together, 5-7 degrees toe-out) on a force platform and were tested for five standing conditions: a- eyes open, b- eyes closed c- standing on Airex 2.5” thick balance pad (www.airex.com) d- use VR without sound, e- use VR with sound. VR played an image of rollercoaster for 90 seconds (WearVR - CastleCoaster). Each test was repeated three times (block randomized). Force platform data were collected for 90 seconds (Fs=100). AP/ML time series data were filtered through a 4th order zero phase Butterworth low-pass filter with cutoff frequency of 5 Hz. The first 10 sec. and last 5 sec. of data were cut off to remove any potential lead-in/out effect.

Results: Mean ML distance COP sway was significantly affected by use of VR (F₁,₄=15.04 P=.0002). The conditions of standing without use of VR or the use of sound with VR did not impact ML sway distance (p>0.05). Similarly, root mean square distance from central sway point in medio-lateral direction, which is known to be single best predictor of future falling risk⁵ was significantly affected by use of VR (p=0.0001) but not affected by use of sound with VR (p>0.05). In analysis of frequency domain variables, ML power computed as the integrated area of power spectrum computed for ML directional movement also was significantly affected by use of VR (p<0.0001) but combination of sound and VR was not significantly different (p>0.05). Standing condition had a significant impact on ML power of postural sway signal (p<0.0001)

Conclusions: Although combination of sound and visual cues could potentially enhance other activities⁶, our results indicate that use of sound did not exacerbate the effect of VR on postural steadiness. VR however impacts postural steadiness both in time and frequency domain variables. Small number of subject and use of healthy young adult participants are limitations of this study that warrants further research.

Clinical Relevance: Use of VR is becoming more common in clinical assessment of postural steadiness. It is however important to know whether use of sound and quality of sound could impact the measurement. Our results indicate that use of sound does not exacerbate the effect of VR on postural steadiness.
Establishing Normative Data for the Four Square Step Test

Purpose/Hypothesis: Trips and slips account for 40-60% of falls in older adults. Compared to younger people, older adults demonstrate decreased velocity and foot clearance during gait, as well as reactive stepping responses. The Four Square Step Test (FSST) measures dynamic standing balance and agility and was developed to identify older adults at risk for falls. A participant is timed while rapidly stepping over low obstacles in four directions, completing the sequence as quickly as possible without touching the grid. The FSST has been shown to have excellent reliability and validity, yet few studies have provided normative data for the FSST, nor delved into the number of trials required to complete two successful trials as the test is designed. The purpose of this study was to establish normative data for the FSST in community-dwelling adults and to explore the frequency and cause of incomplete trials while performing the test.

Number of Subjects: 87

Materials/Methods: Eighty-seven community-dwelling adults (55 females, 32 males) between the ages of 21 and 86 were included in the study. All participants completed demographic and descriptive data, a fall risk checklist, and the Mini-Cog test to screen for cognitive impairment. All participants received verbal instructions and one demonstration of the task, then performed one practice trial prior to testing. Two FSST trials were performed, with the best time recorded. A trial was repeated if the participant failed to complete the sequence successfully, lost balance, or touched the grid. Testers tracked the number and cause of incomplete trials. Data was analyzed descriptively (mean ± SD). Six people were excluded from the data analysis due to cognitive impairment.

Results: Mean performance time of the FSST was as follows: 20-39 year olds (y.o.): 6.22 sec (SD 1.22, n=30), 40-59 y.o.: 6.66 sec. (SD 1.72, n=22), and 60-79 y.o.: 9.27 sec. (SD 4.26, n=29). Fourteen of the 20-39 y.o. and thirteen of the 40-59 y.o. had at least one incomplete trial (70% related to sequencing, 30% touching grid). Nine of the 60-79 y.o. had at least one incomplete trial (50% related to sequencing and 50% touching grid). None of the participants demonstrated a loss of balance during testing.

Conclusions: Normative testing of community-dwelling adults revealed that people in all age groups were challenged by the sequencing and foot clearance requirements of the test, with a more significant change in performance in adults over the age of 60. Testing showed that up to 50% of people in all age groups experienced at least one incomplete or test trial due to inaccurate sequencing or touching the grid, as opposed to losing their balance.

Clinical Relevance: The FSST is a unique physically and cognitively challenging task requiring agility, balance and working memory to complete the test quickly and accurately. The test is easy to administer and is an excellent screening tool to examine the risk of tripping while stepping in various directions.
Purpose/Hypothesis: Changes observed in gait during dual-task testing have been associated with future fall risk and this association is stronger than that for single-task conditions. When the demands of two simultaneous tasks exceed cognitive capacity, overall performance is likely to be degraded, with prioritization of one task over another. The dual-task paradigm is very common in activities of daily living. There is currently a limited number of dual task tests to determine one's risk for falls. The purpose of this study was to pilot a new dual task version of the Four Square Step Test and to establish normative data for various age groups.

Number of Subjects: 87

Materials/Methods: Eighty-seven community-dwelling adults (55 females, 32 males) between the ages of 21 and 86 were included in the study. All participants completed demographic and descriptive data, a fall risk checklist, and the Mini-Cog test to screen for cognitive impairment. Participants performed the FSST without any additional cognitive demands. The participant was then asked to perform a cognitive task involving subtraction from 100 by 3s. A trial was repeated if the participant failed to complete the sequence successfully, lost balance, or touched the grid. Data was analyzed descriptively (mean ± SD). Six people were excluded from the data analysis due to cognitive impairment.

Results: Mean performance time of the Dual Task FSST was as follows: age 20-39 9.82 sec (SD 3.32, n=30), age 40-59 10.73 sec (SD 4.27, n=22), and age 60-79 13.17 sec (SD 3.9, n=29). In comparing these to their respective mean times without dual task as 6.22 sec, 6.66 sec and 9.27 sec., there was an mean increase of 3.60 to 4.07 sec. in all groups with the addition of the cognitive task. More notably was the need for multiple trials in order to perform two successful trials as the original test is constructed. With the dual task demand, older adults more often required a repeated trial due to either touching the grid or forgetting the stepping sequence, despite performing it correctly without the dual task. Participants with one or two incomplete trials in the 20-39 age range was 6 (20%), in the 40-59 age range was 7 (32%), and in the 60-79 age range was 13 (45%).

Conclusions: Dual task demands result in slower and frequently inaccurate performance on a previously learned multi-directional stepping task, with more significant challenges noted in adults over the age of 60. Additional analysis will show how performance on this test is correlated with a respective history of falls, their current fall risk (as determined by a CDC checklist), exercise habits and overall activity level.

Clinical Relevance: The addition of a dual task to a motor activity proves to be challenging for people of all ages, but more significantly for older adults. This places older adults at higher risk of tripping or losing balance when cognitive demands are greater. More research is needed to develop dual task clinical tools as well as to analyze how older adults prioritize when their attention is divided.
Purpose/Hypothesis: The Brain Injury Association of America offers a "provisional" Certified Brain Injury Specialist (PCBIS) to graduate students enrolled in an accredited allied health program prior to completing the required number of direct patient care hours. Once these hours are earned, they may submit for full CBIS status. The purpose of this study is to explore the meaning ascribed to the PCBIS obtained by new graduates of a Doctor of Physical Therapy program and that of experienced physical therapists who are Certified Brain Injury Specialists (CBIS).

Number of Subjects: A purposive sample of 5 novice physical therapist (< 1 year of clinical practice) who obtained a PCBIS and 5 experienced physical therapists (9-45 years of clinical practice) with a CBIS participated.

Materials/Methods: A qualitative hermeneutic phenomenological study design was used. Individual semi-structured interviews were conducted with each participant. Interview transcripts were analyzed by the research team using a six step thematic analysis process to identify super-ordinate themes. Once final themes were achieved, a summary of initial findings was presented to participants for member checking, followed by a review of themes by an external content expert. Participant demographic information was also collected and analyzed.

Results: Both groups viewed the certification as capturing two important characteristics needed for specialized practice: advanced knowledge and clinical experience. Further similarities included that intrinsic motivators rather than extrinsic motivators influenced participants' pursuit and maintenance of the certification. Shared intrinsic factors included professional development and striving to reach a professional goal. The PCBIS group reported a greater need to feel competent before they could enter the workforce with confidence. The CBIS group indicated they felt competent, but achieving the specialty certification demonstrated their expertise to their peers, patients and supervisors. Three common factors that could be either obstructive or facilitative for achieving certification emerged from both groups' experiences: 1) Workplace support, 2) Environment, and 3) Career path. When strong intrinsic motivations were expressed, barriers were minimized. However, clinicians weigh these intrinsic motivators within the context of their career path when determining priorities for investing their limited resources on an advanced certification.

Conclusions: These findings suggest that both groups view the certification as beneficial to both novice and experienced clinicians regardless of the timing of acquisition of specialized knowledge and clinical experience.

Clinical Relevance: New graduates are expected to enter the profession ready to practice within specialized fields while experienced clinicians are expected to be lifelong learners. Further study is needed to determine how specialty certifications best meet the needs of both groups.
Abstract Body:

Purpose/Hypothesis: The Center for Disease Control reports an estimated 1.6 to 3.8 million concussions related to sports and recreational activities annually in the US, concluding that sport concussion has reached an epidemic level.1-3 Of that number, an estimated 50,000-300,000 concussions are sustained by high school athletes each year.4 High school athletes with concussion are an at-risk, yet understudied population. Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) has been utilized to establish baseline neuro-cognitive abilities and to provide data for return to play decisions after concussion. The recommended annual assessment or biennial testing of cognition (ImPACT) in youth athletes may be insufficient as a baseline measure, since their cognitive function is continuing to develop. The optimal frequency of ImPACT administration in the youth athlete has not been determined. The purpose of this study was to examine if changes occur in ImPACT scores over the course of one school year in the high school athlete to determine the frequency recommended for a true baseline assessment.

Number of Subjects: Pilot study ImPACT data on male football athletes (10th-11th grade) from two different schools (n=21) was longitudinally collected.

Materials/Methods: The ImPACT is a widely used neurocognitive-testing component of the current approach to concussion management, which also includes symptom inventories, and the Balance Error Scoring System.5 The computerized test evaluates concentration, attention, memory, visual motor speed, and reaction time. The ImPACT has been shown to have high sensitivity and specificity for concussion and to be a valid and reliable measure in high school athletes.5-13 Testing occurred pre-season, post-season, end of the school year, and pre-season the 2nd year.

Results: Preliminary analysis revealed statistical differences for multiple components of ImPACT. The verbal memory composite had statistical significance (p=0.028) between the end of the school year and the beginning of pre-season testing. The visual memory composite had statistical significance (p=0.0003) from the baseline testing and all other testing times. The visual motor composite had statistical significance (p=0.0035) from baseline to post-season and pre-season the following year. The impulse control composite (p=0.86) and the reaction time composite (p=0.264) were not statistically significant.

Conclusions: This preliminary data suggests that ImPACT composite scores in verbal memory, visual memory, and visual motor are changing even within one school year. Current longitudinal data collection is underway to investigate the recommended frequency of testing for high school female soccer players.

Clinical Relevance: Based upon this pilot data, annual testing for football should be advocated for in the high school population and bi-annual testing for athletes who participate in sports during different seasons could be used to truly determine a baseline for our high school athletes.
Purpose/Hypothesis: Non-invasive brain stimulation is a promising therapeutic tool that can be used for rehabilitation following traumatic brain injury. The Portable Neuromodulation Stimulator (PoNS®) is a noninvasive way of stimulating the brain via the cranial nerves innervating the tongue. When combined with targeted therapy, it has been shown to improve outcomes for patients with neurodegenerative disease or spinal cord injury. This study aimed to determine whether PoNS Treatment (PoNS device plus individualized training) using the device set at a normal stimulation level (active) is more efficacious than training using a low frequency but perceivable stimulation (control) in subjects with chronic symptoms due to mild to moderate traumatic brain injury (mTBI).

Number of Subjects: The trial included 43 men and women 18-65 years of age with a balance disorder resulting from mTBI ≥1 year prior to enrollment and a NeuroCom® Sensory Organization Test (SOT) Composite score ≥16 points below normal. All subjects had participated in a focused physical rehabilitation program and were deemed to have reached a plateau in their recovery prior to enrollment in the study.

Materials/Methods: Subjects were randomized into 2 treatment groups. The treatment was double-blinded and consisted of 14 weeks of rehabilitation while using the PoNS device, and a subsequent 12 weeks of normal daily activity without the PoNS device. The primary endpoint was the change in SOT Composite score from baseline to week 14, which was also evaluated at the end of weeks 2 and 26.

Results: 43 subjects participated (22 active, 21 control). The Composite SOT score indicated no significant difference between the two treatment groups at week 2 (P=0.41), week 14 (P=0.47), or week 26 (P=0.99). Post-hoc analysis indicated that when combined, both the active and control groups had statistically significant (p<0.0005) and clinically meaningful improvements in the Composite SOT from baseline to weeks 2, 14, and 26. Results for secondary endpoints also indicated improvements from baseline.

Conclusions: The combination of PoNS neuromodulation and physical rehabilitation produced significant improvements in the Composite SOT score. The effect of adding PoNS to rehabilitation was sustained for at least 12 weeks after intervention was discontinued.

Clinical Relevance: The improvements in balance achieved by integrating PoNS with targeted therapy in the active group ranged from >20 points at week 2 to >33 points by week 26. The corresponding values for the control group were >25 and >32 points. These results exceeded an 8.48-point increase, which is considered to be clinically significant for concussed patients and patients who received vestibular rehabilitation therapy. The improvements achieved with the combination of PoNS plus targeted therapy persisted for at least 12 weeks after PoNS treatment was terminated, demonstrating that it is an effective form of neurorehabilitation.
The purpose of this systematic review was to determine if student athletes have academic dysfunction issues post sports-related concussions (SRC). A challenge with SRC management is that it has been traditionally based on return-to-play guidelines. There has been little awareness among athletes, families, coaches & administrators that student athletes with SRC struggle academically post injury compared to their non-injured peers. The long term academic effects of SRC are over looked due to primary focus of returning athletes to the sports arena.

7 studies included

A systematic review of recent literature was completed to identify evidence related to the clinical question. The search was completed utilizing EBSCOhost. A PRISMA strategy utilizing key words identified 2187 articles. After applying screening criteria 7 articles were included for data extraction & analysis. Two reviewers assessed quality of evidence using the checklist developed by Downs & Black modified by Kennelly. A neutral third reviewer was utilized to resolve disagreements leading to a consensus quality rating of good/fair/poor.

9477 subjects were included for athletes ranging from middle school to college representing a variety of sports. Through different investigations & survey tools, academic dysfunction for SRC student athletes was evaluated. It was identified that SRC left a negative impact on how SRC students performed in the classroom post injury. Identified symptoms included fatigue, headaches, forgetfulness, nausea & increased frustration in the classroom setting. These symptoms also affected attendance rates, the ability to function in school, complete daily tasks & interaction with others. GPA were decreased post SRC, with females suffering larger observed deficits. Suggested accommodations included active in-class note-taking, extended time for examinations, isolated testing rooms, use of a scribe or computer for written examinations/assignments, & shortened school days.

Evidence from this investigation indicates that there is a strong relationship between SRC & academic dysfunction. A consensus is reached among the analyzed data that SRC student athletes suffer greater academic difficulty compared to non-injured student athletes. It also appears that females have more difficulty with academic dysfunction comparatively. More research is needed to help solidify evidence leading to best practices for the academic dysfunction management of student athletes post SRC.

With the primary focus on return-to-play in SRC management, there needs to be an increased awareness of the impact that SRC has on academic performance of the student athlete both short & long term. While it does not appear that there is much awareness of SRC leading to academic dysfunction, emerging research has shown greater difficulty related to academic performance in student athletes post SRC compared to their non-injured peers.
Purpose/Hypothesis: The SCAT5 (Sport Concussion Assessment Tool) is a standard for the recording and evaluation of sports-related concussions in several NCAA sports, but it is not currently used for cycling. This study evaluated symptom reporting after cycling crashes that involve injury to the head, using a SCAT5-based survey.

Number of Subjects: 780 cyclists residing in the United States. 528 males, 249 females, 2 genderqueer/non-binary, 1 transgender female.

Materials/Methods: REDCap survey-based assessment of cycling-related injuries. 403 participants (280 males, 121 females, 1 genderqueer/non-binary, and 1 transgender female) reported crashes within the past two years. Survey questions were based on the SCAT5 symptom evaluation scale, a list of 22 symptoms that are frequently found to be associated with concussion.

Results: Responses from cyclists who reported a head injury resulting from a crash were evaluated relative to trauma control cyclists who crashed and reported injuries to other areas but not to the head. Cyclists who self-reported “no significant injury” were excluded, leaving 77 head injury reporters (HI) and 260 trauma controls (TC). The HI cohort reported a 4-fold higher incidence of loss of consciousness (13/77, or 16.9% HI vs. 11/260, or 4.2% TC) and memory loss immediately after the crash (44/77, or 57.1% HI vs. 37/260, or 14.2% TC). The HI cohort 2.5 times more frequently reported major, non-cosmetic helmet damage (49/77, or 63.6% HI vs. 67/260, or 25.8% TC). In addition, the HI cohort more frequently reported experiencing 17 out of the 22 symptoms of the SCAT5 assessment. Significantly injured female cyclists were 1.8 times as likely to report injury to the head (34/104, or 32.7% of females vs. 41/231, or 17.7% of males).

Conclusions: The findings of this survey suggest that the SCAT5 tool has potential value for screening and assessing head injuries resulting from cycling crashes.

Clinical Relevance: Head injuries, including concussions, and diagnosed traumatic brain injuries (TBIs), are a major risk associated with cycling [1-6]. Information regarding demographics and symptoms of head injuries in cycling is limited, and a large-scale, systematic epidemiological evaluation of cycling-related head injuries in different demographic groups is lacking. The NCAA ISP (injury surveillance program) currently uses the SCAT5 protocol as a framework to assess whether emergency medical care is needed and to determine an appropriate timeframe for return-to-sport after a potential TBI [7]. Because the sport of cycling lacks a pre-assessment/time of injury assessment instrument like SCAT5, systematic evaluation of potential TBI injuries is less straightforward for cyclists than for other athletes. To begin to address these issues, this survey-based study examined a broad group of competitive and non-competitive cyclists’ reporting of significant head injuries and associated symptoms. Our goal was to assess factors associated with head injury and to determine whether an instrument similar to the SCAT5 may be useful in identifying and following up on cycling-related head injuries.
Purpose/Hypothesis: The purpose of this study was to determine how graded exercise testing (GET) is being used in the clinical management of individuals following a concussion.

Number of Subjects: N/A

Materials/Methods: A literature search of PubMed, Google Scholar, CINHAL, and ProQuest was conducted using search terms (“concussion” OR “mild traumatic brain injury” OR “mTBI”) AND (“Balke” OR “Buffalo” OR “graded exercise testing”). Search limits: English, human subjects, peer-reviewed. Selection criteria: individuals with concussion or post concussion syndrome, GET, and PT clinical management (defined as diagnosis, prognosis, return to play (RTP), and treatment planning). Three reviewers independently assessed each article for methodological quality and came to consensus using Sackett Level of Evidence.

Results: A total of 4,437 articles were screened for eligibility. 11 studies met the selection criteria. Sackett Levels ranged from 4 to 1b. All 11 articles included male and female participants (N=552; ages 10-72). Mechanism of injury was varied with sport related concussion in 9 articles, MVA/fall in 5, and 1 not specified. Time since injury was not clearly defined, however individuals with acute concussion were included in 3 articles and chronic concussion in 10. The Buffalo Concussion Treadmill Test (BCTT)/modified Balke Protocol was utilized in 9 articles. 5 used the BCTT as a diagnostic tool to assess exercise tolerance, 3 as a prognostic tool to predict recovery time, 6 for treatment planning to maintain subsymptom threshold during training, and 3 for RTP decision making. The McMaster All-out Progressive Continuous Cycle Test (MAPCCT) was used in 2 articles for RTP decision making. One article also utilized a modified cycle ergometer protocol for diagnosis and treatment planning. All 11 articles assessed HR and used a symptom exacerbation scale as an objective measure. Additionally 4 used BP, and 6 used RPE to monitor patients during GET. Safety of GET in clinical management was assessed in 6 out of 10 articles with no noted adverse events.

Conclusions: Articles reviewed suggest that GET is utilized for multifactorial clinical management of concussion. GET may be safely implemented in the acute and chronic stages of concussion management. Limitations included a finite number of strong evidence studies with the developer of the BCTT as the primary author and/or contributor of the majority of articles reviewed, and lack of standardization in the use of GET amongst researchers and clinicians. Further research is needed to assess how GET can be utilized as a standardized approach for clinical management of concussion.

Clinical Relevance: GET can be utilized to diagnose concussion subtypes, determine treatment at subsymptom threshold, predict recovery time, and guide return to play decision making in concussion management. Because the majority of PT clinics possess cycle ergometers and/or treadmills, the BCTT/modified Balke protocol and/or MAPCCT can be safely and feasibly utilized in clinical management of concussion in this patient population.
Ready to Be Steady: A Randomized Controlled Trial to Address Balance Deficits in Persons with Traumatic Brain Injury

Purpose/Hypothesis: To evaluate the use of the virtual reality (VR) training (Xbox Kinect™) in comparison to a traditional home exercise program (HEP) to address balance deficits in individuals with chronic traumatic brain injury (TBI).

Number of Subjects: 64 community dwelling ambulatory individuals previously diagnosed with a TBI with remaining balance deficits (39 males, 24 females, mean age 48), at least 1 year post-TBI.

Materials/Methods: Individuals were enrolled and randomized (1:1) into either a VR home-based exercise program using the Xbox Kinect or a traditional written HEP to address residual balance impairment. Subjects completed 12 weeks of training (recommended to complete 3-5 times/week) in their home environment with evaluations at baseline, 6 weeks, 12 weeks and a 24 week follow up assessment. The community balance and mobility (CB&M) scale was the primary outcome used in this trial with secondary outcomes including the Balance Evaluation Systems Test (BESTest) and the Activities Balance Confidence (ABC).

Results: There was no significant differences between the two groups at baseline for all outcome measures. For the primary analysis, there was no significant difference in CB&M scores over time between the two groups (p = 0.9983). However, both groups demonstrated statistically significant improvements in the CB&M from baseline to 24 weeks with the mean VR group increase = 8.60, p < 0.0001 and mean HEP group increase = 8.73, p < 0.0001. Both groups exceeded the minimal detectable change for this measure of 7.5. There was no significant difference in ABC score change over time between the two groups (p = 0.4343) with both groups demonstrating nominal non-significant increases from baseline to 24 weeks. There was also no significant difference noted in BESTest scores over time between the two groups (p = 0.8822) while both groups also demonstrated statistically significant improvements from baseline to 24 week evaluation 5.89 (VR) and 6.80 (HEP) increase, p<0.001.

Conclusions: Significant balance improvements were noted in individuals with chronic TBI in response to home-based balance training programs which included VR as well as a traditional written HEP. There were no significant differences in outcomes between these two types of training interventions demonstrating that both approaches may be beneficial to address balance deficits in home environment even in chronic TBI. Interventions for both groups were designed by a skilled physical therapist to address each subject’s specific balance deficits which may be an important factor in these results.

Clinical Relevance: Individuals with TBI may benefit from home-based balance training structured by a physical therapist and may be able to demonstrate clinically meaningful improvements even years after injury. Commercially available VR systems have become more affordable and may give clinicians and patients an alternative to traditional written HEPs facilitating continued balance training in the home environment.
The Impact of Vestibular Rehabilitation on a Patient with Mild Traumatic Brain Injury after Blast Exposure: A Case Study

Background & Purpose: A blast injury is physical trauma from an explosion that can cause multi-system impairments, including dizziness and vertigo resulting from central and peripheral vestibular dysfunction. Vestibular rehabilitation (VR) may be beneficial to patients (pts) after blast exposure who have impairments with gaze stability, dynamic balance, and ambulation. The purpose of this case study is to describe the impact of VR on a patient (pt) with a mild Traumatic Brain Injury (mTBI) after blast exposure.

Case Description: Pt is a 65 year old male who suffered a blast injury in April 2017 complaining of immediate symptoms (sx) of disorientation, vertigo, imbalance, and aural pain. He presented to VR with a primary complaint of imbalance provoked by quick head and body movement. Upon evaluation, he demonstrated signs and sx consistent with peripheral and central vestibular dysfunction. Pt was seen for 26 sessions of VR with a focus on habituation, substitution, and adaptation exercises to address his sx of imbalance, dizziness, and motion sensitivity. These exercises included ambulation with head turns (HT), gaze stabilization, static balance, optokinetics, dual task activities, training on the Balance Master, and dynamic ball toss activities. Variations of these exercises were also prescribed as part of his Home Exercise Program (HEP).

Outcomes: Outcome measures included Dizziness Handicap Inventory (DHI), Functional Gait Assessment (FGA), habitual gait speed (m/s), gait speed with HT (m/s), Dynamic Visual Acuity (DVA), and Visual Vertigo Analogue Scale (VVAS). Upon follow up, pt improved his dynamic balance as evidenced by his increased habitual gait speed (from 0.85 m/s to 1.05 m/s), increased gait speed with HT (from 0.77 m/s to 1.06 m/s), and improved FGA score (from 18/30 to 22/30). He decreased his score on the DHI (from 64/100 m/s to 54/100), indicating reduced disability due to his sx and improved his DVA score (from 6 line difference to 4 line difference), suggesting increased dynamic gaze stability. Upon re-assessment of his VVAS, he reported improvements in dizziness while being a passenger in a car, watching traffic at a busy intersection, walking over a patterned floor, and being under fluorescent lights.

Discussion: Injuries that result in both peripheral and central vestibular dysfunction may create challenges for VR therapists. Exercises that target specific functional limitations and impairments may be beneficial to pts after blast exposure who experience dizziness, imbalance, and motion sensitivity. This case study demonstrates the effective implementation of a VR program in a pt after blast exposure. Further research is warranted to explore the effectiveness of this intervention for this pt population.
BACKGROUND & PURPOSE: There is an urgent need for high impact, cost effective rehabilitation programs focused on multiple challenges to community re-entry in patients with traumatic brain injury (TBI). The University of Central Florida's Knights on the Go Café (café) offers survivors of moderate to severe TBI the opportunity to rehabilitate in an enriched environment (EE). Participants perform typical job skills involving physical, cognitive, and social domains. The café is equipped with an innovative FDA registered overhead harness system allowing mobility with decreased risk of falls. The purpose of this retrospective case series was to examine participant compliance, risks, and potential benefits including improvement of impairments and activity limitation.

CASE DESCRIPTION: Participants volunteered in the café 1-2 days a week for 2 hour shifts. All participants in the café are assessed with outcome measures as a component of program assessment. IRB approval was obtained for a retrospective analysis of this programmatic data. The retrospective analysis included data from February 2016 through December 2017. The primary outcome measures used include: 6 Minute Walk Test (6MWT), Functional Reach Test, Dynamic Gait Index (DGI), Timed Up and Go (TUG), Nine Hole Peg Test (9HPT) and Montreal Cognitive Assessment (MoCA). Analysis consisted of descriptive statistics comparing improvements of the individuals over the time frame.

OUTCOMES: Participant A data was analyzed from January 2017 to December 2017. The participant demonstrated improvements in TUG normal preferred (2.03 s) and in the MoCA (25 to 28). Participant B's data was analyzed from January 2017 to December 2017. The participant demonstrated improvements in TUG normal preferred (1.86 s), TUG cognitive preferred (2.74 s) and 6MWT by 281 feet (MDC=115 ft). Participant C's data was analyzed from May 2016 to November 2016. The participant demonstrated significant improvements in DGI (8 points), TUG normal preferred (3.24 s), TUG cognitive fast (2.65 s), TUG cognitive preferred (2.55 s) and 9-Hole Peg Test (weaker hand) (18.24 s).

DISCUSSION: The participants had excellent attendance and engagement to café and measurement sessions; the café was perceived as fun and impactful; and measures showed improvement in function. Participants demonstrated significant improvements in hand dexterity, mobility, and aerobic capacity. These improvements may lead to increased functional capacity necessary for employment in less restrictive environments. After participation in the program, participant A obtained employment in a commercial food service. Café-style EEs provides a potentially feasible rehabilitation model for addressing multiple domains simultaneously within a real world setting. The upcoming Phase 1 clinical trial will quantify additional domains including movement, communication and socialization changes after short term café participation as compared to equal dose standard PT, OT, SLP.
Purpose/Hypothesis: The Centers for Disease Control and Prevention (CDC) defines an mTBI or concussion as a bump, blow, or jolt to the head that alters normal brain functioning. As part of a multifaceted approach that includes symptom report, neurocognitive testing, and physical examination, balance testing is seen as a cornerstone of mTBI management. Previous studies have shown that balance deficits may persist past self-report of symptom resolution with injured subjects adopting a more conservative gait strategy in which they walked slower than matched controls. Therefore, the purpose of this study is to determine if objective measures of mobility measured during the timed-up-and-go (TUG) test can identify concussed subjects compared to healthy matched controls.

Number of Subjects: 39

Materials/Methods: Thirty-one concussed subjects (21.9±11.9 years old, 51.6% male) and eight healthy matched controls (23.3±7.8 years old, 50% male) consented and completed Timed Up and Go tests (TUG) to assess dynamic balance while wearing an inertial sensor (ClearEdge Inertial sensor, Quadrant Biosciences, Syracuse NY). A stepwise linear regression was utilized (SPSS Version 24) to determine if TUG metrics contributed significantly to identifying concussed subjects. Those metrics identified were then used in a logistic regression and area under the ROC curve analysis to determine sensitivity and specificity of measures obtained from the inertial sensor. These measures were then compared to total time taken to complete the TUG test to determine if objective measures were more sensitive to injury.

Results: The results of the stepwise linear regression revealed three metrics obtained from the TUG tests that significantly contributed to the model. Max acceleration during the walking phase, max turn speed, and max turn speed when sitting were all significant while max acceleration during the walking yielded the highest effect size (0.80). Area under the ROC curve was 0.914 when using total TUG time but improved to 0.992 with 98% sensitivity and 94% specificity when measurements from the inertial sensor were used including walk acceleration, max walking speed, max turning speed, and max turning speed during the sitting portion of the TUG.

Conclusions: The results show that objective measures on the Timed Up and Go Test can more accurately predict concussed verse control patients than measurements of time alone. Additionally, acceleration and speed during gait testing could be valuable metrics to objectively measure dynamic balance performance in an mTBI population.

Clinical Relevance: As part of a multifaceted approach to concussion management, balance testing can assist clinicians in determining if a patient is fully recovered from an injury. With mounting evidence cognitive and balance deficits may persist even after symptom resolution, the need for objective and reliable measures of balance performance is paramount to ensure the proper care for patients.
ABSTRACT BODY:

Purpose/Hypothesis: Respiratory disease is the leading cause of critical illness and deaths in multiple sclerosis (MS). Research of Threshold Inspiratory Trainer (IMT) training outcomes in advanced MS is lacking. This study examined the effects of a 10-week IMT training in persons with advanced MS.

Number of Subjects: There were 11 subjects in the training group and 10 subjects in the control group.

Materials/Methods: Inclusion criteria were residents of a long-term care facility, age >18 years, MS diagnosis, EDSS ≥6.5, no hospitalization for MS within 2 months before enrollment, no acute illness, not a current smoker, and consent to participate. This study was a quasi-experimental design. Training group practiced 2 sets of 15 repetitions of IMT exercise daily for 10 weeks. Initial IMT resistance was 30% of each participant’s baseline maximum inspiratory pressure (MIP). IMT resistance was adjusted weekly based on the rate of perceived exertion and symptoms. Control group received no training. Demographics, comorbidity, and Expanded Disability Status Scale (EDSS) were obtained at the baseline. Inspiratory and expiratory muscle strength was measured using the MIP and maximum expiratory pressure (MEP) at the baseline (pre-test) and at the end of the training (post-test). Change scores in MIP and MEP (difference in values from pre-test to post-test) were obtained. Subsequently change scores were normalized as percent change scores (change score as a percentage of pre-test value). Independent sample t-test was used to compare baseline characteristics between groups. General Linear Model was used to compare change scores and percent change scores in MIP and MEP with group as the between-subjects factor while controlling for covariates. Two-tailed significance level was p<0.05.

Results: The number of comorbidity was significantly higher in training group (3.2±2.3) than control group (1.4±0.8). Age (training group = 61.9±8.2 years; control group = 61.6±6.8 years), year post MS diagnosis (training group = 26.7±9.9 years; control group = 27.3±10.0 years), and EDSS scores (training group = 8.3±0.5; control group = 8.5±0.5) did not differ significantly between groups. Change scores in MIP (training group = 3.2±11.9 cmH2O; control group = -2.2±5.6 cmH2O) and MEP (training group = 2.5±7.6 cmH2O; control group = -2.5±6.9 cmH2O), and percent change score in MEP (training group = 22±38%; control group = -6±27%) did not differ significantly between groups, while percent change scores in MIP were significantly greater in the training group (29±60%) than the control group (-5±27%) after adjusting for comorbidity as covariate (p=0.026).

Conclusions: Inspiratory muscle strength was improved after a 10-week IMT training. Inspiratory muscle training increased the strength of inspiratory muscles only.

Clinical Relevance: Inspiratory muscle training using the IMT has the potential of improving respiratory function in persons with advanced MS.
Purpose/Hypothesis: Parkinson’s disease (PD) is a neurodegenerative condition that causes both motor and non-motor symptoms, and can greatly impact quality of life (QOL). Quality of life is a subjective measure in which patients reflect upon and report their overall level of satisfaction with their life, health, social, and financial roles and duties. It is within the ICF domain of participation. Based on emerging research, PTs are beginning to utilize large amplitude non-traditional therapeutic methods of treatment for patients with PD. A systematic review by da Silva (2016) determined that physical exercise has significant positive effects on QOL in patients with PD, but the ideal type of exercise to maximize such improvements has yet to be determined. The purpose of this systematic review was to investigate the effects of large amplitude non-traditional PT interventions, as compared to routine PT interventions, on QOL in patients with PD.

Number of Subjects: The three included studies examined a total of 93 subjects.

Materials/Methods: Multiple relevant databases were searched using keywords such as "Parkinson's disease", "amplitude", "pdq-39", and/or "participation" with a published date limitation of January 2008 through January 2018. The 2011 Modified Downs and Black systematic review methodology was utilized to determine study strength and level of evidence.

Results: Of the 665 studies originally identified, 3 met the inclusion criteria and were critically analyzed. All 3 were level II RCTs and each earned a quality rating of "good". Each study examined large amplitude non-traditional therapeutic interventions, including Irish dancing and LSVT BIG, compared to routine PT. Two of the 3 studies dose matched the interventions. Both the PDQ-39 and UPDRS, PD disease specific outcome tools, were used to assess QOL. All 3 studies found no difference in QOL improvements between groups.

Conclusions: This review concluded that there is no difference in QOL outcomes between routine PT and large amplitude non-traditional PT interventions for patients with PD, regardless of dose matching. The limited number of studies weakens this conclusion.

Clinical Relevance: There are many studies that have examined and shown the benefits of exercise for patients with PD in both ICF activity and participation levels, but there is limited research focused on what therapeutic interventions and at what dose are best to improve QOL. Current clinical practice and research mostly focus on measuring activity level outcomes. It is unclear whether the PDQ-39 or UPDRS are responsive to measure changes due to PT intervention. It can be reasonably concluded from this review that any form of physical exercise may improve QOL, but that targeted large amplitude non-traditional PT interventions may be most appropriate to address patient specific goals in the ICF activity level domain. In order to determine how PT interventions affect QOL, it is imperative the clinicians and researchers routinely measure it.
Purpose/Hypothesis: To determine whether persons with MS are utilizing dietary modification and/or supplements in hopes of reducing impairment, and to investigate their perceptions about any potential relationships.

Results: The majority of participants (72%), report having relapsing remitting MS, followed by secondary progressive. Most participants (73%) believe in a connection between diet and MS; with 44% reporting attempts at dietary change. Specific diets reported include: the Mediterranean Diet (16.4%), low Fat (16.4%), ketogenic (5%), caloric restriction (8.2%), gluten Free (13.1%), and low sodium (16.4%). There was a significant association between participants who tried diet modification to manage MS and those who believed there is a connection between diet and MS (Pearson Chi-Square, p=.000). Most participants (89%) report using vitamins and/or minerals to manage MS. Vitamin D (82%) was the most common followed by B12 (32%). The most commonly reported supplement was Omega 3 (21%) followed by Turmeric (18%). There were significant associations between participants who reported using Omega-3 (Pearson Chi-Square 8.23, p=.003) and Turmeric (Pearson Chi-Square 4.08, p=.043) and those who indicated that diet and supplementation helped manage their MS-related impairments. The majority (85%) of respondents report a willingness to participate in diet modification if this would improve their disease condition. However 62% report barriers to changing their diet which include: cost (28%), knowledge (20%), habit (20%) and time (18%).

Conclusions: Although the majority of the study participants believe that diet may influence symptoms related to MS, less than half of participants report making dietary changes. Among participants who did make dietary changes, there was a significant relationship between the ketogenic, paleo, and gluten free diets and the perception of improved management of MS related symptoms. Omega-3 and Turmeric were the leading supplements perceived by participants to improve MS-related impairment. Finally, the majority of respondents report a willingness to change their diet if there is evidence that it would decrease impairment related to MS.

Clinical Relevance: In 2015 the APTA described "screening for" and "providing information on diet" to be within the scope of physical therapist practice. Although the number of subjects was low, this study indicates that certain dietary changes and/or supplementation may reduce MS-related impairment. Based on these findings, additional investigation is warranted.
Purpose/Hypothesis: Functional Electrical Stimulation (FES) stimulates peripheral nerves via electrical current to evoke muscle contractions and when combined with lower extremity cycling (LE), creates patterned leg movements. Previous studies demonstrated FES cycling is safe and effective in the spinal cord injury and stroke populations with improvements seen in walking speed, muscle mass, and bone density. Few studies have applied FES cycling to a neurodegenerative disorder, such as multiple sclerosis (MS). The aim of this study is to assess the effect of an 8-week training program using FES cycling, compared to Cycling Only, in people with MS (PWMS).

Number of Subjects: 14

Materials/Methods: Using a sample of convenience, PWMS were recruited to participate and randomized to the FES Cycling group or the Cycling Only group. Both groups received training three-times per week for 8 weeks using a LE ergometer. Scores on the 6 Minute Walk Test (6MWT), Times 25-Foot Walk Test (T25FW), Five Times Sit-to-Stand (5XSST), and Timed Up and Go (TUG), and spatiotemporal measure of gait were collected at baseline, (before the 1st session), 4-weeks (before the 13th session), 8-weeks (after the 24th training session), and at 4-week follow-up. Scores on the MS Quality of Life-54 (MSQOL), Modified Fatigue Impact Scale (MFIS), Multiple Sclerosis Walking Scale-12 (MSWS-12), and Activities-specific Balance Confidence Scale (ABC) were collected at baseline, 8-weeks, and at 4-week follow-up.

Results: Fourteen participants (8 female, 6 male, mean age = 53.64 ± 10.16 years; Patient Determined Disease Steps (PDDS) mean = 3.71 ± .091) completed the training. Cycling power output significantly increased in both groups over time (FES Cycling, p = 0.03; Cycling only p = 0.004), but no differences were found between groups (p = 0.08). The Cycling Only group demonstrated a slightly larger effect size for power output than the FES Group (d = 0.72 vs. 0.66). Immediately after the intervention period, scores on the 6MWT, 5XSST, and MFIS, and subscores of the MSQOL-54 improved significantly, but changes did not consistently favor one group over the other (p >0.05). There were no significant differences between groups on any of the outcome measures.

Conclusions: FES Cycling or Cycling Only may be an effective intervention for improving walking endurance, sit-to-stand, and QOL in PWMS. This unique pilot study compared FES cycling versus Cycling Only for PWMS using a customized progression protocol.

Clinical Relevance: Exercise is an effective means of maintaining and improving function in PWMS. Barriers to exercise include safety concerns, accessibility, and evidence of exercise protocol efficacy. As cycling is performed in a seated position, it is safer for individuals with balance deficits than other forms of aerobic activity. This study is unique in that it addressed the efficacy of FES cycling versus Cycling Only for PWMS over an 8-week training period using a customized progression protocol.
Purpose/Hypothesis: To compare responses to exercise for people with or without deep brain stimulators (DBS) based on re-analysis of data from a study on effects of long-term exercise on physical function in people with Parkinson's disease (PD).

Number of Subjects: Data from 8 participants with PD, 4 with DBS and 4 without DBS, were compiled from a single-arm prospective study that documented effects of a general, community-based, group exercise program for people with PD over multiple years.1

Materials/Methods: Participants attended a previously described group exercise program attending at least half of the classes offered over a 2-year period.1-2 Participants with DBS were matched to others without DBS based on dates of exercise (e.g. Jan 2010 – Dec 2012), age and gait velocity at baseline. Data were compiled from evaluations performed at baseline and after each 10-week exercise session. Data included gait velocity, timed up and go, grip strength, 30-sec chair stand, single leg balance, six minute walk (SMW), and Unified Parkinson’s Disease Rating Scale (UPDRS). Data were presented descriptively given the small number of participants.

Results: Baseline status was similar for participants with or without DBS based on age, time since diagnosis and modified Hoehn & Yahr score. For both groups, physical function and motor symptoms remained relatively consistent throughout the 2-years. Variability was evident within and across individuals, with large within-subject variability for 30-sec chair stand and SMW. No notable trends suggested between-group differences in any of the measures, nor clear trends toward improvement or degradation in function or symptoms. Missing data points were evident in about 10% of the data for both groups, generally for 30-sec chair stand or 6MW. No adverse events were reported.

Conclusions: Our findings document that individuals with PD who do or do not have DBS, and who engage in consistent exercise, can maintain physical function and avoid increased PD symptoms over a 2 year period. These findings are limited by the observational nature of the comparison between groups, and the descriptive re-analysis of a small set of existing data. The study from which these data were compiled supports this finding by documenting that people with PD who engage in consistent exercise can maintain physical function over multiple years. Further research should confirm the lack of difference between individuals with and without DBS, and determine whether specific forms of exercise preferentially benefit people with or without DBS.

A considerable body of evidence demonstrates that individuals with PD can benefit from participation in varied forms of exercise.3-5 This study adds to that body of evidence by suggesting that these findings hold true regardless of whether participants have received DBS or not.

Clinical Relevance: This study suggests that consistent multi-year participation in group exercise will help individuals with PD maintain physical function whether or not they have a deep brain stimulator implanted.
CONTROL ID: 3028259

TITLE: Feasibility of the Timed Functional Arm and Shoulder Test (TFAST) in people with Parkinson disease (PD)

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Disease SIG

AUTHORS (FIRST NAME, LAST NAME): Kshamata M. Shah1, Janet Readinger2, Ashley Derisme1, Tate Olson1, Hamza Shqeirat1, Philip W. McClure1


ABSTRACT BODY:

Purpose/Hypothesis: Upper extremity pain and disability are common in people with PD. However, no standardized test exists to examine shoulder performance. Further, self-report questionnaires that are specific to the arm have not been used extensively in this population. A new shoulder performance measure, TFAST, has shown good psychometric properties in healthy adults of varied ages and patients with shoulder pain. The purpose of this study is to establish the feasibility and reliability of the TFAST in people with PD.

Number of Subjects: We plan to collect data on 25 people with PD. Pilot data has been collected on 9 participants (mean age 73 (5.9); 8M, Hoehn & Yahr score 2.2 (0.4); duration of PD diagnosis 14 years (7.7)) without active shoulder or neck pathology, and who were considered able to perform the test safely.

Materials/Methods: The TFAST took 10-12 mins to complete on both arms and consisted of 3 tasks – Hand to head and back (30 sec), wall wash (60 sec) and gallon lift (30 sec). For each task, total repetitions (reps) were recorded and used to calculate the total TFAST score (higher scores are better), all tasks were represented equally for a 30s period. Participants completed the jug task with a half-gallon weight if they were unable to complete the task as described. Two subscales of the Unified Parkinson’s Disease Rating Scale (UPDRS) were collected; the self-report sub-scale on activities of daily living (Part II) and a motor examination subscale (Part III). Disability of the Arm, Shoulder and Hand (DASH) (self-report questionnaire) was also collected. Lower scores are better for all 3 scales. Between-session reliability (ICC 2,1), measurement error (SEM and MDC) and correlations were calculated.

Results: All participants with PD completed the test, 3/9 used half gallon weight. The TFAST scores were variable ranging from 17-120 reps, mean reps were 66.3 (31.7). Preliminary reliability and measurement error estimates are as follows: ICC 0.94 (0.73-0.98); MDC90 17.9, SEM 7.96. The correlations with TFAST scores for each scale were DASH (r=-0.62); UPDRS Part II (r=0.03) and Part III (r=-0.56).

Conclusions: Preliminary results show promising feasibility and reliability of the TFAST in people with PD, and supports continued data collection. The total TFAST reps were 11% lower and more variable compared to the published norms for older adults. While the DASH self-report score was moderately correlated to TFAST performance, the UPDRS self-report scores were not correlated. For people with PD, the DASH may provide insight on upper extremity pain and disability.

Clinical Relevance: Majority of the existing scales in the neurologic population are focused either on self-report or assessing if a task can be completed (yes/no), there is no existing scale that measures upper extremity performance. The TFAST may be used to measure shoulder functional performance in people with PD. Future research is focused on expanding the use of the TFAST in patients with a variety of neurological impairments such as PD, stroke, multiple sclerosis.
Purpose: Huntington's disease (HD) is a progressive, autosomal dominant genetic disorder caused by a mutation in the HTT gene. This gene mutation results in degradation of the cerebral cortex and basal ganglia, resulting in a decline in a person's cognition, personality and behavior, mobility, and overall function. Due to the nature of the disease, specialized care is a necessity; the interdisciplinary team often includes movement disorder physicians, social work, palliative care, psychologists, physical therapists (PT), occupational therapists (OT), speech and language pathologists (SLP), nursing staff, and dietitians. Some hospitals have developed comprehensive, multidisciplinary clinics for patients to attend every three to six months. We developed a screening tool to streamline the clinic process by facilitating referrals prior to clinic, and increasing referrals to rehabilitation during the early stages of the disease. This tool ultimately improves communication within the multidisciplinary team and access to care for HD patients.

Description: The screening tool is administered by the clinic social worker by phone, requiring approximately twenty minutes per phone call. There are currently five questions per each rehabilitation discipline and multiple questions for palliative care, social work, and psychology. During administration of the screening tool, patients and their families respond to questions related to current mobility and performance of ADLs, recent falls, and home modification needs. During the early to mid-stages of Huntington's disease, PTs facilitate improved mobility and performance of activities of daily living (ADLs). This occurs through strengthening, aerobic activity, balance and functional training, and education of assistive and adaptive device use. During mid to end-stages of the disease, PTs address postural changes, positioning needs, respiratory changes, and wheelchair prescription. A PT analyzes responses to determine if referral is indicated. Referrals and recommendations are made prior to clinic. The screening tool improves efficiency between the physicians and patient, and increases discussion regarding functional mobility and performance of ADLs.

Summary of Use: Currently, the screening tool is administered one to two weeks prior to the comprehensive clinic. Since development in November 2017, over sixty patients have been screened with over 27 referrals completed, resulting in increased referrals to respective disciplines and improved communication between interdisciplinary team members.

Importance to Members: PTs maintain an important role in maximizing patient independence and safety with mobility. This screening tool increases PT referrals, resulting in improved education and mobility consultation for patients with HD. This tool continues to be refined with increased use. Ultimately, the use of a screening tool in multidisciplinary clinics will increase the efficiency of referrals and quality of care provided to patients with HD.
Purpose/Hypothesis: Individuals with Parkinson’s disease (PD) often develop cognitive symptoms prior to motor symptoms, which often go unnoticed until motor issues impact daily function resulting in delayed PD diagnosis. Earlier diagnosis would enable earlier intervention. Current standardized assessments are not sensitive enough to detect early symptoms of PD. Cognitive-motor dual task performance has been found to be challenging in early PD. The purpose of this proof-of-concept pilot study is twofold: 1. to evaluate a novel dual task assessment combining a functional, bimanual, coin-manipulation task with a secondary cognitive task in individuals with PD and 2. To compare the cognitive/motor task priority choices subjects make when performing seated vs upright tasks.

Number of Subjects: Four individuals with idiopathic PD, Hoehn & Yahr (H&Y) I-III, average age of 71 years.

Materials/Methods: Subjects underwent the following assessments: Montreal Cognitive Assessment Scale, UPDRS-III, H&Y Scale, Dexterity Questionnaire -24, grip and pinch strength, 9-hole peg test, Functional Dexterity Test, Clinch Token Transfer Test (C3t) and Timed Up & Go (TUG) test. The C3t and the TUG were performed under both single and dual task conditions. Time, accuracy and movement scores were generated for the C3t allowing for evaluation of motor and cognitive dual task cost (DTC).

Results: All four subjects demonstrated a C3t performance decrement baseline to dual task condition. Subjects with H&Y II/III (n=2) showed a greater decline than subjects with H&Y I (n=2). All subjects demonstrate greater cognitive and motor DTCs during the C3t dual task than during the TUG dual task. Visual inspection of prioritization patterns differ between the seated C3t and the upright TUG tasks. Data collection is ongoing with plans for a study to include data collection for controls (n=12), PD H&Y I (n=12) and PD H&Y II/III (n=12).

Conclusions: The C3t appears to be a feasible dual-task assessment for individuals with PD. The C3t appears to be sensitive enough to differentiate mild (H&Y I) and moderate (H&YII) disease severity. It appears that subjects may prioritize cognitive and motor tasks differently when performing a seated vs an upright task. Greater numbers of subjects are required for significant conclusions.

Clinical Relevance: The ability to detect the early symptoms of PD via dual task assessment may facilitate earlier diagnosis. Early detection will allow early access to PT where intervention may slow disease progression. The C3t is a functionally based dual-task designed to target impairments that arise with basal ganglia dysfunction across disease stages. The administrator burden is very low. This tool has the potential to become a standardized outcome measure used throughout clinics to monitor change with disease progression and improvement with intervention.
The effect of ankle-focused home exercise program on gait in persons with Multiple Sclerosis: Partial results of an ongoing study.

AUTHORS (FIRST NAME, LAST NAME): Herb Karpatkin, Maxwell Dunfey, Rainier Saliente, Alixandra Peterson, Rebecca Kleiner, Suzanne Babyar


ABSTRACT BODY:

Purpose/Hypothesis: Evidence suggests that loss of ankle push off power during gait may be common among persons with MS (pwMS). Many factors may cause this loss of power including limitations in ankle plantarflexion and dorsiflexion strength and range of motion (ROM). A home exercise program (HEP) targeting these limitations may improve gait in pwMS. The purpose of this study was to determine if individualized physical therapy home exercise to improve ankle strength and range of motion would improve gait of pwMS. We hypothesized that pwMS who demonstrated reduced ankle flexibility and strength loss would show improvements in gait after a 6-week home program addressing these impairments.

Number of Subjects: To date, 5 subjects have completed training. Data collection will continue through December 2018.

Materials/Methods: Subjects are being recruited from local MS practices. Inclusion criteria are: definite diagnosis of MS, ability to ambulate for 6 min with or without assistive device, and difficulty with ankle push off as evidenced by limitations in ankle strength and range, respectively determined by hand held dynamometry (HHD) and goniometry. Exclusion criteria are: current or recent MS exacerbation and difficulty with gait for reasons unrelated to MS. Subjects provide informed consent and demographic information (age, gender, disease severity, years since diagnosis). Primary outcome measures include the 6-minute walk (6MWT), the Dynamic Gait Index (DGI) and kinematic data as measured by the Zeno(TM) walkway using Protokinetics Movement Analysis Software during the 1st and 6th min of the 6MWT. Gait fatigability is measured by comparing gait in 1st to 6th min of the 6MWT. A 6-week individualized HEP is designed based on the outcomes of the HHD and range of motion. Weekly phone calls monitor HEP compliance. Outcome measures are collected at 3 and 6 weeks. Comparisons are made using nonparametric repeated measures statistics with a p-value of .05.

Results: To date, 5 subjects (EDSS 4.7, +/- 2.1) have completed training. Mean 6MWT distances have improved from 1011.4' to 1069.8'; mean DGI scores have improved from 14.2 to 17. Based on an average of 17 steps/person, mean stride velocity in the 1st minute of the 6MWT improved from 41.6 cm/s to 45.02 cm/s (p = .069). Percent time in stance increased (p=.014). Gait velocity increased from 85.1cm/s to 93.9cm/s. Although improved, gait velocity and cadence did not show significant differences across weeks. Gait performance measures are similar at the min1 and min6 of the 6MWT for most variables. Intersubject variability is high.

Conclusions: Preliminary findings suggest that the ankle exercise home program may be effective in improving gait in pwMS. Data collection will continue through December 2018, to allow for better hypothesis-testing.

Clinical Relevance: Diminished ankle push off power may impact gait of persons with MS. A home exercise program that specifically addresses loss in ankle muscle strength and ankle joint ROM may be an effective intervention for improving gait in this population.
**ABSTRACT BODY:**

**Purpose/Hypothesis**: Multiple Sclerosis (MS) is a disease of mobility. Physical therapists (PT’s) use mobility measures to quantify the degree of impairment in persons with MS (pwMS) and to determine intervention strategies. It is therefore important that these measures produce results that give consistent information. However, MS is often a disease of variability, with symptoms capable of fluctuating over time depending on multiple factors. Although, reliability studies have been performed on most common MS mobility measures, a comparison of measurements of the same subject over days and weeks has not been performed. The purpose of this study is to perform commonly used mobility tests on pwMS over a period of days, weeks, and months, and to see how consistent these measurements are. We hypothesize that there will be a considerable variability in these common MS measures over time. If correct, our hypothesis will suggest that clinicians who work with pwMS should evaluate their performance frequently so that a clearer picture of what their true mobility deficits are.

**Number of Subjects**: To date, 4 subjects have completed the full testing protocol.

**Materials/Methods**: Subjects are being recruited from local area MS practices. Inclusion criteria includes a definitive diagnosis of MS, ability to walk 6 minutes continuously with or without an assistive device, and ability to read and sign an informed consent. Exclusion criteria include recent or current exacerbation and orthopedic, cardiopulmonary, or non-MS neurologic condition preventing ability to engage in mobility tasks. Following signing of Informed consent, subjects will provide demographic and subject characteristic information (age, years since diagnosis, disease severity). Mobility measures including the 6-Minute Walk Test (6MWT), the MiniBESTest (MBT), the 25 foot walk test (25FWT) and the Stair Climbing Power Test (SCPT). The tests will be administered on three consecutive days, then once a week for 4 consecutive weeks, then once a month for 2 months. Secondary measures will include the Multiple Sclerosis Impact Scale-29, Fatigue Severity Scale, and the MS Walking Scale-12.

**Results**: To date, four subjects (2 female, 2 male, EDSS: 4.4, MSIS29: 85.5, FSS: 5.7, MSWS12: 47) have completed the study. Preliminary descriptive statistics measuring mean score ranges for all subjects are as follows: Mean MBT score range: 4 points; mean 6MWT range: 127.7 feet; mean SCPT score range: 4.95 seconds; 25FWT range: 4.6 seconds.

**Conclusions**: Depending on the day, scores in common MS mobility measures present with considerable variability. This variability is equal to or greater than the Minimal Detectable Change for the 6MWT, MBT, and the 25FWT.

**Clinical Relevance**: Clinicians should take this variability into account when evaluating mobility deficits in these patients, as it suggests that a single measurement may not accurately represent the patient’s true abilities and may potentially result in inappropriate intervention strategies. Data collection for this study will continue through December of 2018.
Purpose/Hypothesis: Determine if 10 weeks of inspiratory muscle training improves maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP) and fatigue level in patients with advanced Multiple Sclerosis (MS).

Number of Subjects: Eleven individuals with MS.

Materials/Methods: This study was a single cohort pre-test, post-test design with a 10 week baseline where no exercise was performed, a 10 week inspiratory muscle training period, and a post-test to determine any changes in MIP, MEP, and fatigue. Subjects were residents of The Boston Home in Dorchester, MA, USA and over 18 years of age. Exclusion criteria: did not have physician-diagnosed MS; other neurologic conditions; had an EDSS of <8.0; hospitalized due to an exacerbation of MS in the last two month; current smokers; any new unstable medical conditions. Researchers collected demographic and health data, Modified Fatigue Impact Scale 5 (MFIS-5) scores, EDSS scores, and MIP and MEP using a standardized protocol with MicroRPM Pressure Meter. Testing was repeated at a second pre-intervention baseline. The best of three scores on the MIP was used to calibrate resistance on the Threshold Inspiratory Muscle Trainer (IMT, Philips, Andover, MA). Resistance was set at 30% of the maximal score. Participants were trained and instructed to use the device daily, for 3 sets of 15 repetitions. Exercise progression was adapted from Fry et al. (2007). Based on their RPE score, resistance was adjusted weekly. Testing was repeated after the 10 week intervention phase including MIP, MEP, and MFIS-5 scores.

Results: MIP at Pre-Test 1 and MIP at Pre-Test 2 were strongly and positively correlated (r=0.90, p<0.001). MEP at Pre-Test 1 and MEP at Pre-Test 2 were positively correlated (r=0.78, p=0.005). MIP at Pre-Test 2 was significantly different from MIP at Pre-Test 1 (p=0.026). On average, MIP at Pre-Test 2 was 4.7 cmH2O higher than MIP at Pre-Test 1 (95%CI=0.60-8.9) (p=0.029). Average MIP did not differ significantly between Pre-Test 2 and Post-Test (p=0.394). Prior to the intervention at Pre-Test 1, MFIS– 5 was not significantly correlated with MIP or MEP. Prior to the intervention, MFIS – 5 was not significantly correlated with MIP or MEP.

Conclusions: In individuals with advanced MS, it may be possible to regain respiratory strength lost during the progression of the disease. Our study showed a significant decline of baseline MIP in the 10 week no intervention phase. No significant difference in reduction of muscle strength was found between Pre-Test 2 and Post-Test, demonstrating that inspiratory muscle training can assist in maintaining respiratory strength in this population.

Clinical Relevance: Involvement of the respiratory system in MS is common and pneumonia and sepsis are leading causes of death in individuals with advanced MS. Addressing this critical area with relatively simple breathing exercises may be an effective method of preventing respiratory compromise in persons with advanced MS.
BACKGROUND & PURPOSE: Parkinson’s disease is a chronic condition that causes progressive mobility deficits associated with decreased quality of life and increased mortality. European clinical practice guidelines recommend physical therapy (PT) for people with Parkinson’s disease (PD) soon after diagnosis to provide education, physical activity advice, and individualized interventions when needed. However, PT is frequently under-utilized early on and individuals aren’t referred until gait and balance problems occur. The purpose of this administrative case study is to present the application of a proactive PT (PAPT) approach, to optimize participation in evidence-based exercise for PD, using implementation frameworks for the (1) implementation process, (2) determinants of implementation success, and (3) implementation evaluation.

CASE DESCRIPTION: The PAPT program targeted people with early stage PD before the onset of significant gait and balance dysfunction. It was initiated in one outpatient neurological rehabilitation center in the United States. The program used a shared decision-making model to promote long-term maintenance of independent exercise. The Knowledge-to-Action Framework was used by champions to assess gaps between knowledge and current practice as well as synthesize current knowledge regarding exercise in PD. Implementation barriers were addressed using the Consolidated Framework for Implementation Research. The program was evaluated using the RE-AIM (Reach, Effectiveness, Adoption, Implementation, Maintenance) framework with mixed methods.

OUTCOMES: In the program’s first year, 38 people were referred, 28 were evaluated, and 20 participated in 6 month program evaluation. After the first session, individuals followed 1 of 4 care paths to provide individually tailored intervention. Following PAPT, the number of participants reporting regular participation in aerobic, strengthening, flexibility, and balance exercise increased. Participants reported a median of 140 of aerobic exercise per week. Implementation barriers included location, insurance coverage, and difficulty scheduling long-term follow up visits. Participants reported physical and emotional benefits of the program. Referral rates increased from targeted referral sources by 55-163%.

DISCUSSION: The PAPT program, designed to help people with PD optimize and maintain an exercise routine prior to the onset of significant mobility problems, is an example of how to implement existing CPGs in the US Healthcare System. Implementation frameworks assisted with the implementation and evaluation of a PAPT delivery model that helped people with PD to increase and maintain independent exercise participation.
A Case Report of a Clinical Decision Making Approach to Address Functional Limitations in an Individual with Kennedy's Disease, a Rare Neurological Disorder

**Background & Purpose:** Kennedy's disease (KD) is a rare, progressive X-linked genetic motor neuron disease. Although there is literature available describing the etiology of Kennedy's disease, there is little to no evidence supporting physical therapy interventions. Muscular endurance, task specific training, strength training and energy conservation has been found effective for other progressive neurological diseases such as Myasthenia Gravis (MG), Lower Motor Neuron (LMN) disorders, Parkinson disease (PD), Huntington's disease (HD), and Multiple Sclerosis (MS). The purpose of this case report is to describe a clinical decision making approach and selection of therapeutic interventions and outcome measures to meet patient specific goals, improve function, and reduce general fatigue in a person with KD.

**Case Description:** The patient is a 51-year-old male diagnosed in 2016 with Kennedy's disease who attended a pro-bono physical therapy clinic 2 times a week for 12 weeks. The patient presented with weakness through his core as well as his upper and lower extremity. Patient presented with fatigue and activity limitations such as ascending and descending stairs, sit to stands, and long distance ambulation. Management of this patient relied on research from other progressive neurological diseases that have similar presentation of symptoms such as MG, MD, PD, HD, and MS. Exercises and management of symptoms were pulled from a variety of literature to assist with management of this patient such as task specific training in PD and HD literature, fatigue management in MS literature, and recommendations for strengthening from MG and lower motor neuron literature. A plan of care included core strengthening exercises, functional training (STS, floor transfers, turns, stairs, over ground and body weight support gait training), task-specific balance exercises with progression of these over the intervention period.

**Outcomes:** Outcome measures utilized were the Functional Gait Assessment (FGA), 5 time Sit-to-Stand Test (FTSTS), Six Minute Walk Test (6MWT), The Timed Up and Go (TUG), 10 Meter Walk Test (10MWT), and Single Leg Stance (SLS) were used pre and post physical therapy intervention. The FGA, FTSTS, 10MWT and 6MWT all demonstrated significant improvements with decreased stated fatigue after testing. TUG and SLS both improved but did not reach a significant change. Improvements also noted through video analysis with quality of movement.

**Discussion:** Outcome measure findings indicated improvements across multiple domains of exercise with utilization of task specific training during strengthening, functional training and balance training. This case indicates that physical therapy interventions with focus on task specific training and mindful strengthening strategies to avoid fatigue may enhance quality of movement and functional ability in patients with Kennedy's disease. Clinicians may be able to utilize this clinical decision making model with other patients with rare neurological disorders.
TITLE: Relation between physical activity and sleep in individuals with Parkinson Disease

ABSTRACT BODY:

Purpose/Hypothesis: To examine the relation between physical activity (measured using an activity monitor) and sleep (self-reported and measured using an activity monitor) in individuals with Parkinson disease (PD) and healthy older adults (HOA).

Number of Subjects: PD=11, HOA=11

Materials/Methods: Participants with mild PD (Hoehn-Yahr stage < 2, able to walk a city block without an assistive device, on a stable dose of medications, no cognitive deficits) and HOA volunteered. They wore an activity monitor (Fitbit Charge HR) continuously for 14 days which collected data on steps, intensity (sedentary, light, moderate or higher activity minutes), sleep, and heart rate. All subjects filled out the Epworth Sleepiness Scale (EDSS), the Parkinson’s Disease Sleep Scale (PDSS), and the PROMIS Sleep Disturbance form (PROMIS).

Results: Participants with PD had significantly fewer steps (PD=6157.9 (3678.6), HOA=14238.3 (3618.0), p<0.01), greater sedentary minutes (PD=890.6 (181.7), HOA=587.7 (63.7), p<0.01) and fewer moderate or higher intensity minutes (PD=36.5 (27.7), HOA=89.0 (36.1), p<0.01) per day compared to HOA. Participants with PD also had fewer total minutes of sleep (PD=393.8 (89.5), HOA=455.1(33.2), p=0.05), and lesser restless duration (PD=12.0 (6.2), HOA=28.2 (13.5), p<0.01), and reported greater difficulty with sleep based on the PDSS (PD=16.8 (8.0), HOA=9.7(5.7), p<0.05) and EDSS (PD=11.4(6.4), HOA=5.1(3.4), p<0.01) compared to HOA. In the PD group, there is a significant association between sedentary minutes and minutes asleep (r=-0.85, p<0.01), and restless duration (r=-0.76, p<0.05), as well as with self reported measures of sleep based on the EDSS (r=0.70, p<0.05) and the PDSS (r=0.70, p<0.05), indicating that sleep quantity and quality are significantly associated with the amount of sedentary activity. In the HOA group, we found a negative correlation between light activity minutes and minutes asleep (r=-0.76, p<0.05), as well as between moderate or higher intensity minutes and time in bed (r=-0.60, p=0.05), and the PDSS (r=-0.78, p<0.01), indicating that the intensity of physical activity has an association with quantity of sleep. Also, as the number of steps increases, time asleep (r=-0.81, p=0.01) decreases, but the difficulty sleeping as measured by the PDSS (r=-0.66, p<0.05) and PROMIS (r=-0.64, p<0.05) also decreases.

Conclusions: As sedentary activity increases, quantity and quality of sleep decreased in those with PD whereas in HOA, difficulty sleeping decreases with an increase in the amount of physical activity.

Clinical Relevance: Previous data has examined physical activity and sleep as separate entities in individuals with PD but have examined the relationship between structured activities like exercise (vs. incidental physical activity) and sleep. Given the high prevalence of sleep disturbances in individuals with PD, this information could prove to have a substantial impact on health, function and quality of life.
Background & Purpose: Functional decline is expected over time for people with Parkinson disease (PD). Intense exercise incorporating motor learning principles may be beneficial to people with PD. The purpose of this case series is to examine the longitudinal effects after repeated participation in a weeklong intensive exercise program called Movement Camp (MC), for individuals with PD.

Case Description: Four participants, Hoehn and Yahr stage 2-3, completed three to four of four annually scheduled MCs. One participant completed all four consecutive MCs. One participant completed three consecutive MCs. Two participants completed three MCs with a one-year gap between participation. Participants ranged in age from 65-76 years, and disease duration from 3 to 20 years. MC was developed based on the principles of skill, capacity, and motivation and was offered annually. The MC week consisted of 3.5 full days of exercise, 5.5 hours per day (19 hours total) of exercise and two half days of testing. Participants rotated through four high-intensity one-hour, literature-based exercise stations targeting balance, gait quality, endurance and upper extremity function and three 30-minute group-training sessions. Rate of perceived exertion (RPE) was collected at each exercise station. During each MC, testing was completed at the beginning of the week, immediately post intervention and at six-weeks post intervention. Levodopa equivalent was calculated for each participant at the start of each MC.

Outcomes: We examined endurance, gait speed, balance, functional mobility and disease severity. RPE during exercise ranged from 2.5-6.2 indicating that participants were working moderately hard to hard at each exercise station. The time from initial baseline to last outcome measure completed ranged from two to three years. When comparing initial baseline measures (from the first camp) to the last measure for each individual, all participants maintained or improved performance on the outcome measures, e.g. percent changes ranged from 10.5%-33% for the Mini-BESTest, 0-37% for the six-minute walk test, 0-26% for the five times sit to stand and 2-76% change in the Unified Parkinson Disease Rating Scale. Levodopa equivalent remained stable for three of the four participants over a two to three year time period.

Discussion: This case series provides initial evidence that brief intensive exercise based on motor control principles may help maintain or improve function and minimize changes in medication dosage in people with PD over three years.
Title: Perceived Benefits of Exercise on Fall Risk and Physical Functioning in Older Adults with Parkinson Disease: A Qualitative Analysis

Abstract Body:

Purpose/Hypothesis: Physical decline and fall risk have been shown to increase as a person ages. Certain conditions such as Parkinson disease (PD), a chronic progressive neuro degenerative disease, exacerbate and increase these processes. Exercise interventions to improve physical functioning, quality of life and fall risk in this population are myriad, and the literature shows that overall, physical activity can help to slow or delay these processes in persons with PD. However, limited research exists regarding the perceived impact of exercise on physical function and fall risk in this population. The purpose of this research is to explore how participation in a twice-weekly exercise class influences perceived physical functioning and fall risk in people with PD.

Number of Subjects: Data was collected from seven males with PD, Hoehn and Yahr stage 2 or 3, age range 64-81 years and disease duration 7 to 22 years.

Materials/Methods: This qualitative study utilized structured one-time interviews of 7 participants of the Dan Aaron Stay Fit program (Stay Fit), a multimodal community group exercise class for people with PD. The survey consisted of 12 questions regarding the participant’s experience with PD, their perceived risk of falling and the perceived effect of Stay Fit on their physical functioning and fall risk. Conventional-content analysis was performed to develop codes and themes from the data.

Results: Two primary themes emerged from the data: Stay Fit Impacts Function and Consistent Exercise is Important. In Stay Fit Impacts Function, participants discussed the impact that Stay Fit has had on their physical functioning and fall risk. Participants describe how they have experienced increased endurance, better balance, improvement in gait and mobility and decreased falls because of their participation in Stay Fit. In Consistent Exercise is Important, participants discussed their beliefs regarding the benefits of exercising frequently and the risk of physical decline associated with not exercising regularly. Participants cite these benefits as reasons they take part in regular exercise such as Stay Fit.

Conclusions: Exercise has been shown to improve quantitative measures of physical functioning but its perceived effect on this population and the experience of those with PD as it relates to exercise has not been studied in depth. However, the results of this study suggest that people with PD believe that physical activity has helped improve their physical functioning and decrease their risk of falling. Participants’ perceptions of exercise align with the current literature.

Clinical Relevance: This study adds to the understanding of the perceived effect of exercise on physical functioning and fall risk in people with PD and provides further dimension and insight regarding the lived experiences of this population and their motivation to exercise.
Purpose/Hypothesis: Parkinson’s disease (PD) is the second most prevalent neurodegenerative disease globally and is characterized by incapacitating motor and cognitive symptoms. In addition, between 30-70% of individuals diagnosed with PD experience pain. Compared to the wealth of PD research pertaining to the effects of exercise and physical activity on motor symptoms, the effects of exercise on pain is poorly understood. The purpose of this systematic review is to systematically appraise available PD research on exercise for pain relief, and to subsequently identify gaps to inform future study.

Number of Subjects: 427 subjects (across 6 eligible studies)

Materials/Methods: A systematic search was performed across MEDLINE, CINAHL, Embase, Web of Science and Scopus for studies published since 2006. Inclusion criteria was utilization of an experimental or observational research design, enrollment of individuals with idiopathic PD who also experienced pain, test of exercise effects on pain, and publication in English. Eligible studies were qualitatively appraised using the Modified Downs and Black tool.

Results: Of 638 titles, 6 articles met eligibility criteria. 4/6 studies showed improvements (p<.05) in pain reduction after interventions (within group), or compared to a control group (between group). Studies primarily investigated immediate and short-term effects. Exercise type varied by study and included aquatic Ai-Chi, Nordic Walking, aerobic and strength training, and traditional physical therapy. Studies also demonstrated lack of uniformity in exercise parameters and pain outcome measures, with only 2/6 studies using pain as the primary outcome measure. Pain outcome measures included parent measures like the Visual Analog Scale, or subscales extrapolation including the Unified Parkinson’s Disease Rating Scale and Nottingham Health Profile. Across studies, types of PD pain was not specified. Qualitative assessment revealed one study to be rated as fair while the remainder were rated as poor. Primary limitations were lack of internal validity and poor statistical power.

Conclusions: The majority of appraised studies found pain reduction immediately following exercise interventions for participants with PD pain. However, limitations in current evidence include variability in exercise parameters and pain outcomes, as well as suboptimal study quality. Moreover, little is known about the value of exercise for PD pain beyond immediate effects. Future research should implement well-designed, randomized controlled trials with standardized exercise interventions and pain outcome measures, specificity to PD pain types, and longer-term time points.

Clinical Relevance: Current research suggests the potential for immediate pain reduction among patients with PD pain. However, clinicians should scrutinize the current literature based on the high variability in exercise parameters. Moreover, clinicians need to closely monitor patients for longer-term effects, which have not been substantiated scientifically.
Physical therapy practice patterns for people with Parkinson’s disease: a mixed methods study

Purpose/Hypothesis: Physical therapy (PT) is an evidence-based intervention that is underutilized for people with Parkinson’s disease (PD), particularly early in the disease. This mixed methods study blends quantitative and qualitative data to describe current practice and to elicit implementation strategies for improved care. We hypothesize that PT practices vary across provider organizations and stages of PD, and that modifiable barriers and facilitators will be identified.

Number of Subjects: 186 survey and 50 focus group participants.

Materials/Methods: Online surveys were sent to 251 physical therapists (PTs) and 268 doctors (MDs) at 32 academic medical centers with PD expertise in the United States. Surveys addressed PT referral practices, exercise prescription, and use of evidence-based PT measures and interventions across Hoehn and Yahr (HY) stages. Based on survey results, explanatory focus groups and interviews were conducted at 6 centers selected for regional variability (urban/rural), level of proactive PT practice, and use of routine long-term PT monitoring.

Results: Survey response rates were 43% for PTs and 29% for MDs. Over 80% of MD respondents reported referring most (>60%) of their patients in HY 3-4 PD, while <25% reported frequent referrals in HY 1, 2, and 5. 61% of MD and 58% of PT respondents support using PT to prevent declines in function in early PD. 33-53% of MDs report providing verbal exercise instructions, but not written. 60-71% of PTs provide verbal and written instructions for balance and flexibility exercises, but only 31-46% report written prescription of aerobic and strengthening exercise. 70% of MD and PT respondents would recommend that an infrequent exerciser with HY 1 PD should attend PT at least every 6-12 months in the absence of personal or environmental barriers, with decreasing intervals of 1-2 months in HY 4. However, only 40% of PTs reported using routine follow-ups. Recommended interventions change from exercise prescription in HY 1 to balance and gait in HY 2-3. Patients, PTs, and MDs identified similar facilitators to PT use, with rural and urban centers developing relationships with clinical experts and community programs. Modifiable process barriers included communication, improving sustainable PT expertise, improving patient and clinician knowledge of insurance, enhancing patient motivation through routine follow-ups with expert PTs, and disseminating research on PT and exercise to patients and clinicians.

Conclusions: Expert PD centers provide varied PT practices for people with PD across the stages of the disease, with moderate levels of proactive exercise prescription and long-term monitoring of exercise and function. Potential implementation strategies target modifiable processes and patient/clinician barriers.

Clinical Relevance: Many expert PD centers strive to accomplish proactive referrals to PT in early PD for exercise prescription and perform routine PT follow-ups at set intervals with consistent therapists. Promising strategies addressing processes and patient/clinician barriers to PT are shared.
Purpose/Hypothesis: Pupillary response is a non-intrusive, neurophysiological measure of cognitive workload\(^1,2\). Preliminary studies have shown that pupillary responses are also sensitive to changes in postural control conditions in healthy young individuals\(^3\). However, the reliability of pupillary response during challenging postural control conditions in individuals with Parkinson’s disease (PD) has not been established. We hypothesized that pupillary response would demonstrate high test-retest reliability during postural control conditions in individuals with PD.

Number of Subjects: Six individuals with PD (age: 66.1±5.6, sex: 3 female, Hoehn and Yahr stage II-III while ON medication), and ten age- and sex-matched healthy controls (age: 67±5.7, sex: 6 female) were recruited.

Materials/Methods: All subjects were tested at the University of Kansas Medical Center. Subjects were asked to wear eyetracking glasses (SensoMotoric Instruments) in order to record the pupillary response across four conditions: (1) single postural control task with eyes open; (2) single postural control task with eyes occluded; (3) dual task condition with eyes open; (4) dual task condition with eyes occluded. During the single postural control task, subjects were asked to stand on the balance platform (Advanced Mechanical Technology, Inc.) for 60 seconds with eyes open and eyes occluded. The dual task involved standing on the balance platform while performing the auditory Stroop test. To examine the test-retest reliability of the pupillary response, the conditions were administered twice for each subject on the same day. Cognitive workload, indexed by pupillary response, was transformed on a continuous scale ranging from 0 to 1\(^4\). Intraclass correlation coefficients (ICC) were used to interpret the test-retest reliability of pupillary response in each condition for both groups. ICC was interpreted as follows: >0.75 was excellent, 0.60–0.74 was good, 0.40–0.59 was fair, <0.40 was poor\(^5\).

Results: Pupillary response values during all of the conditions displayed good to excellent test-retest reliability in both people with PD and healthy controls (ICC>0.60). However, the pupillary response during dual task condition with eyes occluded showed poor test-retest reliability for individuals with PD (ICC=0.30).

Conclusions: Pupillary response showed good to excellent test-retest reliability in nearly all conditions for individuals with PD and healthy controls.

Clinical Relevance: Pupillary response may potentially be used as a real-time and objective tool to evaluate cognitive workload during challenging postural control conditions in individuals with PD. Thus, pupillary response could be a potential tool to improve physical rehabilitation outcomes through understanding changes in postural demand in PD.
Purpose/Hypothesis: To investigate if movement inspired by yoga influence QOL, sleep, posture and motor control in patients with Parkinson’s disease (PD).

Number of Subjects: 5 males and 2 females with an average age of 76 years old.

Materials/Methods: Intervention: 6 week exercise program including breath control, relaxation exercises and physical postures inspired by yoga. Poses progressed from seated to standing with guarding utilized at a 1:1 ratio. A weekly home exercise video of 1-3 poses was provided with a paper log sheet to document compliance. Outcome measures: PDQ-39, Parkinson’s Disease Sleep Scale (PDSS), FitBits for sleep behavior, 5 time sit to stand, PostureScreen Mobile app, timed finger-tapping test and spousal responses to the question “Did you notice any changes in your spouse’s PD symptoms, sleep, mood, walking or general activity level?” Outcome measures were assessed 1 week prior and after the intervention (PDSS and PDQ also at a 3 month follow up).

Results: PDQ 39: Statistical significance in the Cognitive Dimension pre-post (p = 0.038), but total scores were non-statistically (NSS) and non-clinically significant (NCS) and a decline was noted at the 3 month follow up. Sit to Stand, Finger Tapping and PDSS Scores: NSS, NCS. Posture Screen Mobile Testing: NSS. Positive posture changes were noted in select participants. Fit Bit: Not reliable. Subjective: Responses were positive with themes of enjoyment and changes in social interactions, walking and sleeping.

Conclusions: A theme in post intervention surveys was that participants enjoyed participating in the intervention. This may be related to the positive significant changes in cognitive domain of the PDQ-39 and furthermore links between the intervention and QOL within PD. Throughout the intervention the participants improved fluidity in movements as noted by decreased physical assistance required for correct positioning. Unfortunately the home exercise video compliance was low which may explain the NSS results. Further research is still required to develop effective parameters of intervention and population for these outcomes as well as to improve home exercise compliance and spousal involvement/effect.

Clinical Relevance: The subjective and social changes that we observed in this study suggest a possibility that with the correct outcomes tools and a less varied pool of subjects, movement can be optimized to enhance QOL and function in PD patients and spouses.
Background & Purpose: Parkinson’s Disease (PD) is a neurodegenerative disease that impacts movement, daily function, cognition and quality of life. Sleep disorders in patients with PD are common and also impact quality of life. It has been accepted that exercise, at the right intensity, can provide symptom relief similar to medication. A growing body of evidence suggests that nutrition may play an important role in PD. Due to the diversity of symptoms, a multiprofessional team approach is the preferred approach to treatment. This case report demonstrates the role of the physical therapist in utilizing a wellness approach to improve the quality of life of an individual with PD.

Case Description: Pt is a 56y/o female with Parkinson’s Disease who presented for a skilled PT evaluation after being diagnosed within the year. Upon evaluation, she presented with a PT diagnosis of Force Production Deficits due to comorbidities including B TKA and a secondary diagnosis of Movement Pattern Coordination Deficit due to incoordination in L extremities more than R extremities. Non-motor complaints included difficulty with sleeping, fatigue and brain fog, inability to manage full time work and coaching, difficulty with word finding, driving and cognitive deficits. She was seen for 12 visits over 8 weeks with treatment focused on strength training, high amplitude and high intensity interventions for neuroplasticity as well as wellness management. Wellness management included referrals for ST, OT, movement specialist, nutrition education, hydration education, sleep education and referral for sleep study.

Outcomes: Upon evaluation, Pt completed the Five Time Sit to Stand (FTSTS), 6 minute walk test, Functional Gait Assessment, Mini-BEST, Timed up and Go and Timed up and Go Cognitive. Of those measures, she was within normal limits in all but FTSTS (23.3s), 6MWT (1215ft) and FGA (23/30). Upon discharge, she had improved FTSTS to 11s, 6MWT to 1558ft and FGA to 27/30. Other measures that were tracked over the course of therapy included access to an interprofessional team. By discharge, she had been referred to a movement specialist, speech therapist, occupational therapist and sleep specialist. Pt was able to return to full time work and coaching without needing naps during the day. Pt also reported improved BMI and an improvement in total cholesterol of 236 to 183, including increasing HDLs and decreasing LDL from the start of therapy until discharge.

Discussion: Comprehensive, client-centered physical therapy for people with PD is based on strategies to bypass the defective basal ganglia, improving motor learning and performance, management of secondary consequences, as well as on assisting people to make lifelong changes in physical activity habits. The results of this case study support the efficacy of providing a wellness approach to treat and refer for symptom management and improved quality of life.
TITLE: Changes in gait kinematics during a 12 minute walk in persons with multiple sclerosis

ABSTRACT BODY:

Purpose/Hypothesis: Fatigability, a decline in physical performance with repetition, is commonly experienced by people with multiple sclerosis (pwMS). Our previous work has shown that there are changes in temporospatial gait parameters during prolonged walking in pwMS. The main purpose of this study was to quantify changes in lower extremity kinematics (LEK) during prolonged walking in a sample of pwMS. The secondary purpose was to examine the relationship between the magnitude of changes in LEK and self-report measures of disease severity, walking and fatigue.

Number of Subjects: Thirteen people with a confirmed diagnosis of multiple sclerosis participated in this study [(11 women, 2 men; mean age=57 (+/- 4.4), mean years since diagnosis=12.9 (+/- 8.6); median Disease Steps (DS) and Patient Determined Disease Steps (PDDS) were 3 (IQR=1) and 3 (IQR=2), respectively].

Materials/Methods: Participants ambulated continuously for 12 minutes along a 58-foot-long, obround track. Eight Vicon Bonita passive optical cameras and a Modified Helen Hayes marker set were used to capture LEK during each pass through the capture volume for each lap walked. Prior to the walk, participants completed the Modified Fatigue Impact Scale (MFIS) and 12-item Multiple Sclerosis Walking Scale (MSWS-12). Perceived fatigue was rated before and after completing the walk using a visual analogue scale (VAS-F). The difference between the two were calculated as ΔVAS-F.

Paired sample t-tests were employed to compare magnitude of excursion at each joint and the total magnitude of excursion in all joints combined. Spearman’s correlations were performed to determine relationships between patient self-report measures and kinematic changes in gait over time.

Results: The magnitude of combined joint excursion changed over time [(6.069), p <0.001, CI 95% (28.73-60.92)] as did total excursion for each joint (left hip flexion p =0.001, right hip flexion p< 0.001, left hip abduction p = 0.027, right hip abduction p = 0.021, left knee flexion p<0.001, right knee flexion p = 0.001, left ankle flexion p = 0.009, right ankle flexion p = 0.001) Changes in gait kinematics did not significantly correlate with DS, PDDS, MSWS-12, MFIS or ΔVAS-F.

Conclusions: This study confirms previous findings and anecdotal evidence: gait kinematics in pwMS change over time, but like the disease itself, the between-participants differences were widely varied. In addition, this study confirms the findings of previous studies that self-report measures do not correlate well with functional performance. Clinical Relevance: Fatigability is an important problem experienced by pwMS. Objective, multifactorial measures must be developed to better describe the impact of fatigability on gait and walking. Addressing kinematic changes related to fatigability is an important element of a physical therapy plan of care. Self-report measures of fatigue do not correlate with changes in walking performance and may not be useful in examining walking capacity or guide exercise progression.
The impact of group exercise on balance confidence in persons with Parkinson’s disease

Purpose/Hypothesis: As a means to provide ample exercise, minimize health care costs and increase social interactions, opportunities for group exercise have expanded for individuals with Parkinson’s Disease (PD). Among those symptoms known to improve with exercise and impact motor performance, self-efficacy has not been shown to benefit from group exercise. Given that decreased balance efficacy in people with PD has been demonstrated as an independent predictor of gait deficits and postural instability, it is essential that interventions target confidence. Due to the larger scale of group exercise courses, participants often fail to stand out and do not receive significant or meaningful attention. To minimize this, we offered classes in a hybrid group exercise model. This model includes increased number of instructors who participated alongside participants, strategies to increase group camaraderie including pairing of participants to instructors for increased individualized attention, pairing of participants for increased socialization, and celebrations of group and individual accomplishments within the class. The primary aim of this study was to understand how participation in this form of hybrid group exercise for people with PD impacts balance confidence.

Number of Subjects: 12 (aged 51-81 years, 5 males, 7 females, H&Y 1-3)

Materials/Methods: 12 community-dwelling individuals with PD were recruited for a weekly 8-week community boxing course. The Activities-specific Balance Confidence Scale (ABC) was used to assess balance confidence.

Results: Post exercise ABC scores were obtained for 9 subjects. All subjects who attended at least 7 of the 8 classes reported an increase in balance confidence, whereas those who attended 6 or fewer reported a decrease in balance confidence. Three participants reported an increase in balance confidence (ranging from 1.56% to 30.63%, with an average increase of 13.13%); 4 reported a decrease in balance confidence (ranging from -1.25% to -14.06%, with an average of -7.81%). Two participants indicated no change in balance confidence.

Conclusions: Despite less sessions than previous research that showed group exercise does not improve self-efficacy, our preliminary data suggests that a hybrid group exercise model with increased individualized attention from instructors and participant socialization is associated with improvement in balance confidence. Additionally, individuals with higher attendance rates in the class reported increased balance confidence, suggesting that other personal or environmental factors such as higher motivation, greater family/community support may contribute to greater self-efficacy. Further research is needed to better understand these contributing factors.

Clinical Relevance: Our results suggest that previous negative outcomes regarding group exercise and self-efficacy were ameliorated with this hybrid approach. Other motor, cognitive, and/or psychological manifestations of PD that have been shown to be improved by individual compared to group exercise may be beneficially impacted by this cost-effective approach.
Ultrasound Measures of Muscle Morphology Are Associated with Disease Status and Muscle Performance in Individuals with Multiple Sclerosis

TITLE: Ultrasound Measures of Muscle Morphology Are Associated with Disease Status and Muscle Performance in Individuals with Multiple Sclerosis

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ABSTRACT BODY:

Purpose/Hypothesis: Chronic nervous system pathology, like Multiple Sclerosis (MS), influences changes in skeletal muscle, thereby reducing performance. Characterizing changes in muscle morphology with diagnostic ultrasound (US) may help explain functional asymmetries. The purpose of this study was to determine if measures of quantitative US muscle morphology are associated with MS disease status, functional ability and leg asymmetries. We hypothesized there would be significant relationships between muscle quality and disease status or functional ability, and significant differences between muscle thickness and quality of the more affected versus less affected leg based on muscle strength.

Number of Subjects: We enrolled Veterans with MS from the Washington DC VA Medical Center (n=29, women=15, men=14, Caucasian=6, African-American=23, age=49 years (SD11.15), relapse-remitting=21, secondary progressive=8, Body Mass Index (BMI)=27.18 (SD4.97)).

Materials/Methods: Disease status was evaluated using the Expanded Disability Status Scale (EDSS). Function was measured using gait speed and five time sit to stand test (5STS). Quadriceps strength and power were determined from averaged peak maximal volitional contraction at 60 deg/s. and 180 deg/s. Quadriceps thickness and echogenicity were obtained with B-mode quantitative US and 13-6 MHz linear array transducer. Muscle quality was represented by grayscale post-image processing on ImageJ. Pearson’s correlation coefficients were used to determine associations and paired t-tests to determine differences between the less and more affected. All statistical tests done in SAS 9.4 and evaluated at alpha=0.05.

Results: Our participants had moderate disability (EDSS=3.6 (SD1.37), disease duration=10.3 years (SD4.97), gait speed (m/s) = 1.32 (SD0.31), 5STS time (s) = 11.44 (SD4.05)). Muscle thickness was related to age (r=0.58 p=0.001) whereas grayscale was positively associated with age (r=0.40 p=0.03), disease duration (r=0.43 p=0.02) and BMI (r=0.50 p=0.005). MS asymmetries were evident in muscle thickness (p=0.02), strength (p=0.002) and power (p=0.042). There were moderate relationships of muscle thickness and strength (r=0.40 p=0.032) and power (r=0.44 p=0.017) in the less affected leg with slightly stronger associations on the more affected leg (muscle thickness and strength: r=0.64 p=0.0002, power: r=0.58 p=0.0010).

Conclusions: Measures of morphology were related to disease status and muscle performance in individuals with MS. Specifically, muscle quality was associated with disease duration, whereas muscle thickness was related to quadriceps strength and power. Quadriceps strength, power and muscle thickness differed significantly between the less versus more affected leg, indicating an asymmetry. A larger sample is needed to control for sex differences in muscle morphology.

Clinical Relevance: Diagnostic US is a viable relatively low-cost tool that physical therapists can use to assess changes in muscle physiology in individuals with MS that relate to muscle performance and limb asymmetries.
**Title:** Use of the Adult Myopathy Assessment Tool (AMAT) to Quantify Functional Impact of Fatigue in Veterans with Multiple Sclerosis

**Current Section:** Neurology

**Current Sub-Category:** Degenerative Disease SIG

**Authors:**

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**Abstract Body:**

**Purpose/Hypothesis:** Clinicians are limited in their ability to measure the impact of subjective fatigue and fatigability on functional ability for individuals with multiple sclerosis (MS). The AMAT assesses function and endurance related to muscle dysfunction, and is a valid predictor of function. The purpose of this study was to examine the relationship of the AMAT with disease status, function, muscle performance and fatigue in individuals with MS. We hypothesized the AMAT is directly related to muscle performance and fatigability and more strongly associated with disease status than gait speed or the five-time sit to stand (5STS) times.

**Number of Subjects:** We enrolled individuals with MS from the Washington DC VA Medical Center (n=29, women=15, men=14, Caucasian=6, African-American=23, mean age=49 years (SD11.15), relapse-remitting=21, secondary progressive=8).

**Materials/Methods:** Disease status was evaluated using the Expanded Disability Status Scale (EDSS). Function was measured using the AMAT, gait speed and 5STS. Self-reported fatigue was captured by the Modified Fatigue Impact Scale (MFIS). Quadriceps strength and power were determined from averaged peak maximal volitional contraction at 60 deg./sec. and 180 deg./ sec. A 60-second maximal volitional isometric contraction (MVIC) quadricep fatigue test with the less affected leg was used to calculate fatigability (exhaustion time to 60% of MVIC). Regression analyses with Spearman’s correlations were used to examine associations of interest at alpha=0.05.

**Results:** Our sample population had a mean EDSS of 3.6 (SD1.37), gait speed of 1.32 m/s (SD0.31), 5STS time of 11.44 sec (SD4.05) and reported subjective fatigue (MFIS=45.14 (SD16.19)). Mean AMAT score was 36 (SD7.6), range [18-45]. AMAT score was directly related to gait speed (r=0.76 p<0.0001), 5STS (r=-0.64 p<0.002), strength (r=0.60 p<0.0005) and power (r=0.57 p<0.001). The AMAT functional subscale exhibited a small, non-significant, association with exhaustion time (r=0.34 p=0.07). There was no significant relationship between AMAT or its subscales with subjective fatigue. EDSS was related to the AMAT (r=-0.39 p<0.03) and functional subscale (r=-0.50 p=0.005), but not related to gait speed or 5STS times. An MS-specific test was explored by removing two items (#9 and #10) where fewer than 10% of participants scored below a full score. However, the adjustment did not strengthen the reported relationships.

**Conclusions:** The AMAT was associated with functional ability and was more strongly related to disease status for individuals with MS than gait speed and 5STS times. The AMAT was moderately associated with quadriceps performance, and the functional subscale may have a relationship with fatigability. A larger and more diverse selection of disease progression is required to create an MS-specific AMAT.

**Clinical Relevance:** Our results suggest the AMAT captures additional variance in disease progression not reflected in gait speed or 5STS alone and may be a superior clinical test for assessing function in individuals with MS.
ABSTRACT BODY:

**Purpose:** The purpose of this presentation is to provide an overview of a community-based interval training program that focuses on delivering intense exercise for people with Parkinson’s disease (PD) and is supported by physical therapists. The collaboration between physical therapists and exercise practitioners allows for patients with PD to maximize intensity of exercise while minimizing disruptions due to musculoskeletal and other adverse events that may limit exercise.

**Description:** Intense exercise, particularly cardiovascular exercise, is a promising modality to provide neuroprotective benefits in people with PD. However, many barriers exist to incorporating intense exercise into daily life. These barriers include, cardiorespiratory fitness, self-efficacy for exercise and fear of falling. The PushBack at Parkinson’s disease (PB@PD) is designed to maximize intensity of exercise and address these barriers to exercise. Participants initiate improving cardiorespiratory fitness during an initial episode of physical therapy where patients are monitored and encouraged to achieve a targeted heart rate. The program improves self-efficacy for exercise by providing peer models in a socially cohesive group. Structured exercises and guarding from volunteers allows participants to challenge and improve balance.

PB@PD is offered at community gyms by exercise practitioners trained by physical therapists at the University of Vermont Medical Center to deliver a targeted circuit based group of exercises with a focus on intensity. This project was initiated at one site and is now expanding to a geographically large and rural area.

Prior to entering the program, participants are evaluated by a physical therapist and have a preparatory episode of physical therapy to help identify optimal intensity levels and exercise modifications. The participants are then seen at least every 6 months by a physical therapist to evaluate for maintenance or improved function and cardiovascular response. The physical therapist is available to assist with problem solving if a participant is having trouble exercising or if the exercise practitioner has concerns. Physical therapists at remote sites are trained with the latest information for evaluation, intervention and on-going support for people with PD.

**Summary of Use:** In this platform, the program will be presented, including identified facilitators and barriers to implementing this program in a variety of sites. This will include evaluation of program metrics, qualitative data from participants and physical therapy utilization.

**Importance to Members:** The purpose of PB@PD program is to facilitate maximum exercise capacity for as long as possible in people with PD. By design, this program utilized physical therapists to their highest professional capacity by providing support to intense community group exercise programs with individual physical therapy check-ups of participants at regular intervals.
Purpose/Hypothesis: One commonly reported problem by people with multiple sclerosis (PwMS) is impaired mobility. Decreased mobility leads to physical inactivity which leads to deconditioning. Deconditioning further impairs mobility and disability ensues. Preventing decline in mobility may slow the progression of disability. PwMS who are non-ambulatory face barriers for improving strength and muscle endurance. Functional electrical stimulation (FES) cycling offers an opportunity to directly train muscles during a functional activity. We hypothesize that combining volitional activation of muscles and FES may improve muscle function that can be used for functional retraining. Backus et al has demonstrated improvement in FES cycling performance, fatigue, and quality of life in persons with severe MS. Previous protocols were based on those for people with complete paralysis due to spinal cord injury, while participants with MS had muscle function that may be trained. More meaningful outcomes may be elicited by providing a greater stimulus, i.e. volitional muscle activation that is augmented, not substituted for, with FES. The purpose of the study was to evaluate various protocols of FES cycling to determine safety and potential efficacy to decrease symptoms and improve function in PwMS who are non-ambulatory.

Number of Subjects: 9

Materials/Methods: Nine PwMS using a wheelchair for mobility performed FES leg cycling to evaluate different protocols requiring increasing muscle demand 1-2x/week for 6 to 8 sessions. Safety was measured by change in vital signs, adverse events (AEs) or increase in fatigue, pain or spasticity pre-post each session and pre-post the testing period. Feasibility was assessed by change in performance parameters during FES cycling. Functional Assessment of Multiple Sclerosis (FAMS), Multiple Sclerosis Impact Scale (MSIS-29), Exercise Self Efficacy Scale (ESES), Patient Health Questionnaire – 9 item (PHQ-9), and Zarit Caregiver Burden scale (ZCB) were assessed post-all testing sessions to assess potential efficacy of FES cycling.

Results: There were no AEs or differences between protocols in vitals or symptoms. Cycling performance varied between protocols. Scores improved on FAMS (+8.51%, SD 14.77), MSIS-29 (-16.1%, SD 14.42), and ZCB (n=4) (-9.34%, SD 12.16), and declined on ESES (-1.91%, SD 24.68) and PHQ-9 (11.9%, SD 53.43).

Conclusions: Persons with MS can safely perform FES cycling using parameters requiring more effort. Future studies should assess the functional effects of FES cycling in persons with severe MS who are non-ambulatory.

Clinical Relevance: Once a person with MS experiences impaired mobility, a rapid decline in function may begin. Preventing the decline in mobility and increasing physical activity may help slow the progression of disability in people with MS. As a rehabilitation tool, FES cycling may offer a potential opportunity for neuromuscular training if cycling protocols are utilized that adequately challenge the muscle in these individuals.
Does Whole Body Periodic Acceleration Reduce Non Motor Signs in Persons with Mild to Moderate Parkinson's Disease?

**Purpose:** Parkinson's disease (PD) is commonly characterized by non-motor symptoms including depression, anxiety, and sleep disturbances. These non-motor symptoms can significantly affect quality of life for people with PD. In PD, Nitric Oxide (NO) production is reduced, which inhibits sleep. Whole Body Periodic Acceleration (WBPA) has been found to increase secretion of NO. This study assessed whether WBPA would improve non-motor symptoms in persons with Parkinson's disease.

**Description:** There were 13 participants with PD, with a mean age 70.8 years. Activity trackers were used to monitor sleep, awakenings, and step counts for 24 hours per day over 6 weeks. The participants were instructed to wear the activity trackers 7 days prior, during, and 7 days after the intervention. Additionally, the Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep, the Patient Health Questionnaire (PHQ-9) for depressive symptoms and Parkinson's Disease Quality of Life (PDQ-8) to assess quality of life. Blood pressure was also monitored before and after each session. The duration and frequency of the WBPA intervention was 3 times per week for 4 weeks for 45 minutes each session. Blood pressure (BP) was monitored before and after each session.

Repeated measures were used to assess for main effects, t-tests were used for all the dependent variables, paired t-tests used to assess pre vs post systolic BP. Significant differences were found in the results of the self-reports, PSQI (p .04), PDQ-8 (p .01), PHQ-9 (p .02), as well as assessment of pre vs post systolic BP (p .00). There were no significant effects between pairs in sleep (p .84), awakenings (p .10), and activity (p .37) as measured using the activity trackers.

**Summary of Use:** With the small sample size of 13 subjects, we were able to demonstrate meaningful improvements in sleep via PSQI quality of life via PDQ-8, and depressive symptoms via PHQ-9. Systolic blood pressure was also seen to significantly decrease after the intervention. Interventions such as this may have a significant role in PD management of non-motor symptoms, and further studies can use this information as a start for other potential interventions for the treatment of non-motor symptoms in PD. Further studies to assess optimal dosing of WBPA and to assess modifications to allow its use in the home would be beneficial.

**Importance to Members:** Whole body periodic acceleration has been shown to be of benefit in triggering neuroprotective responses in the brain, heart, and arteries. These responses have been demonstrated to measurably improve the quality of life in persons with PD. In the future, with continued research, applications such as this may become mainstream, even in the homes of persons with PD.
Purpose/Hypothesis: Spinal and bulbar muscular atrophy (SBMA) is an X-linked neuromuscular disorder that results in progressive bulbar and extremity muscle weakness. In addition to causing motor neuron degeneration and myopathy, SBMA also affects somatosensory perception and mechanisms used for maintaining upright balance. While previous studies have quantified function using outcomes like quiet stance, 6MWT, TUG test and questionnaires, there is a dearth of research focusing on postural control during dynamic tasks like stepping, turning, and lunging forward, which are representative of everyday function. Poor performance of these tasks may be indicative of an increased fall risk, a common finding in patients with SBMA. The goal of this study was to quantify and analyze characteristics of dynamic postural control during functional tasks in a group of ambulatory patients. We hypothesize measurable deficits of function in our patients compared to healthy controls.

Number of Subjects: 54

Materials/Methods: This is a cross sectional analysis comparing 54 males diagnosed with SBMA (mean age 54±9, range 29-74), and a normative dataset (NeuroCom SMART EquiTest® System, Natus Inc., Seattle, WA) with 47 controls (27 F, 20 M, range 40-59). Three trials of the following tests with their respective variables were performed on the NeuroCom System: 1) Step Quick Turn (SQT): turn time, turn sway velocity, 2) Step Up and Over (SUO): lift-up index, movement time, impact index, and 3) Forward Lunge (FL): distance, impact index, contact time, force impulse. Between group comparisons were conducted using unpaired T test while Cohen's D was calculated for determining effect sizes.

Results: Not all patients were able to perform all tests; the completion rate was 65% for SQT, 56% for FL and 52% for SUO. Those who completed the tests scored significantly poorer (p<0.005) on all variables for FL and SUO, and on turn time for SQT, compared to controls. These findings were supported by effect size calculations that were large (>0.8) for all variables of FL, medium (0.64) for all but one variable of SUO (Impact Index), and small (.026 and .032) for SQT (Turn Sway Velocity).

Conclusions: Our findings suggest that dynamic balance during functional tasks is significantly affected in patients with SBMA. FL had the lowest scores for all the test variables when compared to controls, while SUO proved to be most challenging in terms of proper test execution. This is possibly due to lower limb weakness seen in this population, especially of the quadriceps, which we speculate affects FL and SUO more than SQT abilities.

Clinical Relevance: This study provides an insight into the postural control of patients with SBMA during functional tasks. By reporting the underperformance of our cohort on certain variables, we hope to support further investigation of these variables as (1) predictors of fall risk, (2) markers of disease progression, and (3) potential outcomes for intervention studies. Furthermore, future research efforts should investigate possible correlations between these variables and muscle strength.
CONTROL ID: 3039998

TITLE: For persons with Parkinson’s Disease, does bicycling reduce motor symptoms and improve motor performance?

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Disease SIG

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ABSTRACT BODY:

Purpose/Hypothesis: Persons with Parkinson’s Disease (PD) exhibit motor symptoms and declines in motor performance. Gait and treadmill training have been shown to improve these symptoms; however, lack of supervision may prove difficult and unsafe. Bicycling may be a safe and feasible alternative to treadmill training. The purpose of this review is to critically appraise the evidence supporting the use of cycling in reducing motor symptoms and improving motor performance in persons with PD.

Number of Subjects: After eliminating duplicates, five total articles were extracted for this review.

Materials/Methods: A search was conducted using the following databases (and timelines): PubMed (1950-November 2017), Medline (1950-2017), and CINAHL (1981-2017) The key words were selected based on the Population Intervention and Outcome (PIO) format, using AND and OR Boolean operators as follows: Population: Parkinson*. Intervention: bicycl* OR bik* OR dynamic cycl* OR tandem cycl* OR dynamic bicycl* OR tandem bicycl* OR dynamic bik* OR tandem bik*. Two separate searches were conducted for motor symptoms and motor performance outcomes as follows: Motor symptoms OR UPDRS; Motor performance OR gait OR cadence OR balance. Articles were kept if they met the following inclusion criteria: stationary bicycling, motor performance and/or motor symptoms, level of evidence (LOE) greater than or equal to 2b on the Oxford Center for Evidence Based Medicine (OCEBM) scale, Hoehn & Yahr < 3, and exercise during off time of medication. The PEDro scale was used to appraise randomized control trials (RCTs). Data were extracted from the articles for the PIO as well as dose. After eliminating duplicates, five total articles were extracted.

Results: Five articles met the inclusion criteria (Arcolin et al., 2016, Ridgel et al., 2015, Nadeau et al., 2017, McGough et al., 2016, and Uygur et al., 2017). Their levels of evidence ranged from 1b-2b. Three of the five studies were RCTs ranging on the PEDro scale from 5/10 to 9/10. The other two studies were cohort studies. Participants included persons with PD Hoehn & Yahr (H&Y) levels 1-3, aged 59-68 years old. Various types of cycling methods were used in each of the studies, including cycle ergometer bikes, dynamic high-cadence bikes, stationary recumbent bikes, and forced tandem bicycling. Four of the five studies paced the subjects at a specific RPM (60-90). The exercise dose varied widely among the studies (120-1800 minutes). UPDRS motor symptoms decreased between 13.9% and 22%. Four out of five studies reported improved balance on the TUG (3.8-15%), as well as gait speed (3.2-15.6%). Findings were clinically meaningful in only one study (McGough, 2016).

Conclusions: There is promising yet limited evidence that bicycling reduces motor symptoms and improves motor performance in persons with PD and H&Y levels 1-3.

Clinical Relevance: Based on the evidence, cycling appears to be a safe and feasible intervention to reduce motor symptoms and improve balance and gait in persons with PD.
TITLE: Which domains of cognition, using the Montreal Cognitive Assessment, are related to balance in people with Parkinson’s disease?

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Disease SIG

AUTHORS (FIRST NAME, LAST NAME): Karl Arabian², Evan T. Cohen¹, Rosemary Gallagher²

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ABSTRACT BODY:

Purpose/Hypothesis: There is a known relationship between cognition and balance in healthy older adults and people with Parkinson’s disease (PD). Knowledge of deficits in specific cognitive domains and their relationship to balance may impact the choice of physical therapy examination and interventions for people with PD. However, this relationship remains unexplored in people with PD. Additionally, although balance in people with PD is routinely assessed by physical therapists, cognition is not, and is due to a variety of reasons, one of which is time constraints in the clinic. The Montreal Cognitive Assessment (MoCA), a valid and reliable tool to assess cognition in people with PD, requires little training, and is practical in terms of administration time (approximately 10 minutes). It is considered an assessment of global cognition and was developed as a screen for mild cognitive impairment. It covers a range of cognitive function including visuospatial/executive, naming, memory, attention, language, abstraction, and orientation. The purpose of this study therefore was to examine the relationship between domains of cognition, using the MoCA, and balance, using the MiniBESTest, in people with PD.

Number of Subjects: 83

Materials/Methods: A convenience sample of eighty-three people with PD; 79.5% (n=66) men, mean age 67.5 (SD=8.4), and mean Unified Parkinson’s Disease Rating Scale total score of 39.7 (SD=14.0) participated in the study. Balance was assessed with the MiniBESTest. Domains of cognition were assessed with the MoCA. Spearman rho correlations were used to evaluate bivariate relationships and multiple regression was used to assess multivariable relationships after adjusting for potential confounders.

Results: MiniBESTest total score was significantly correlated with MoCA total score (rho=0.313, p=0.004). This relationship appeared to be driven largely by three MoCA domains: visuospatial/executive, language, and recall. After adjusting for age in the regression model, the combination of these three MoCA domains predicted 20% of the sample variance in the MiniBESTest score (R²=20.2, p=0.001) with a one-point increase in MoCA-language predicting a 1.44 point increase in MiniBESTest score (β=1.44, p=0.008). The MoCA visuospatial/executive and recall domains were not significant in the multivariable model.

Conclusions: The study findings indicate that although the MoCA is an assessment of global cognition, the specific subdomains of language, visuospatial/executive, and recall are related to balance control.

Clinical Relevance: Physical therapists should be mindful of these relationships as they may influence the choice of tests and measures to utilize with the patient with PD, and ultimately may influence the choice of balance interventions with these specific cognitive deficits in mind.
A Novel Framework for Addressing Freezing of Gait in Parkinson Disease: Combining Education and Evidence-Based Interventions in a Small Group Community Setting

Purpose/Hypothesis: Freezing of Gait (FoG) impairs mobility and is a major risk factor for falls in people with Parkinson disease (PD). Medical interventions, including levodopa and deep brain stimulation, are often inadequate for treating FoG. Rehabilitation approaches that utilize compensatory methods to overcome a freezing episode, such as auditory cueing and stepping strategies, have been shown to decrease gait impairments and FoG. More recent research indicates restorative interventions that incorporate cognitive training into exercise interventions to address impairments in executive function are beneficial. While the advantages of a multi-faceted intervention to address FoG are well documented, the educational, goal setting, and action planning components are frequently omitted. These are important because research suggests self-generated information is more likely to be remembered than information supplied by others. In this pilot study, we investigated a novel intervention that combined education, goal setting, action planning and group discussion in an effort to reduce FoG. We hypothesized participants completing this intervention would demonstrate less FoG and improved gait and functional mobility.

Number of Subjects: Seven participants with idiopathic PD who self-report experiencing FoG in the past month.

Materials/Methods: Participants completed six training sessions (i.e., once weekly for six weeks) in a community setting. Each session consisted of education and group discussion followed by supervised practice of strategies in environments designed to trigger FoG. Participants set personal goals and developed a written strategy for overcoming/preventing FoG. Baseline and post-test outcome measures included: New Freezing of Gait Questionnaire (nFOG_Q), two-minute walk test, ten-meter walk test, Mini-Balance Evaluations System Test (Mini-BESTest), Movement Disorder Society-Unified Parkinson Disease Rating Scale–III (MDS-UPDRS III) and Parkinson Disease Questionnaire-39 (PDQ-39).

Results: No falls or injuries occurred, and attendance was high. Participants had favorable feedback and showed improvements in balance on the Mini-BESTest (p = .022), walking on the two-minute walk test (p = .048) and freezing on the nFOG_Q (p = .052). No improvements were noted for the remaining outcomes.

Conclusions: To date, interventions designed to treat FoG in PD have focused on physical and cognitive training while education, goal setting and action-planning have been omitted from training programs. This preliminary study of a novel intervention to address FoG suggests this framework was feasible, safe and effective.

Clinical Relevance: FoG is a debilitating and frustrating symptom of PD. This study combines research in behavioral change with evidence-based FoG reduction strategies. This intervention may offer support for a new method of helping people with PD who freeze. Results from this study provide a foundation for future studies focusing on educational and physical interventions in a community group setting.
End-Effector Robotic Rehabilitation in Progressive Multiple Sclerosis

Purpose/Hypothesis: Progressive multiple sclerosis (MS) is characterized clinically by gradual disease progression and accumulation of neurological disability, independent of relapses. Rehabilitation has been recommended as a means to reduce disability and restore function. High quality evidence supporting progressive MS rehabilitation is limited. An end-effector robot-assisted gait trainer (RAGT) addresses many of the limitations of therapist-assisted gait training while providing an environment for regaining mobility and independence. The purpose of this study was to establish the safety and feasibility of RAGT and determine its impact on movement capacity, fatigue, and quality of life in patients with progressive MS. The data presented includes the first four subjects randomized to the RAGT group.

Number of Subjects: First four subjects with progressive MS who completed the RAGT protocol. Three women and one man ranging in age from 33 to 63. The group has two individuals with EDSS scores of 4.5 and two with 6.5.

Materials/Methods: Single-blinded, randomized clinical trial using RAGT. Subjects trained 2 times per week for 10 weeks for a total of 20 training sessions. Physical Therapists individualized training intensity and RAGT characteristics to maximize benefits for each subject. Motor capacity outcomes (Walking speed and endurance [2 MWT]) and quality of life measures (Modified Fatigue Impact Scale [MFIS] and the Multiple Sclerosis Impact Scale 29 [MSIS-29]) were assessed at baseline and after the final training session (20th session). Subjects were monitored at each visit for adverse events.

Results: There was no reported adverse event for any subject. Three of the four subjects experienced a 10% or greater increase in walking speed with an average improvement of 0.085 m/s. The group averaged 4% improvement in walking distance. Subjects experienced an average improvement of 16% on the MFIS and 14% on the MSIS-29. MFIS subscales revealed the greatest amount of improvement in the physical domain (86%). The MSIS-29 subscales indicated that individuals had a significant decrease in physical disability.

Conclusions: These four subjects with progressive MS tolerated the treatment dosage of 2 times per week for 20 weeks and did not experience any adverse event throughout the training. Focused gait training using RAGT resulted in improvement in walking speed and endurance. Subjects reported that training had a positive effect reducing their disability and fatigue.

Clinical Relevance: These findings, while not conclusive, indicate that individuals with progressive MS responded favorably to RAGT training. This was evident with individuals who had mild and moderate/severe walking impairment. Subject interviews following completion of the study indicated that the robotic training improved their quality of life. These early outcomes warrant further investigation of the G-EO end-effector as a viable option for managing individuals with progressive MS.
Does a Medical Therapeutic Yoga Program Improve Quality of Life and Functional Performance in People with Multiple Sclerosis?

**Purpose/Hypothesis:** People diagnosed with Multiple Sclerosis (pwMS) live with numerous symptoms including, but not limited to, fatigue, muscle weakness, spasticity, balance and coordination deficits, gait disturbance, increased rates of osteoporosis, and cognitive deficits. These impairments can have a negative impact on an individual’s physical activity participation. Medical Therapeutic Yoga (MTY) provides a biopsychosocial framework with which healthcare providers can address many of these needs simultaneously. The goal of the current study was to examine the effects of an interdisciplinary MTY program on balance, gait speed, coordination, self-efficacy for physical activity, and quality of life in pwMS.

**Number of Subjects:** 11 (Ages 47-70 years; 10 females; 5 African-Americans and 6 Caucasians); Type of MS: 2 Primary progressive, 1 reported transverse myelitis, 8 reported relapsing-remitting MS.

**Materials/Methods:** The sample consisted of pwMS who responded to a flyer and/or were participants in a community-based physical therapy program for pwMS. The intervention was co-facilitated by a sport and exercise psychology expert and a physical therapist and consisted of five, 90-minute group sessions. Each session included education on a topic related to MS, breath/sound meditation, physical yoga practice, and relaxation exercise. Participants were asked to journal to monitor their engagement in a self-directed home program. Pre and Post each 5 week intervention, the Patient Determined Disease Step (PDDS), Single limb stance, sharp Romberg, Mini BESTest, Timed 25 ft walk, 9-hole peg test, Modified Fatigue Impact Scale (MFIS), the Self-Efficacy for Physical Activity Scale, and the Quality of Life measure were performed. Three people completed the 5 week program twice.

**Results:** Paired sample t-tests were conducted on all variables for all 5-week cycles. Results indicated statistically significant improvements in the Mini-BESTest $t(13) = 3.163$ and Self-Efficacy for Physical Activity $t(11) = 3.40$ at $p<.01$, and significant results for the MFIS $t(13) = 2.179$ at $p<.05$. The cognitive TUG demonstrated promising results with $t(13) = 2.03; p = .063$.

**Conclusions:** Our results indicate that a 5 week MTY group intervention has the potential to improve reactive, anticipatory, sensory orientation, and dynamic gait in pwMS while simultaneously helping to improve fatigue. Promising results were found with the cognitive TUG indicating that with a larger sample size, MTY may potentially help improve dual tasking in pwMS.

**Clinical Relevance:** A 5 week group yoga intervention could positively impact how pwMS are able to participate in their communities by improving fatigue, balance, and self-efficacy for physical activity. PwMS face both physical and psychological barriers that limit their willingness to participate in physical activity. MTY offers a framework to address both of these barriers simultaneously and warrants further exploration.
TITLE: Evaluation of muscle strength and gait parameters in ambulatory children and adults with spinal muscular atrophy.

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Disease SIG

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ABSTRACT BODY:

Purpose/Hypothesis: Spinal Muscular Atrophy (SMA) is a neuromuscular disease characterized by muscle atrophy, weakness, and impaired motor function.¹ Proximal muscle groups are selectively vulnerable with predominant weakness of the iliopsoas and quadriceps.² Compensatory ambulation mechanisms include hip abductors for pelvic rotation during swing and knee flexors for stance phase support.³ Fatigue is another observed characteristic, captured on 6-minute walk test (6MWT).⁴

This study explored muscle weakness’ effects on gait and fatigue. In a healthy population, the quadriceps to hamstring (QH) strength ratio is 2:1.⁵ The study aims to evaluate: [1] QH ratio in SMA patients and its relationship to walking ability [2] muscle strength of the hip abductors (HA), ankle plantar flexors (PF), and hamstrings’ (HS) relationship to velocity, stride length and cadence. We hypothesize a positive association between: [1] QH strength ratio and 6MWT [2] HA, PF, and HS strength and velocity, stride length, and cadence.

Number of Subjects: 10

Materials/Methods: Five participants with SMA and 5 age-matched healthy controls (7 males and 3 females, mean age 25 years (range 6-50) were evaluated. Clinical assessments included the 6MWT, 10-meter walk (10MW), and handheld dynamometry for strength. Fatigue was defined as difference in distance walked during the 6MWT’s first and last minute. Custom-made instrumented insoles (SportSole)⁶ and an instrumented walkway (ProtoKinetics Zeno)⁷ captured gait parameters. Mann Whitney U tests compared the groups. Spearman correlation coefficients determined the association of strength and QH strength ratio with gait parameters and 6MWT distance.

Results: SMA patients had longer 10MW times, weaker knee flexors and extensors, and a lower QH strength ratio compared to healthy controls (p<0.05). SMA patients walked less and exhibited greater fatigue (p=0.008) on the 6MWT. They walked at slower speeds, taking shorter strides at lower cadence (p<0.05). The QH strength ratio positively associated with 6MWT distance (rₛ=0.929; p=0.001), velocity (rₛ=0.881; p=0.004), cadence (rₛ=0.952; p=0.0003) and negatively associated with fatigue (rₛ=-0.881; p=0.004). Knee flexor and extensor strength positively associated with velocity (flexor: rₛ=0.855, p=0.002; extensor: rₛ=0.952, p=0.0003). Knee flexor strength positively associated with stride length (rₛ=0.818; p=0.004) and knee extensor strength positively associated with cadence (rₛ=-0.976; p=0.00003).

Conclusions: Weakness of knee flexors and extensors was associated with functional measures and gait parameters. In SMA, a lower QH strength ratio may impact functional endurance. HA and PF strength in SMA was similar to controls which may indicate a compensatory role in walking ability.

Clinical Relevance: Understanding muscle weakness and fatigue’s impact on gait parameters could direct rehabilitation methods. Future studies should focus on maximizing available muscle strength to promote functional activities in this population.
Estimating muscle oxygen uptake during exercise using near infrared spectroscopy in ambulatory patients with Spinal Muscular Atrophy

Purpose/Hypothesis: Spinal Muscular Atrophy (SMA) is a progressive neuromuscular disease characterized by weakness and muscle atrophy due to motor neuron loss. Individuals with milder SMA phenotypes can walk but weakness causes gait impairments, reduced endurance, and fatigue. In addition, there is evidence of mitochondrial DNA depletion and altered mitochondrial biogenesis in SMA muscle tissue. Fatigue, exercise intolerance, and reduced exercise capacity may be the clinical manifestation of these observations. Evaluating muscle oxygen uptake during exercise may help explain reduced exercise capacity and impaired muscle function. Lean body mass (LBM) is associated with oxidative capacity in healthy individuals and patients with SMA, however the relationship of muscle oxygen uptake to LBM has not been evaluated.

Materials/Methods: Three patients with SMA, 3 healthy controls, and 3 patients with MM matched for age were enrolled. Assessments included muscle oxygen uptake measured on the vastus lateralis using near-infrared spectroscopy to determine the change in deoxygenated hemoglobin (HHb) from rest to peak exertion. Peak aerobic capacity (VO2max) was measured with using a ramped cardiopulmonary exercise test. Ambulatory function was assessed with 6-minute walk test (6MWT). LBM was estimated with Dual Energy X-ray Absorptiometry. Relationship between change in HHb, VO2max, 6MWT distance, and LBM were examined using Pearson correlation coefficients. Between group differences were determined using analysis of variance.

Results: Mean score for relative change in HHb from rest to peak exertion was lowest in SMA (mean=1.11; SD=1.56), followed by MM (mean=5.01; SD=6.21), and greatest in healthy controls (mean=12.35; SD=9.00). Between group differences were not significant (p=0.171). For all groups, there was a positive association between change in HHb and 6MWT (r=0.69; p=0.039), VO2max (r=0.92; p<0.001), and LBM (r=0.71; p=0.031).

Conclusions: Muscle oxygen uptake was greatest in healthy controls and lowest in patients with SMA when comparing rest to peak exercise responses and was positively associated with peak aerobic capacity, ambulatory function, and LBM. These results suggest there is an impairment in muscle oxygen uptake during exercise in SMA which is likely due to mitochondrial dysfunction.

Clinical Relevance: Patients with SMA demonstrate attenuated training responses to aerobic conditioning programs which contributes to impaired endurance, fatigue, and functional limitations. Targeted therapeutic treatments may be needed to address the apparent disturbance in mitochondrial biogenesis.
A Systematic Review of Physical Therapy Interventions for Parkinson’s Disease

Introduction

Purpose/Hypothesis: The purpose of this systematic review is to identify effective interventions applied by physical therapists to address common impairments in patients with Parkinson’s Disease (PD).

Number of Subjects: n/a

Materials/Methods: A search of PubMed, Medline, Scopus, Wiley Online Library, EbscoHost, CINHAHL were used to identify studies published from 2007 to 2017 written in English with the keywords: Parkinson’s Disease, posture, balance, gait, rigidity.

Results: 25 studies published between 2007 to 2017 that met the inclusion criteria were used. Based on the level of evidence criteria by Shekelle et al., the quality level of evidence for this systematic review contains 13 studies qualified as category IB, two studies as IIB, and 10 studies as III. Using a hyperextension brace while performing strengthening exercises for 30 minutes a day for four months, strengthening while wearing a weighted backpack twice a day for five weeks, or a multiple intervention approaches that incorporate functional strengthening for five days a week in a four week period are beneficial when addressing posture. Usage of an UpRight device for 21 consecutive days or Kinesio tape with postural rehabilitation in 12 visits over four weeks can be incorporated. Use of aquatic rehabilitation can be used to treat abnormal flexion when completing five sessions per week for a total of eight weeks. To address rigidity, Yoga can be beneficial when performed two times a week for 12 weeks. Interval training three times a week for eight weeks can decrease rigidity. Treatments for gait include LVST BIG four times per week for four weeks. A curved walking program for 12 sessions over four to six weeks can increase gait speed. Auditory cueing during the first month of gait training and progressive resistance training can be incorporated two times a week for 10 weeks. Such improvements include decreasing freezing of gait, increased stride length, and speed of movement. To address balance impairments, Tai Chi can be done for two to three times a week for 60 minutes, dance therapy for 75 minutes, Adaptive Tango twice a week, or Argentine Tango can be performed five times a week. Repetitive step training three times a week or HiBalance training three times a week can improve balance.

Conclusions: This review indicates that multiple approaches can be used to treat common impairments such as posture abnormalities, rigidity, balance and gait deficits seen in patients with PD.

Clinical Relevance: This systematic review provides a clinician with evidence-based interventions to treat postural abnormalities, rigidity, balance and gait impairments seen in patients with Parkinson’s Disease.
Purpose/Hypothesis: To preserve postural stability when a standing person lifts an arm rapidly, corrective actions in lower extremity muscles (gastrocnemius-soleus; GS) occur prior to the arm’s (anterior deltoid; AD) movement; these actions are termed anticipatory postural adjustments (APAs). People with Parkinson’s disease (PD) have abnormal APAs, both in onset and scale. PD-associated bradykinesia slows force production that, when combined with an inability to quickly change ‘set’, results in postural instability. Older adults also have abnormal APAs and researchers have reported that 30 minutes of medicine ball tossing significantly improved APAs. Many people with PD who participate in non-contact boxing (NCB) report improved balance. Since the arms are rapidly activated in NCB we wondered how APAs are affected. The purpose of this study was to identify the effects of a single 30-minute session of NCB on APAs.

Number of Subjects: Eighteen community-dwelling adults, 68.4 ± 4.9 years, diagnosed with PD (Hoehn & Yahr stages 1-3) participated. Those with conditions that limited participation were excluded.

Materials/Methods: Exercises consisted of NCB activities including foot positioning, punching, jabbing, and upper cuts, and defensive body maneuvers conducted in a single 30-minute session. Before and after exercise, subjects completed three trials of randomly ordered rapid bilateral arm lifts (BAL), either self-paced or cued, to induce APAs. Outcome measures assessed: electromyographic (EMG) data from GS and AD recorded with disposable surface electrodes (Pathway MR20™); two-dimensional video data analyzed to assess arm and leg movement (Kinovea™); arm acceleration monitored using ErgoArmMeter™; and ground reaction forces and moments recorded using a Bertec™ force plate. Data were analyzed off-line. Statistical analysis used SPSS 23 for Windows.

Results: Video and EMG analyses revealed that latency of leg to arm onset was delayed for both self-paced and cued conditions prior to exercise. Following single session training, latency of leg motion onset significantly improved during the cued BAL (p=.001), but only slightly improved during self-paced BAL. Findings were further reinforced by significant arm acceleration in the first 50% of cued BAL (p=.01). EMG and force results also improved, but not significantly; lower extremity joint excursion was unchanged.

Conclusions: The effect of a single NCB session significantly improved onset of lower extremity movement as a component of APAs, perhaps influenced by initial improvement in arm acceleration during cued trials. Self-paced trials were statistically unchanged. We noted that the cued condition resulted in improved performance, which is similar to other study results where an auditory cue influences movement in PD.

Clinical Relevance: This study provides insight into how NCB may influence balance improvement, especially when NCB is practiced routinely. Components of NCB favorably influence appropriate APAs.
Purpose/Hypothesis: Determine if interventions involving mindful practice provide positive physical outcomes in patients living with multiple sclerosis (MS).

Number of Subjects: N/A

Materials/Methods: A systematic review was conducted using the following databases from earliest record to January 12, 2018: MEDLINE, PubMed, CINAHL, and PsycINFO/PsycART. The search terms neurodegen* and multiple sclerosis were combined with mindful*, MBSR, mindfulness-based stress reduction, mindfulness-based intervention, mindfulness-based cognitive therapy, MBCT, meditat*, mindful* meditat*, mind-body therapy, yoga, tai chi, qigong, relax*. Inclusion criteria were study in English, human subjects with diagnosis of MS, randomized control trials (RCT), and intervention involving mindful practice. Quality of studies was scored using the PEDro scale.

Results: 24 randomized control trials met eligibility criteria. Two articles were scored as “poor,” 18 as “fair,” and four as “excellent.” Results from the studies indicated that participating in mindful practice produced positive physical outcomes in 44 out of the 47 outcome measures assessing fatigue, pain, gait, function, quality of life (QOL), balance, sexual function, and MS specific symptoms. 25 of these 47 positive outcomes had statistical significance. Strength of evidence was greatest for addressing symptoms of fatigue, pain, balance, QOL, and MS specific.

Conclusions: Results indicate that mindful practice improves symptoms commonly experienced by patients with MS. As studies used a variety of type and length of mindful interventions and many different measures, specific recommendations are challenging to make. Future studies should address these limitations to promote the creation of best practice.

Clinical Relevance: Mindful practice can be used by physical therapists treating patients with MS. Therapists employing evidence-based practice should rely on the results of this review, their own expertise, and patient beliefs to determine which form of mindful practice may be of greatest benefit. Yoga and relaxation interventions most frequently yielded statistically significant effects and can easily be incorporated into a physical therapy plan of care and become part of patient continuing self-care following discharge.
TITLE: Multimodal Interventions in persons with Parkinson’s disease increases performance in the Sensory Organization Test: Findings from Computerized Dynamic Posturography

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ABSTRACT BODY:

Purpose/Hypothesis: Individuals with Parkinson’s disease (PD) experience numerous functional deficits, most notably in postural control. While there are a myriad of PD interventional studies that have implemented postural control outcome measures, there are a limited number of studies that have measured facets of postural control using Computerized Dynamic Posturography (CDP). Therefore, the purpose of this study is to assess the Sensory Organization Test (SOT) using CDP in individuals with PD who participated in a group interventional study, implementing dual task activities, dynamic postural control activities and lower extremity agility training. The hypothesis is there will be a difference between pre and post SOT scores in individuals with PD who participate in a group six-week multimodal intervention.

Number of Subjects: There were 12 participants, 7 males and 5 females, mean age of 66 (8.4) with a Hoehn and Yahr (H & Y) scale 1-3.

Materials/Methods: Participants were recruited through the local Parkinson’s support group. Inclusion criteria: ages 40-75, Hoehn and Yahr (H & Y) Scale 1 to 4 with a stable medical regimen for over one month and be able to follow an exercise program. Exclusion criteria: hospitalized within the last three months, a second neurologic diagnosis or uncontrolled hypertension. The SOT was performed as the initial assessment using the CDP for both pre and post-testing. Participants were tested three times in the six SOT conditions, providing a composite SOT and sensory score (vestibular, visual and somatosensory). The six week intervention consisted of two days per week of three 15 minute sessions of 1) dynamic postural control activities, 2) lower extremity agility drills and 3) dual task gait activity and an additional session of flexibility. Data was analyzed with IBM SPSS 25, providing descriptive statistics, using pair t-test to compare pre and post testing in SOT conditions and sensory score. H & Y groups were analyzed within SOT conditions and sensory scores using one-way ANOVA. P values were set at .05

Results: Results found that SOT conditions 1-3 were within the norm for pre and post testing, while conditions 4-6 showed variable pre and post-test scoring. Paired t test showed no significant pre and post within group differences in conditions 4-6. One way ANOVA found a main effect of H & Y groups on condition 6, P=.001, on the composite condition score, P=.002 and on the sensory score (vestibular), P=.05

Conclusions: In this cohort, conditions 4-6 showed below SOT norms in pre-testing. Post testing conditions 4-6 showed increases, however were not significant. However, the intervention appear to facilitate increases in condition 6, the composite score, and the vestibular sensory score.

Clinical Relevance: A multifaceted interventional program may be able to facilitate an increase in postural performance, specifically in the vestibular arena.
Purpose/Hypothesis: Physical therapists routinely address motor symptoms that can interfere with the ability of people with Parkinson disease (PD) to be physically active. However, non-motor symptoms may have a considerable impact on engagement in physical activity and are often overlooked. Specifically, depression, apathy and anhedonia (a diminished interest in engaging in pleasurable activities) are prevalent non-motor symptoms in people with PD. Anhedonia has been found to be correlated with quality of life in people with PD; however, the relationship between anhedonia and physical activity has not been investigated. The purpose of this study was to determine the relationship between non-motor symptoms and physical activity in people with PD. We hypothesized that physical activity would be associated with non-motor symptoms in people with PD and to a lesser extent, with motor symptoms.

Number of Subjects: 27 individuals with early to moderate PD (Hoehn and Yahr 2-3)

Materials/Methods: This was a cross sectional study. Self-reported physical activity levels were assessed with the Physical Activity Scale for the Elderly (PASE). Motor symptoms and walking capacity, impairments in the motor domain, were measured using the Unified Parkinson Disease Rating Scale (UPDRS), motor sub-score and the 6 Minute Walk Test (6MWT). Apathy, depression and anhedonia, impairments in the non-motor domain, were measured using the Apathy Scale, the Geriatric Depression scale (GDS) and the Temporal Experience of Pleasure, Anticipatory subscale (TEPS-AS), respectively. Pearson’s bivariate correlations were examined between the PASE score and all measures in the motor and non-motor domains. Factors that were significantly correlated with the PASE (≤ 0.2) were included in the step-wise linear regression model to explain their relative contributions to physical activity.

Results: UPDRS Part III, 6MWT, GDS, TEPS-AS and Apathy Scale were significantly correlated with the PASE at ≤ 0.2. Step-wise linear regression revealed that the TEPS-AS was the only significant contributor to PASE score explaining 28.6% of variability (p = .004). Higher levels of anhedonia were significantly associated with lower levels of physical activity.

Conclusions: Among all motor and non-motor symptoms in this analysis, anhedonia was the only significant factor associated with physical activity levels in this sample of persons with PD. Greater levels of anhedonia (lower levels of anticipation of pleasure) were significantly associated with lower levels of physical activity. Depression, apathy, walking capacity and motor symptoms were not significant contributors of physical activity.

Clinical Relevance: Physical therapists may need to consider the contribution of anhedonia to reduced physical activity. Future, larger, longitudinal studies are needed to examine the stability of this finding to determine if anhedonia should be a target of treatment.
Purpose/Hypothesis: Walking endurance in Persons with MS (PwMS) is frequently not assessed in the clinical environment and might represent a domain of walking that is important in not only tracking disease progression but also maintaining status as a community ambulator. The purpose of this study is to look at the effect of an endurance walk on PwMS who are minimally disabled and do not present with gait abnormalities (Patient Determined Disease Steps scale [PPPD] of 2 and below). This study will look at how gait parameters are affected following a 6 minute walk test (6MWT) in minimally impaired PwMS. This data will be compared to data on healthy controls who also complete the 6MWT. Specifically we investigated two hypothesis: [1] that there will be a difference in gait parameters at the beginning of the 6MWT between PwMS and the healthy controls and [2] that PwMS will show worsening of gait parameters at the end of the endurance walk compared to healthy controls.

Materials/Methods: The experimental group consisted of 20 PwMS, 17 females and 3 males, mean age of 49.4 years old (+/- 11.2 SD) and mean PPPD of .65 (+/- SD .9), and the healthy controls consisted of 20 subjects, 18 females and 2 males, mean age of 43.6 years old (+/- 9.6 SD). Gait parameters, including gait velocity, cadence, step length and double support time were collected at the beginning and at the end of the 6MWT using the GAITRite Functional Ambulation System. Subjects were instructed to perform the 6MWT walking at a fast gait speed.

Results: There was a significant difference in gait velocity, cadence, double support (DS) time and step length between the PwMS and the controls at the beginning of the 6MWT. When comparing the difference in gait parameters from pre to post 6MWT of the PwMS and controls, again there was a significant difference between the same gait parameters. Comparison of pre to post gait characteristics of the PwMS there was only a significant difference for cadence. No significant difference was found for pre to post 6 MWT for the control group. Although not significant there was a trend seen in that the PwMS demonstrated a reduction in gait speed, step length and an increase of DS time, while the healthy control demonstrated an increase in gait speed, step length and a decrease of DS time by the end of the endurance walk.

Conclusions: These findings are consistent with the hypothesis that there is a difference in gait parameters collected at the beginning of a 6MWT between PwMS and healthy controls. In addition, PwMS showed a worsening of gait parameters at the end of the endurance walk compared to healthy controls.

Clinical Relevance: PwMS who are classified as minimally disabled would not demonstrate observable gait deviations but subtle deficits in gait parameters can be measured with use of instrumented gait analysis and use of an endurance gait test. In addition, earlier detection of gait impairments is important because it can identify targets of rehabilitation at an earlier disease course.
Purpose/Hypothesis: The purpose of this study was to explore changes in activities and cognition after three months of boxing training for people with Parkinson disease (PD). We hypothesized that improvements would be demonstrated across all measures with moderate to large effect sizes.

Number of Subjects: Fourteen participants with PD who were new to boxing training were enrolled in this prospective, repeated measures study. Eight participants completed the baseline and 3-month testing sessions at the time of abstract submission and are included in the analysis. {[n=8, mean age 59.6(11.5), median months post diagnosis 12.9(14.8), Hoehn & Yahr 2].}

Materials/Methods: Participants were instructed to attend boxing training at least twice weekly for three months. The 90-minute group sessions included warm-up and stretching activities, strength and resistance training, endurance activities, non-contact boxing training consisting of footwork skills, and punching a focus mitt, speed bag and heavy bag, and a cool down. Participants are instructed to exercise as intensely as they can tolerate during circuit-based intervals. Outcomes, tested prior to (baseline) and after 3-months of boxing training, included the 10-meter comfortable walk test (CWT), six-minute walk test (6MWT), Mini Balance Evaluations Systems Test (MiniBEST), Movement Disorder Society – Unified Parkinson Disease Rating Scale, Activities of Daily Living subsection (MDS-UPDRS II), Daily Step Counts with a StepWatch Activity Monitor (SAM), and Trail Making Test (TMT). Participants with PD completed testing during the ON phase of their PD medications.

Results: Participants spent a median of 247.5 (90.0) minutes/week exercising with boxing training. All outcomes showed improved mean group scores over time with significant changes on the MiniBEST [Base 21.4(4.8) to 3-mo 24.9(2.7), p=.02], MDS-UPDRS II [Base 13.6(4.8) to 3-mo 10.5(4.9), p<.01], and TMT [Base 54.5(34.3) to 3-mo 31.3(24.4), p=.03]. Moderate to large effect sizes were demonstrated across all outcomes (Cohen’s d=.44-.90), except daily step counts (Cohen’s d=.14).

Conclusions: The group of participants with PD showed mean improvements in all activity-based outcome measures as well as cognition after three months of boxing exercise classes. The multi-modal aspect of boxing training incorporating various modes of exercise may positively affect multiple outcomes including balance, activities of daily living and walking function. Rotating through different circuit-training drills with multiple-step directions during the boxing class may have had a significant impact on cognition (set shifting) as measured with the TMT. These preliminary findings are promising and warrant continued study.

Clinical Relevance: Physical therapists should encourage their patients with PD to maintain regular exercise habits. Higher intensity, interval-based boxing training is growing in availability and becoming a popular choice of exercise for individuals with PD.
Purpose/Hypothesis: Individuals with a 55-200 CGG repeat expansion in the fragile X mental retardation 1 gene are at risk for developing FXTAS, a neurodegenerative disorder characterized by cerebellar ataxia, balance deficits, and cognitive dysfunction. We explored gait deficits in subjects with FXTAS to examine the effects of a DT cognitive motor testing paradigm and fast paced gait, conditions more likely to reflect real life situations, which we hypothesized would exacerbate gait deficits. We also examined the association between cognitive function, gait outcomes and falls in FXTAS.

Number of Subjects: Twenty-five individuals with FXTAS (mean age 67.1 ± 10.1 yrs.) and 27 controls (mean age 63.48 ± 7.73 yrs.) participated in the study.

Materials/Methods: Gait analysis was conducted using an inertial sensor based two-minute walk test (APDMTM) under a 1) self-selected (SS) typical pace, 2) fast as possible (FAP) pace and 3) DT cognitive interference condition asking subjects to perform a concurrent verbal memory task while walking at their normal speed. The dual task cost (DTC %) for gait parameters was calculated as (ST value - DT value/ST value) x 100. The Montreal Cognitive assessment scale (MoCA) was used to measure global cognition and screen for dementia; the Single Digits Modalities test was used to determine information processing speed. Subjects self-reported of the number of falls they had sustained within the past year.

Results: FXTAS subjects had marked reductions in stride length and velocity, increased gait variability and slower turns compared to controls (0.001 > p < 0.014). These deficits were observed with all three testing conditions (SS, FAP, and DT) but most significant under DT and FAP conditions. FXTAS subjects also had longer gait cycle times (p = 0.002) and spent significantly greater time in double support and stance phase (p = 0.03) under FAP conditions. DTC for turn duration was significantly greater for FXTAS vs. controls (p = 0.013) demonstrating that there was significant cognitive interference for turning. Lower information processing speed was associated with worse gait and turning function in FXTAS (p = 0.034 to 0.0006) and greater number of falls self-reported in the past year (p = 0.012). The DTC for time in double support and swing phases of gait were significantly correlated with falls in FXTAS (p = 0.01).

Conclusions: The use of fast paced gait and DT paradigms to stress the locomotor system and/or cognitively challenge subjects significantly exacerbate gait and turning function in FXTAS individuals. Lower information processing speed in FXTAS is associated with worse gait and increased falls.

Clinical Relevance: Gait stress testing paradigms and associated gait and cognitive markers may be useful in future studies to: 1) help detect fall risk in FXTAS, 2) determine effective treatment interventions based on both cognitive and motor deficits in order to improve cognition, gait and turning and thereby reduce fall risk and 3) provide clinically relevant outcome measures for clinical research.
Purpose/Hypothesis: Parkinson’s disease (PD), a progressive neurodegenerative disorder, has long been characterized by motor symptoms due to a disruption in the dopamine regulation pathways involving the basal ganglia. Accumulating evidence now suggests that PD is not just a dopamine deficit disorder but is a multisystem degeneration with both motor and non-motor symptoms that are present and disabling. There is also increasing awareness of the prodromal, or pre-motor phase of PD where non-dopamine related symptoms may first appear. It is thought that patients would benefit from potential treatments to address these non-motor symptoms at that time to help alleviate their effects. Some of these symptoms include disturbances in the visual, vestibular, and oculomotor systems that have been identified early in PD. Studies available are small studies or examine singular issues of the visual, vestibular, and oculomotor systems and don’t consider the functional impact of these systems. The aim of this study was to better understand the presence of deficits of the visual, vestibular, and oculomotor deficits and system integration as well as understand their functional impact in persons with PD.

Number of Subjects: 93

Materials/Methods: This was a cross sectional study. Participants underwent a battery of reliable and valid tests of the visual system, vestibular system, oculomotor system, and tests of system integration. They also completed a measure of visual functioning, the National Eye Institute Visual Functioning Questionnaire. Scores were then assessed based on available cut-off and normative reference values to determine the presence of impairments.

Results: Approximately 95% of participants had some impairment in measures of visual, vestibular, and oculomotor system function and/or system integration. Seventy-three percent of individuals had two or more impairments. Participants also demonstrated decreased visual functioning scores indicating the visual, vestibular, and oculomotor deficits affected visual functioning in persons with PD.

Conclusions: Visual, vestibular, and oculomotor deficits are present in people with Parkinson’s disease to a large degree and appear to affect visual functioning. This study confirms that the majority of persons with mild to moderate PD have impairments in at least one of these systems or the integration of these systems. Participants also demonstrated decreased vision-related quality of life scores compared to available reference scores.

Clinical Relevance: This study confirms that impairments in the visual, vestibular, and oculomotor systems and the integration of these systems are present and common in people with Parkinson’s disease. Healthcare professionals should be aware of the potential presence and impact of visual, vestibular, and oculomotor impairments and impairments in the integration of these systems. These deficits also may have an impact on function and quality of life. Clinicians should screen for these deficits or refer to appropriate healthcare providers to identify and potentially treat these deficits.
Purpose/Hypothesis: Fatigue is a common and debilitating non-motor symptom affecting as many as 59% of persons with Parkinson’s disease (PD). Clinically, fatigue is often underreported or not assessed, even though it significantly affects quality of life and is a leading cause of disability. The cause of fatigue in PD remains unknown and there are no effective treatments. Deficits of the visual, vestibular, and oculomotor systems may contribute to fatigue. These systems are critical for gaze stabilization and for postural stability. When these systems are disrupted, conscious control is used to accomplish visually driven activities which can contribute to fatigue. Deficits in the visual, vestibular, and oculomotor systems are associated with fatigue in other neurologic populations (e.g. multiple sclerosis). The goal of this study was to determine if there was an association between deficits of the visual, vestibular, and oculomotor systems and fatigue in Parkinson’s disease.

Number of Subjects: 93

Materials/Methods: This was a cross-sectional study. Participants completed the Modified Fatigue Impact Scale (MFIS) measure of fatigue. Participants underwent a battery of reliable and valid tests of the visual, vestibular, and oculomotor systems, and system integration. They also performed a measure of functional balance. Scores were analyzed using multiple linear regression to assess any associations between fatigue and our explanatory measures as well as balance (a potential mediator) and fatigue. Exploratory analyses were performed to examine potential associations with disease duration, PD classification, and visual functioning-related quality of life.

Results: Although we did not find any associations between our explanatory measures or functional balance and fatigue, associations with fatigue and measures of depression and sleep were present. No association between our explanatory measures and disease duration or PD classification was found. There was a significant correlation between the Dynamic Visual Acuity Test (DVAT) and visual functioning.

Conclusions: This study eliminates visual, vestibular, oculomotor, and system integration deficits as potential contributors to fatigue and confirms known associations between sleep and depression and fatigue. No known associations between our explanatory measures and disease duration and PD classification support evidence that deficits in visual, vestibular, and oculomotor dysfunction occur early in the disease process and with all types of PD. Impaired DVAT was associated with impaired visual functioning.

Clinical Relevance: PD fatigue appears different than fatigue found in other neurologic diseases. This study has eliminated visual, vestibular, and oculomotor deficits as a potential contributor to fatigue in PD. The results do support the presence of visual, vestibular, and oculomotor deficits early in PD and with both classifications of PD. Due to positive associations with visual functioning, the DVAT may be a good clinical screening measure to identify visual deficits that affect function in people with PD.
Purpose/Hypothesis: Parkinson’s disease (PD) leads to progressive neuromotor effects such as changes in posture and gait, smaller movements, and impaired arm swing. Arm swing deficits are one of the earliest motor signs of PD, and a strong predictor of higher fall risk and lower perceived quality of life. Our group’s previous work has explored this impairment using ArmSense, a wrist-based vibratory cuing device to encourage larger arm swing. Gait velocity, step length, cadence, and arm swing amplitude show an immediate change with these cues, and a previous single-subject study found possible associated changes in functional balance during gait. However, it is unclear how much training is needed for retention, or whether these changes could be seen in a larger, more robust design. The purpose of this work was to explore the effects of four weeks of walking with ArmSense on gait parameters, balance, and quality of life. We hypothesized that after training, uncued gait would demonstrate retention of changes associated with the use of ArmSense, as well as greater improvement in gait parameters, balance, and quality of life than in a dose-matched control group.

Number of Subjects: Sixteen volunteers with PD (mean age 62 ± 6.2 yrs, 8 male/8 female, 15 at H&Y stage 2 and one at stage 1) with no additional neurological diagnoses or health problems limiting walking, randomized into ArmSense and Control groups.

Materials/Methods: The study included two lab sessions (pre- and post-training), with home training (30 mins/day, 5 days/week x 4 weeks) between sessions. Session 2 took place 1-2 days after training. Groups received matched walking time. The ArmSense group received cues for increased arm swing, with vibratory feedback at the wrist for each swing that reached target amplitude. Step length, gait velocity, arm swing, interlimb coordination, Activities-Specific Balance Confidence Scale (ABC), Functional Gait Assessment (FGA), Timed Up and Go (TUG), and Parkinson’s Disease Questionnaire (PDQ-39) were analyzed. Non-parametric Wilcoxon tests or t-tests were used as appropriate to detect significant between- and within-group differences.

Results: Comparing uncued walking in session 1 vs session 2, increases in step length (p=0.000), velocity (p=0.000), arm swing amplitude (p=0.000) were seen after training in ArmSense, but not Control (p=0.122, p=0.261, p=0.301, respectively). Comparing session 1 and session 2, FGA and TUG showed a significant difference in ArmSense (p=0.027, p=0.048) but not Control (p=0.396, p=0.267). ABC and PDQ-39 scores did not show significant changes between or within groups.

Conclusions: Following gait training with arm swing cues, compared to a walking group with no cuing, individuals with Parkinson’s disease may demonstrate retention of gait changes and improved gait stability.

Clinical Relevance: Training for larger arm swing via a portable cuing device may lead to improved gait and balance that is retained after four weeks of training. More research is needed to further clarify and characterize these effects.
ABSTRACT BODY:

Purpose: We propose preliminary proof-of-concept in developing a clinical-decision-making tool for physical therapists to assist with the assignment of their clients with Parkinson disease (PD) into multi-level group exercise classes. Ongoing access to optimal practice and challenge is essential to slow motor and cognitive deterioration in people with a neurodegenerative disease. The benefits of physical therapy quickly disappear (3-6 months) but may be extended with longer training periods, intermittent therapy bouts, tapered supervision or sustained practice. Group exercise classes have also been shown to impact aspects of cognition, mood, motivation, and quality of life that may not be optimal in therapy alone conditions.

Description: We have a 6-year program of providing ongoing PD-specific group exercise classes as an extension to our physical therapy practice. Therapists evaluate clients at baseline and every 6 months and provide therapy bouts as needed to address individual goals. At evaluation, therapists utilize clinical judgment to assign or reassign individuals to the most appropriate level of PD-specific group exercise classes to provide optimal challenge. Classes rank from lowest to highest level of functioning as Moves 1, Moves 2, Circuit 1, Circuit 2.

Summary of Use: In the process of assigning people to multilevel classes, therapists developed a two-part tool consisting of descriptive and quantitative components. Descriptive component: key factors to consider related to class format (e.g., cognitive-motor complexity, skilled task dosing), level of assistance required for class activities (e.g., operating aerobic equipment), and personal factors (e.g., independence with activities of daily living, self-reported falls, executive function). Quantitative component: Ten-Meter Walk Test at preferred and fast speeds; Timed Up and Go Normal and Cognitive; transfer stand to prone to stand; Three-Meter Backward Walk; Six-Minute Walk Test, Five Times Sit to Stand, and the Montreal Cognitive Assessment. We performed retrospective chart reviews from a subset of participants (n=92) with initial evaluation dates ranging from July 2013 to January 2017. Discriminant function analysis revealed that class performance differed among classes on all outcomes (p<.001). Cutoff scores were calculated from baseline data as two standard deviations from the mean of each group's performance on each measure.

Importance to Members: This clinical decision-making tool may be useful to guide the physical therapy plan of care for people with Parkinson disease of varying functional mobility and cognitive levels. This tool can help with appropriate assignment to multilevel group exercise classes, facilitating long-term adherence. It can also serve as a tool to guide communication and coordination between therapists and fitness professionals.
Purpose/Hypothesis: Freezing of gait (FOG) in Parkinson’s disease (PD) has been shown to be associated with exaggerated loss of motor automaticity with increased reliance on attention to execute movements. It has been proposed that the exaggerated loss of automaticity in PD patients with FOG (PD-FOG) may partially explain FOG and may explain the strong link between FOG and dual tasking. However, few studies have examined the effects of dual tasking during gait tasks of varying complexities, or have compared PD-FOG to PD patients without FOG (PD-nFOG). Specifically, we investigated three hypotheses: 1) PD-FOG will experience a higher dual task cost (DTC) than PD-nFOG during gait tasks, 2) increased secondary task complexity using the Freezing of Gait Score (FOGscore) will increase DTC (DTC of motor secondary task compared to DTC of motor and cognitive secondary task), 3) and levodopa will decrease the DTC in PD-FOG more than in PD-nFOG.

Number of Subjects: 26 participants with PD were enrolled in the Center for Neurodegeneration and Translational Neuroscience.

Materials/Methods: Participants were dichotomized on freezing of gait (FOG) with clinical observation during performance of FOGscore tasks. This resulted in 11 classified as PD-FOG and 15 as PD-nFOG. Participants were assessed on the FOGscore which consists of tasks to elicit FOG (gait initiation, two 360 degree turns, and passing through a narrow space) performed under 3 timed conditions: 1. single motor task; 2. addition of a secondary motor task; and, 3. addition of a combined motor and cognitive task. From these measures, DTC was calculated for motor secondary task of FOGscore and combined motor and cognitive secondary task of FOGscore using the formula: (Dual task time – single task time)/single task time. These measures were completed in both “on” and “off” levodopa states.

Results: For hypothesis 1, there were differences noted in DTC between groups for FOGscore condition 3 (p=.049) but not for FOGscore condition 2 (p=.273). However, when taking all measures of DTC together, those with FOG showed a higher DTC than those without FOG (p=.034). In examining Hypothesis 2, there were differences in the task complexity analysis with condition 2 having a lower DTC than condition 3 of the FOGscore (p<.000). For hypothesis 3, there were no differences noted between levodopa states and DTC (p>.080), although it approached significance and may have been underpowered.

Conclusions: Our results offer evidence that PD-FOG exhibit higher DTC than PD-nFOG. DTC difference between PD-FOG and PD-nFOG may require use a secondary cognitive task (combined motor and cognitive secondary task of FOGscore). Further investigation is warranted in investigating the role of a complex or novel primary motor tasks (FOGscore) versus more functional tasks, such as the Timed Up and Go Test. Levodopa effects on dual task cost warrant further investigation.

Clinical Relevance: Increasing the cognitive load by adding a secondary task, especially during complex or novel primary tasks may deteriorate performance more in PD-FOG than PD-nFOG.
Purpose/Hypothesis: Physical therapy (PT) intervention for individuals with acquired brain injury (ABI) is standard practice during the first year post-injury, as the potential for recovery is greatest during this acute period. While it is possible for functional gains to continue even decades after injury, PT treatment often does not occur in the chronic phase due to insurance limitations and other factors. In Massachusetts, the ABI waiver program provides support and funding to Medicaid-eligible individuals in transitioning from a nursing facility to a community setting. Once this transition takes place, appropriate services including outpatient PT are funded to support individuals in maintaining their community living status. The purpose of this study was to investigate if “maintenance” level PT services provided through the waiver program can in fact result in significant functional gains in individuals with chronic (>2 years post injury) ABI based on outcomes data collection over a 4 year period.

Number of Subjects: 21

Materials/Methods: 15 male and 6 female ambulatory ABI waiver participants, mean age 51 years old, with ABI (11 stroke, 6 traumatic, 4 anoxic) performed the Berg Balance Scale (BBS) and 10 meter timed walk at the time of their initial evaluation and at yearly intervals beginning in April of 2017. Participants were attending outpatient PT at least twice per week for at least 6 months, with interventions including gait training, balance activities, and therapeutic exercises.

Results: 9 participants (43%) had significant increase (> /= 0.05 m/s) in self selected gait speed since evaluation with a mean improvement of 0.2 m/s. 10 participants (48%) had no significant change in gait speed and 2 participants (9%) showed a significant decrease in gait speed. In terms of balance, 13 individuals (62%) improved BBS scores significantly (> /= 5 points) since initial evaluation with a mean improvement of 8.4 points. 7 participants (33%) maintained or showed non-significant gain in BBS score, and 1 participant (5%) declined significantly. Additionally, 4 individuals (18%) decreased the level of physical assist required for ambulation and 2 individuals (9%) progressed to a less restrictive assistive device.

Conclusions: This data supports the hypothesis that individuals with chronic acquired brain injury can continue to make functional change even years after their injury, particularly in terms of balance and reduced fall risk. It provides support for the ABI waiver model employed in Massachusetts which includes maintenance level PT services.

Clinical Relevance: The improvements noted on the BBS are of interest as they indicate decreased fall risk across the individuals who participated in the study, indicating that regular physical therapy intervention, even at a maintenance level, may reduce fall risk and improve function in individuals with chronic ABI. Further areas for study would include comparison to a control group, assessment of quality of life measures, and analysis of yearly data over a longer time period.
Background & Purpose: Pain is the most common reason Americans access the health care system. It’s a leading cause of disability and a major contributor to health care costs. Pain is a complaint of patients with neurological diagnoses, affecting 20-40% of patients. Anxiety is common among hospital patients and those with neurological conditions and is associated with poorer outcomes and adverse events. There is a growing interest in the utilization of VR to reduce pain and anxiety. VR is effective in reducing experimental pain, burn injury pain care, needle pain and anxiety. However, the role of VR in reducing pain and anxiety in patients with neurological conditions in acute inpatient rehabilitation is unknown.

Case Description: Immersive head mounted VR was utilized in 20 patient encounters (12 patients total) with variable neurological diagnoses including Cerebral Palsy, Stroke, and spinal cord injury. Hardware included the Samsung GearVR headset with a Galaxy S7 phone and headphones, a portable, commercially available VR system. The device was preloaded with 20+ modules tested for clinical populations by a VR healthcare software company (Applied VR, Los Angeles, CA) aimed at addressing a variety of hospital patient needs.

Outcome measures were recorded prior to and immediately following VR including 1) The Numerical Pain Rating Scale (NPRS)/Faces Scale; 2) The Spielberger State-Trait Anxiety Inventory (STAI: Y-6); 3) nausea and dizziness via a 0-10 numerical scale and 4) Visual Analog Scale (VAS) utilized to determine, “In the last 5 minutes, how much time did you spend thinking about your pain?” Additional questions post VR included a VAS to determine how “real,” the experience felt.

Outcomes: Paired t-tests demonstrated statistically significant improvements comparing pre and post values of pain, anxiety and time spent thinking of pain. Mean pain pre VR (5.87±2.13) to post VR (4.00±2.78) decreased 1.87 (95% CI, .266-3.48) (p=.025). Mean pre VR STAI: Y-6 (55.29±11.77) to post VR (39.02±11.30) decreased 16.27 (95% CI, 10.88-21.66) (p=.000). Mean VAS time spent thinking about pain pre VR (4.11±3.84) to post VR (1.44±2.39) decreased 2.66 (95% CI, 1.26-4.06). VR did not increase dizziness or nausea.

Discussion: Changes in pain, anxiety and time spent thinking about pain were statistically significant immediately following VR. Pain scores are approaching, but have not yet reached MCID of 2. This suggests that portable, commercially available VR may be a viable adjunct for patients presenting to inpatient rehabilitation to manage pain and anxiety without inducing adverse effects of dizziness and nausea. More research is needed to determine whether participating in VR impacts functional outcomes, patient satisfaction, medication use and how long the improvements last. Additional exploration into the correlation between how immersive the patient feels the experience is or the amount of time spent in the experience and improved pain and anxiety is warranted.
Purpose/Hypothesis: The aging process results in structural and functional declines in brain health [1, 2]. Recent research suggests that obesity may contribute to decreased white matter (WM) microstructure. This study explored the relationship between body composition and WM microstructure in cognitively healthy community dwelling adults. We hypothesize that percent body fat will demonstrate a negative relationship with WM microstructure.

Number of Subjects: One-hundred and three community dwelling older adults participated in this study (mean age = 65.05, SD = 4.01). Fourteen of the participants failed to complete the study, and one of the remaining 89 participants was excluded due to outlier status. WM-body composition relationships were analyzed in the remaining 88 participants (mean age = 65.3, SD = 8.45).

Materials/Methods: To assess percent body fat, a total body dual energy X-ray absorptiometry (DEXA) scan was performed on a Lunar iDXA (Lunar Inc., Madison, WI) densitometer. Diffusion tensor imaging (DTI) magnetic resonance imaging (MRI) was used to assess WM microstructure. All testing was conducted at the University of Kentucky. Body mass index (BMI) was also considered.

Results: Age-related declines in WM microstructure were prevalent throughout the brain. Percent body fat demonstrated a negative relationship with WM microstructure in the occipital lobe (r = -0.263, p = 0.013). BMI also demonstrated a negative relationship with occipital lobe WM microstructure (r = -0.228, p = 0.034).

Conclusions: Body composition and BMI are related to WM microstructure in community dwelling adults. Future longitudinal studies are warranted to establish a causal relationship between body composition and WM microstructure.

Clinical Relevance: Obesity is a growing health concern throughout the United States. According to a survey from the National Institute of Diabetes and Digestive and Kidney Diseases, more than 1 in 3 adults are considered to be obese [3]. Further, obesity is a growing epidemic in children and adolescents, with 1 in 6 between the ages of 2 and 19 classified as obese [3]. Our findings support recent evidence demonstrating that increased BMI has a negative relationship with WM microstructure [4, 5]. Physical therapists can play an integral role in a multidisciplinary effort to combat the multifactorial contributors to obesity (health services, social and physical environments, individual behavior, biology and genetics).
Purpose/Hypothesis: The gold standard for assessing gait parameters is a force plate, motion capture, or instrumented walking mat; however, due to high cost and limited portability, their clinical utility is limited. The purpose of this study was to establish the test-retest reliability of the VirtuSense Technologies VirtuBalance (VB) device, a low cost, portable infrared camera, and provide evidence for its concurrent validity by comparing it to an instrumented walking mat, the Protokinetics Zeno Walkway (ZM).

Number of Subjects: 39 healthy individuals (mean age: 34.0±6.8; 24 females, 15 males) participated in this study.

Materials/Methods: For test-retest reliability, intra-class correlation coefficients (ICCs), were calculated for two 4 meter walking trials separated by 30 seconds. Each trial consisted of instructions to walk at normal pace and required the participant to start from a resting position and walk 4 meters. For concurrent validity, an average of the 2 trials for both the VB and ZM devices was calculated and compared to the other using ICCs. Simultaneous footfall data were collected from the VB and ZM devices while each participant completed 2 separate 4 meter walking trials. While the ZM has a measuring surface of 7 meters, the VB has a 4 meter range of measurement. Therefore, only the 4 meter range was used in the analysis as both devices captured data over that shared distance.

Results: Test-retest ICC (3,2) values for stride length (ICC=.957), step length (ICC=.943), step time (ICC=.760), cycle time (ICC=.891) were all in the good-excellent range. Cadence (ICC=0.683), velocity (ICC=0.302), swing (ICC=.272), and stance (ICC=.288) were less reliable. For concurrent validity, the ICC values were stride length (ICC=0.994), step length (0.971), step time (ICC=.901), cycle time (ICC=.922), cadence (ICC=0.838), velocity (ICC=0.825). Both swing (ICC=.092) and stance (ICC=.061) had very low ICCs.

Conclusions: The results demonstrated that footfall data from the VB device were reliable for measuring stride length, step length, step time, and cycle time in healthy individuals. However, reliability for some measurements that included temporal components were not sufficiently reliable. Because VB and ZM had different starting points (ZM=first footfall at gait initiation; VB=first movement into infrared reading frame at full speed), this made the measurements off by a margin and, subsequently, lowered the reliability values.

Clinical Relevance: The VB device provides excellent intra-rater reliability and high concurrent validity for spatial measurement data; however, because of the aforementioned differences between the two devices on the start times, temporal measurement data were less reliable. Because of this, we recommend that gait is initiated within the infrared reading frame to improve reliability of timed gait parameters.
Perception of Visual Verticality is Altered in People With Severe Chronic Low Back Pain: A Cross-Sectional Study

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ABSTRACT BODY:

Purpose/Hypothesis: The subjective visual vertical (SVV) test has been used to assess perception of verticality in patients with whiplash injury or neck pain (1 - 3). However, the SVV test has not been used to assess perception of verticality in patients with chronic low back pain (LBP). Therefore, the aim of this study was to investigate the perception of verticality in people with chronic LBP compared to people without back pain (healthy). Our hypothesis was that people with chronic LBP will have larger SVV errors than people without.

Number of Subjects: Participants with mechanical LBP (n=25) and healthy controls (n=25) participated in this cross-sectional study.

Materials/Methods: A cross-sectional study design involved participants aged 18 – 60 years. Participants with LBP were included if they had LBP of more than 3 months without leg symptoms, and had disability rating of 20 or more on the Modified Oswestry Disability Questionnaire (MODQ). Healthy participants had no history of LBP. The MODQ, Numeric Pain Rating Scale, and Subjective Units Distress Scale were collected. The SVV test was done in a dark room with the participants wearing goggles. The SVV was tested in 3 conditions: rod, rod and frame, rod and disc. In each of these conditions, the rod was initially tilted 40 degrees clockwise and counterclockwise, and the participants were asked to bring the rod back into vertical position. Using SPSS, the statistical analysis included descriptive statistics, analysis of variance (ANOVA) to compare the LBP group against healthy group. Also, ANOVA was done on a subgroup of people with severe LBP (n=14) and the healthy group (n=25).

Results: When the whole LBP group was compared to the healthy group, ANOVA showed no significant interaction (p = 0.2), or group main effect difference (p = 0.2) on the deviation from verticality. However, deviation from verticality was significantly different between the SVV conditions (p < .001): the SVV values were significantly greater in the rod and disc and rod and frame conditions compared with the rod in darkness. When considering the subgroup of people with severe LBP, the interaction effect between condition and group was significant (p = 0.046). Simple main effects showed that the severe LBP subgroup had larger deviations from verticality (7.5 ± 0.9 deg) compared to the healthy group (4.2 ± 0.7 deg) specifically on the rod-and-frame condition (p = 0.007).

Conclusions: It appears that errors in judging verticality is similar when the LBP group was compared to the healthy group. However, errors in judging verticality were significantly larger in people with severe LBP. This suggests that there might be a subgroup of people with severe LBP that has an altered perception of verticality (4).

Clinical Relevance: Sensorimotor exercises that improve proprioception and thus perception of verticality should be included in rehabilitation of LBP (5). Examples of such exercises include lumbopelvic-hip dissociation, laterality recognition, and foam standing with and without perturbation.
Purpose/Hypothesis: Falls are the leading cause of hospitalization, unintentional injury, and death among older adults. Several outcome measures have been established to assess fall risk, with a handful of studies revealing an association between gender and fall incidence (women falling more than men). The purpose of this study was to assess whether gender was a significant predictor of future fall status after 12 months in a sample of community-dwelling older adults. A secondary purpose was to compare results by gender to explore factors that may have contributed to the increased number of falls in our female subjects.

Number of Subjects: Forty-five older adults (31 female) from a senior living community participated in the study. To be included in the study, subjects had to live independently, be able to walk inside their home without help from another person, and be able to provide informed consent.

Materials/Methods: Balance confidence was measured using the Activities-specific Balance Confidence Scale (ABC). Subjects then completed balance performance measures in randomized order including the Tinetti, Berg Balance Scale (BBS), and Timed Up and Go (TUG). Following testing, subjects were telephone interviewed every 3 months for one year to determine how many falls they had experienced in the most recent 3 months. Subjects who fell at least once in the 12-month follow-up period were classified as “fallers,” and subjects who did not fall were classified as “non-fallers.” Descriptive statistics, Chi-square, independent t-tests (2-tailed), and standard logistic regression were calculated with SPSS v24.0.

Results: Twelve months after baseline testing, 14 of 31 females (45.2%) had fallen, while only 2 of 14 males (14.3%) had fallen ($X^2=4.01$, $p=0.045$). There were no differences in age, number of comorbidities, number of medications taken, or reported health status changes between men and women ($p>0.05$). Results of a standard logistic regression showed that gender was a predictor of fall status; being male reduced the likelihood of experiencing a fall. With gender as the single variable, the model was statistically reliable (-2 Log likelihood=54.17, $X^2=4.41$, $p=0.04$). There were no significant differences in balance performance scores between men and women on any of the three balance measures used ($p>0.05$). However, women had significantly lower ABC scores than men ($t=2.29$, $p=0.03$).

Conclusions: Female gender was a significant predictor of future fall status in our sample of community-dwelling older adults. Surprisingly, women did not have poorer balance performance on any of the three well-established outcome measures used. However, our female subjects did report poorer balance confidence than our male subjects.

Clinical Relevance: Our findings indicate that women may be at greater risk of falling than men despite comparable balance performance. Studies with larger sample sizes are needed to further explore the role of gender in fall risk, and investigate factors that impair balance confidence – despite balance performance – in women.
Background & Purpose: In cases of severe facial paralysis, Hypoglossal-Facial Nerve Anastomosis (HFA) may be used to re-innervate the face. This procedure aims to create a new motor circuit by which the face is controlled via motions of the tongue. Literature outlining rehabilitation interventions following HFA remains scarce. The purpose of this case report is to describe the interventions used to facilitate motor relearning of facial expression through tongue movements following an HFA procedure.

Case Description: The patient was a previously healthy 33 year-old female who had two pontine hemorrhages and subsequent surgical resection of a cavernous hemangioma. Following the resection, she presented with left hemiplegia and hemisensory deficits, as well as a mixed presentation of cranial nerve deficits (double vision, nystagmus with left gaze, decreased sensation and flaccid facial paralysis on the right side of her face). Following no improvement in her facial paralysis with conservative management, she underwent an HFA procedure and was evaluated by a physical therapist 16 weeks post-operatively.

Outcomes: Upon examination, the patient had little right sided active movement of the face and was unaware of how to use her tongue to create facial expressions. She was directed to push her tongue into the following positions and the resultant facial movements were recorded as baseline: upper right molars (partial lift of her right upper lip and nasolabial fold), lower right molars (partial sneer), and palate (trace movement in right upper lip). Based on the initial movements, the patient was trained to thrust her tongue against specific teeth or palate targets to create different expressions, and to taper the amplitude of the thrust for an expression gradient. The patient was seen once a week for 45 minutes for 8 visits over 14 weeks. The plan of care and treatment progression for this patient was modified from previously published work. Motor relearning principles were incorporated and treatment techniques included manual therapy, facial PNF, mirror therapy, and education in home exercises.

Facial asymmetry and function were measured using the Sunnybrook Facial Grading Scale (FGS), and Facial Disability Index (FDI) subscales FDIP (Physical) and FDIS (Social). The patient demonstrated improvement in her scores; FGS (38 to 54), FDIP (40 to 80) and FDIS (36 to 72), though MDIC or MDC do not yet exist for these tests.

Discussion: The patient demonstrated an improvement in volitional facial expression following the combination of an HFA procedure and physical therapy. The changes in her FGS and FDI scores, as well as her self-reported refined understanding of tongue placement to produce distinct facial expressions suggest that motor learning did occur. A follow up study using fMRI to examine the potential reorganization of the homunculus within the motor cortex may elucidate neuroplastic changes underlying motor relearning after HFA and rehabilitation. The outcome of this report suggests the need for further exploration of rehabilitation interventions following HFA.
Purpose/Hypothesis: Rural communities are often at risk for environmental disparities with Appalachian Kentucky leading the way, due to a rugged geography, high poverty, and limited access to services and essential resources. In addition, Kentucky is ranked among the worst with respect to risk-factors for stroke including diabetes (46th out of 50), hypertension (47th), obesity (44th), smoking (49th), high cholesterol (49th), and heart disease (48th). When a stroke is superimposed onto of these co-morbidities and structural barriers, care for these individuals becomes increasingly complex.

In order to better understand the overall complexity of the stroke population in rural Kentucky, we examined the total number and types of co-morbidities as well as the prevalence of multiple co-morbidities that will impact the overall long-term health and health care for these individuals. A secondary analysis examined whether there are gender and age differences in this stroke population.

Number of Subjects: 5325 individuals, 18 years of age and older, seen at an Academic Medical Center for the primary diagnosis of Acute Ischemic Stroke (AIS) or Transient Ischemic Attack (TIA) between the years of 2010-2017.

Materials/Methods: Individuals with AIS and TIA were identified through the Kentucky Appalachian Stroke Registry (KApSR), using our previously published methods. The variables that were examined included: gender, age, co-morbidities (hypertension, hyperlipidemia, tobacco use, obesity, diabetes, CAD, AFIB, COPD, prior stroke, heart failure, and PVD). For diabetes both ICD-10 codes and A1c values were used. For obesity we calculated Body Mass Index. The data was analyzed using descriptive statistics.

Results: With respect to age, 15% (n=795) of the sample was under the age of 50, while 32% (n=1,704) were between the age of 50 and 64 and 53% (n=2,826) of the sample were 65 years or older. Overall there were no significant differences between genders except for tobacco use, with males having higher rates than females. Over 78% (n = 4,153) of the individuals had 3 or more co-morbidities. Over 61% (n=3,285) had at least 3 out of the top 5 co-morbidities (hypertension, hyperlipidemia, tobacco, obesity, diabetes).

Conclusions: The results of this study indicate the majority of individuals affected by stroke in rural Kentucky have multiple co-morbidities. In addition, almost half of these individuals are having their strokes at a younger age, which will require a shift in the focus of therapeutic interventions (e.g. re-integration into the workforce versus just community re-integration).

Clinical Relevance: The results of this study suggest the 5 primary co-morbidities in individuals who have had a stroke are all modifiable, and physical therapy is strategically positioned to address them through interventions and education. The question is, are individuals who are affected by stroke receiving the full expertise from physical therapists? Is a more holistic approach to physical therapy intervention for stroke needed?
ABSTRACT BODY:

Purpose/Hypothesis: Processing of sensorimotor signals for path navigation is an actively-studied topic in neurology and has implications for neurologic rehabilitation. Vision is the primary means of path navigation but those without vision are accurate in perceiving short walked distances. This locomotor odometry is based on idiothetic information and influenced by symmetry characteristics of walking including changing leg length. Given known alterations to sensorimotor anatomy and gait symmetry after transtibial amputation (TTA), we compared accuracy of perceived distance walked across various distances and step lengths in persons with and without TTA. Given evidence that idiothetic information derived from the act of walking specifies distance walked, we hypothesized persons with TTA would exhibit greater inaccuracy of perceived distance walked.

Number of Subjects: 8

Materials/Methods: 2 female and 6 male consented participants, represented 2 groups: 4 persons with TTA (mean age 32 years, height 176cm, weight 80kg) and 4 sex, age, height and weight -matched persons without TTA (32 years, 172cm, 88kg). Subjects walked 10, 25, and 40m at self-selected speed, with separate trials of three step lengths (short, normal, long) while wearing noise-cancelling earphones, sleep mask and opaque goggles. Subjects with TTA walked with their prosthesis and no assistive device. Subjects walked a set distance, were stopped by an experimenter guide when that distance was reached, turned 180 degrees and cued to walk to the origin point. Subjects walked a total of 27 trials; 3 trials for each distance at each step length. Duration of the walk out and error distance from the origin point were recorded.

Results: Group x distance x step length ANOVA revealed a significant main effect on absolute error for distance (F=22.485 (2,58), p = 0.000) but no main effect for group or step length. Error increased with distance consistent with Weber’s law. Post-hoc analysis identified differences between 10-40m and 25-40m. There was a main effect for group and step length on duration and a group x step length interaction (F=6.32 (2,58), p=0.003). Subjects with TTA took longer to complete trials and the shorter the step, the longer the trial duration.

Conclusions: Contrary to our hypothesis, subjects with TTA were able to use idiothetic information, perhaps from proximal joints or unaffected limb, to perceive walking distances up to 40m across differing step lengths as accurately as subjects without TTA. It remains to be determined what impact, if any, longer walking durations used by subjects with TTA had on the results.

Clinical Relevance: Understanding the processes and extent to which persons with alterations to sensorimotor anatomy and function perceive walking distance may provide directives for gait rehabilitation, especially path navigation. This study has provided a step forward in understanding odometry function in persons with such alterations. Studies in persons with acute and chronic unilateral and bilateral amputation, and central lesions to the sensory system are warranted.
Title: Improved Mobility and Quality of Life in a Person with Guillain Barre Syndrome After Pro-Bono Physical Therapy.

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Abstract Body:

Background & Purpose: Guillain Barre Syndrome (GBS) is a relatively rare disorder of the peripheral nervous system with rapid onset of sensory and motor deficits and typical distal to proximal progression. The clinical course and outcomes of GBS are highly variable. Approximately 25 percent of patients with GBS require mechanical ventilation during acute hospitalization, a negative prognostic indicator. There is limited research on GBS and physical therapy (PT); however, exercise has been linked to improved outcomes. Providing pro bono PT to individuals who cannot otherwise afford care is specified in the American Physical Therapy Association’s Code of Ethics. The purpose of this case report is to demonstrate the effectiveness of pro-bono PT for a patient with chronic impairments due to GBS.

Case Description: The patient, a 44 year old female with GBS, was hospitalized for 2 months and required mechanical ventilation. She received 1 month of inpatient rehabilitation before being discharged home without further PT due to lack of insurance despite residual tetraparesis. For this case report at 5 months post diagnosis the patient began pro bono outpatient physical therapy through a student-run clinic and as a patient participant in a university PT course for a total of 23 one hour sessions over 4.5 months. On initial evaluation in the pro bono clinic she was dependent in all functional mobility. Interventions included locomotor training with body weight support during treadmill walking, overground walking in multiple directions and on varied surfaces, stair climbing, transfer training, and standing balance activities. High intensity speed-focused training was emphasized.

Outcomes: After 23 sessions of pro bono PT the patient improved in balance, mobility, and quality of life. Previously dependent for all mobility, post intervention she improved on the following outcomes (pre, post): Berg Balance Scale (0/56, 15/56), 6 minute walk test (unable, 139 m), 10 meter walk gait speed (unable, .31 m/s), Functional Ambulation Category (0/5, 4/5). WHO Quality of Life-BREF domains (mid, post %): Physical (38, 44), Psychological (69, 75), Social (56, 69), Environment (69, 75). She ambulated independently with a rollator for all post intervention walking tests.

Discussion: Following 4.5 months of pro bono PT the patient’s primary mode of mobility improved from being pushed in a manual wheelchair to walking independently with a rollator on level surfaces at home and in the community. The patient was young, highly motivated, had strong family support, and was generally healthy prior to GBS, all positive prognostic indicators. Progressive high intensity speed-focused locomotor training may have contributed to improved outcomes. Physical therapy including locomotor and functional mobility training may be effective in improving gait speed, endurance, balance, functional mobility, and quality of life in individuals with chronic impairments due to GBS.
Background & Purpose: Primary hemi-facial spasm (HFS) is involuntary unilateral contractions of facial muscles due to a vascular compression of the facial nerve root. Microvascular decompression surgery (MVDS) is potentially curative by alleviating vascular compression of the facial nerve root. 91% of those affected with HFS who are treated with microvascular decompression surgery have complete resolution of symptoms within a 2.5 year period. Rare side effects include mild facial weakness. Unlike Bell's Palsy, people with HSF are rarely referred to physical therapy (PT). In this case series, two cases of slow onset hemi-facial palsy after MVDS for HFS were referred to physical therapy for trial of conservative therapy.

Case Description: Two women with 10 and 5-year history of slow onset hemi-facial weakness after MVDS were referred to PT to address facial muscle palsy. Case 1 presentation included unilateral facial palsy and imagining Magnetic Resonance Imaging (MRI) indicated no inflammation of the facial nerve at cerebellopontine angle. Case 1 presentation included unilateral facial palsy, implantation of gold bar in eye lid for successful eye closure during sleep, carrier of hepatitis B and MRI positive for inflammation of facial nerve at cerebellopontine angle. Both women participated in PT at an outpatient neurologic clinic for 7 and 5 visits (case 1 and 2 respectively). PT included 1 session per week comprised of neuromuscular re-education, sensory stimulation focused on sensory cortex re-mapping, skill training, mirror training, diaphragmatic breathing, mindfulness and establishment of a home exercise program.

Outcomes: Patient Specific Functional Scale (PSFS) and Facial Grading System (FGS) were assessed at initial evaluation and at completion of PT. Case 1 improved her FGS score by 26 points, PSFS score by 9 points and demonstrated improved resting symmetry with only asymmetry noted in right eye brow at rest and right lip during speech. Case 2 showed no improvement in her FGS score, a decrease in PSFS by 3 points and no change in facial symmetry resting or active. Hospital Anxiety and Depression Score (HADS) and Stress Questionnaire were obtained by each case at end of therapeutic intervention to investigate additional potential differences between cases that could have affected therapeutic outcome.

Discussion: Two rare cases of slow onset hemi-facial palsy participated in PT targeting neuroplasticity and neuromuscular re-education. Case 1 results suggest that PT is a viable and beneficial option for people suffering from hemi-facial palsy post microvascular decompression. Case 2 had several factors that could have affected her prognosis including higher a HADS score, higher Stress Questionnaire results and continued inflammation around facial nerve as observed on MRI. Therefore, poor prognosis for functional improvement in PT may be related to psychological influences and presence of active facial nerve inflammation.
Purpose: An estimated 1.6 to 3.8 million concussions occur annually in the U.S.¹ A multi-disciplinary treatment approach for post-concussion syndrome (PCS), including rehabilitation, is advocated.² Little is known about the patterns of care for patients with concussion who access rehabilitation services. The purpose of this study is to describe the characteristics and health care utilization of patients who received routine care for a concussion at a single multidisciplinary outpatient rehabilitation clinic.

Description: Number of participants: 19

Methods/Materials:
Subjects were identified using the University of Utah’s Electronic Data Warehouse. Subjects were included if they had a new consultation to a rehabilitation professional (orthopaedic or vestibular physical therapist, occupational or speech therapist) at a single community clinic for a concussion between January 1, 2017 and June 15, 2017. We defined the initial visit with rehabilitation professional as the index visit. An episode of care was defined when no additional visits to a rehabilitation professional occurred within 6 weeks of the last rehabilitation visit. Patient outcomes were recorded 3-months following the initial consultation with a rehabilitation professional.

At the index visit we recorded patient demographic information, number of rehabilitation visits the patient received during the episode of care, the rehabilitation provider type seen at each visit, patient comorbidities and Post-Concussion Symptom Scale (PCSS) scores for each patient. Descriptive statistics were used to characterize the sample.

Results:
Mean age was 39.6 years (SD = 16.0) with 57.0% females. Median number of days from concussion to initial evaluation in rehabilitation was 87 (IQR = 125). Twelve (63.0%) patients reported loss of consciousness at the time of their concussion and 12 (63%) reported neck pain at the index visit. The combined average number of visits for all rehabilitation providers was 12.9 (SD = 8.5) and average length of stay in rehabilitation was 70.0 days (SD = 57.7). Nineteen (100%) patients were managed by a vestibular physical therapist, 15 (78.0%), 15 (78%) were managed by a speech therapist, and 7 (37.0%) and 7 (37.0%) were managed by an orthopaedic physical therapist and an occupational therapist respectively. The mean baseline PCSS score was 42.6 (SD = 31.1) and the mean final PCSS score was 29.2 (SD = 31.9) with a mean change of -18.1 (SD = 27.3).

Summary of Use: Fifty percent of the patients waited nearly 3 months to receive rehabilitation post-concussion.

PCSS scores changed by nearly 42%. It is unknown whether PCSS scores would have changed by a greater percentage if the patients had accessed rehabilitation services sooner. Considerations for future work include examining the association between timing of rehabilitation and health care utilization.

Importance to Members: In patients with concussion who access routine care, reducing the time to rehabilitation may represent an opportunity to improve the quality of care.
The Effect of Visual, Vibratory, and Auditory Cueing on Walking Speed and Functional Mobility in Individuals with Parkinson's Disease

Purpose/Hypothesis: Visual and auditory cueing have demonstrated increased speed and mobility for individuals with Parkinson’s disease (PD). Vibratory cueing has been understudied in people with PD and has not been compared to the other forms of external cueing available. This study was designed to preliminarily investigate the differences in these cueing forms on speed and mobility for individuals with PD. We hypothesize that 1.) external cueing would improve walking speed and functional mobility and 2.) there would be negligible differences between methods.

Number of Subjects: 8 participants with Parkinson’s disease (Hoehn and Yahr 1-3) and no cognitive impairment (≥23/30 Montreal Cognitive Exam [MoCA]) recruited from a “Rock Steady” program.

Materials/Methods: All participants completed activities during their “on-phases”. Prior to testing, the MoCA, demographic information, fall history report, and past medical history were collected. Participants completed 2 repetitions of the Functional Reach Test (FR). Following the FR, the order for the Timed Up and Go Test (TUG) and the 10 Meter Walk Test (10MW) were randomized and completed. Participants had 2 practice trials each for the TUG and 10MW. Following practice trials, each assessment was performed with 2 baseline trails, 2 trials with vibratory cueing, 2 trails with visual cueing, and 2 trials with auditory cueing; performed in randomized order.

Results: Eight participants (5 females, 3 males) with median (interquartile range) age of 60.5 (11.5) years agreed to participate. The median time since diagnosis was 4.41(2.50) years. None were classified as fall risk (<7 inches for FR) with median reaches of 27(10.13) inches. For the TUG the participants demonstrated times of: 6.68(1.09) seconds (s) for control, 6.41(0.87)s with auditory cues, 6.37(1.09)s with visual cues, and 6.78(1.01)s with vibratory cues. The percent change from control are -2.75(2.30)% with auditory cues, -3.27(3.03)% with vibratory cues, and -1.17(5.12)% with vibratory cues. For the 10MW the participants demonstrated speeds of: 2.76(0.23) meter/seconds (m/s) for control, 2.81(0.36) m/s with auditory cues, and 2.68(0.28) m/s with visual cues, 2.67(0.25) m/s with vibratory cues. The percent change from control are 2.90(7.83)% with auditory cues, 2.19(7.67)% with vibratory cues, and 1.32(4.83)% with vibratory cues.

Conclusions: There was no difference in performance with cueing for the TUG or the 10MW. There was a trend for auditory cues to be more effective for 10MW and visual cues for the TUG though not statistically significant. This could illustrate that tasks may be influenced by a certain type of cueing in relation to how these tasks are performed though a more robust study is necessary.

Clinical Relevance: Different types of cueing does not significantly impact TUG and 10MW performance. Different cueing strategies may be more or less effective across different tasks. Patient performance could dictate the utilization of cueing to maximize safety.
The Effect of Isolated Attention Training on Motor and Cognitive Performance

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ABSTRACT BODY:

Purpose/Hypothesis: Previous studies provide evidence of a competition for attentional resources when performing an integrated motor and cognitive task. While the dual-task training paradigm has been investigated by many, questions remain. The current interdisciplinary pilot study, the second in this line of research, investigated the relative impact of training visual spatial attention in isolation on motor, cognitive, and integrated performance. We hypothesized that post training, the experimental group would demonstrate significant improvement in these domains as compared to a control group.

Number of Subjects: 33 healthy participants (17 M, age 21-34); 31 included in analysis (17 Control).

Materials/Methods: Pre- and post-test outcome measures were administered to all participants. Isolated motor performance was tested using the Star Excursion Balance Test (SEBT), and cognitive performance was measured with the STROOP test. To assess integrated performance, participants walked on the GAITRite Portable Walkway System® under three conditions: 1. walk only 2. walk/attention 3. walk/attention/barrier. The experimental group received an attention training intervention using the NeuroTracker® 3D-MOT system (NT), for a total of 10 15-minute sessions. SPSS v24 was used for all analyses, with parametric (paired, independent t-tests, repeated measures GLM) and non-parametric (Mann-Whitney U) statistics employed as appropriate.

Results: There were no significant between-group differences for the post-test STROOP, SEBT, or spatiotemporal variables of gait across all conditions. For the experimental group, significant within group differences between pre- and post-testing on the STROOP test (p < .01) and between first and last sessions of NT (p < .02) were found. Significant differences of velocity, step length and stride length between gait conditions across groups (p < .01) were observed in both the pre and post-tests.

Conclusions: Findings suggest that training the attention system in isolation has a positive impact on cognitive performance in healthy young adults. The motor and integrated tasks were not sensitive enough to detect change in this healthy population. This pilot study did succeed in improving our overall paradigm for this line of work by adding an isolated cognitive outcome measure and by developing an enhanced gait protocol. The conditions developed for the walking task were able to perturb the gait of this healthy population, indicating that this enhanced testing protocol is inducing competition for attentional resources.

Clinical Relevance: Studying the impact of training the attention system using the NT allows for the consideration of the NT as a treatment tool to target other systems (motor and cognitive) and expands on the current understanding of the dual task training paradigm. Future studies should investigate the impact of training attention in isolation with patient populations diagnosed with neurodevelopmental or neurodegenerative disorders.
Balance Error Scoring System Baseline Performance in College Athletes

Purpose/Hypothesis: Concussion management guidelines include neurocognitive and balance evaluation with growing appreciation of relevant psychological factors. Concussion-related balance assessment has focused on the Balance Error Scoring System (BESS). Return-to-play (RTP) protocols using the BESS rely on comparison of baseline and post-concussion scores. Optimal RTP decisions are informed by normative and psychometric data to delineate normal score ranges and identify reliable change. Despite growing literature on the BESS, comparison of various sources of normative data remains limited. This study examined baseline BESS scores among college athletes in relation to demographics and concussion history and across normative data sources.

Number of Subjects: 134

Materials/Methods: Retrospective examination of baseline data from college athletes including history, balance testing, and symptom report. None of the participants sustained a concussion within three months prior to baseline evaluation. Given the distribution of BESS scores in the sample, non-parametric analyses were used (i.e., Kruskal-Wallis tests and Spearman rank-order correlations). BESS total scores were converted to norm-referenced scores using data from the test manual and two publications in 2013 and 2018. Scores were defined as normal (≥10th percentile) or below expectation (<10th percentile).

Results: The sample was 46% female. Sports included women’s lacrosse (n=27) and rugby (n=35), and men’s lacrosse (n=12), rugby (n=38), and soccer (n=22). No prior concussion was reported by 59% of participants; 17.2% reported 1 prior concussion and 23.8% reported 2 or more prior concussions.

The average BESS total score was 15.5 (SD=7.3; Mdn=14; range 3-40). BESS total scores were not significantly different by gender (p=.40) or sport (p=.09). Among female athletes, however, BESS total scores were higher for rugby players (M =17.7, SD=7.3; Mdn=16) than lacrosse players (M=13.3, SD=5.2; Mdn=13), H(1)=5.13, p=.02.

BESS total score was not associated with number of prior concussions (r_s =.05, p=.62), post-concussive symptoms (r_s =.12, p=.20) or neck symptoms (r_s =.11, p=.26).

Using normative data from the manual, 79.1% of participants demonstrated normal BESS total scores and 20.9% scored below expectation. Using normative data published in 2013 and 2018, 33.6% and 20.9% of participants, respectively, scored below expectation. The number of prior concussions was not significantly different between normal and below-expectation groups (p = .77 - .96).

Conclusions: Concussion history and gender were not related to baseline BESS scores, but among female athletes, a difference in BESS scores between sports was observed. Below-expectation baseline BESS scores were observed in 20-33% of athletes regardless of concussion history.

Clinical Relevance: Findings highlight the need to identify the optimal normative data source for a given population and bring attention to the potential benefit of baseline testing, especially given the use of the BESS in RTP decisions.
Virtual reality/active video gaming use and learning needs among physical and occupational therapists practicing in the US

Purpose/Hypothesis: Despite increasing evidence supporting the effectiveness of virtual reality (VR) and active video gaming (AVG) interventions for many client populations, little is known about the extent and nature of clinical VR/AVG use by physical therapists (PTs) and occupational therapists (OTs) practicing in the US. The purpose of this study was to 1) describe current clinical VR/AVG use in the US, 2) determine barriers and facilitators to VR/AVG application, and 3) evaluate therapists' VR/AVG-related learning needs and preferred forms of support.

Number of Subjects: Three hundred and sixteen (316) PTs and 130 OTs.

Materials/Methods: A cross-sectional online survey was conducted in 2017-18. Participants were recruited via convenience and snowball sampling. Responses were summarized using descriptive statistics and content analytical techniques.

Results: The 446 respondents came from 41 states. Two-thirds (68%) had previous clinical experience with VR/AVGs, with Nintendo’s Wii and WiiFit as the most familiar (39%, 21.5%) and accessible (44.6%, 29.8%) systems. Only 14% reported access to rehabilitation-specific AVG systems and 5.6% to any type of head-mounted display (HMD). Current use of VR/AVG was reported by 31% of respondents. Respondents used VR/AVGs predominantly with clients with stroke (35.4%), brain injury (25.6%), cerebral palsy (25%), or musculoskeletal injuries (20.4%). Therapists targeted goals related to balance (53.5%), upper extremity function (20.4%), participation/engagement (18.8%), strength/endurance (16.4%), and mobility/gait (14.6%). Most (65%) of respondents agreed that VR/AVGs offered benefits beyond those of conventional treatments. The most commonly reported barriers to VR/AVG use were lack of time, space and funds, while client motivation was the most frequent usage facilitator. The majority (77%) of respondents were interested in learning more, with online resources (including videos and interactive training modules) as the preferred educational format. The most prevalent learning needs were management of technical issues, access to educational resources, and selecting games to meet differing client needs.

Conclusions: Findings from this first national survey of VR/AVG use in rehabilitation in the US indicate that clinicians are most comfortable with older off-the-shelf AVGs and that access to VR and rehabilitation-specific AVG systems is limited. Despite enthusiasm for the potential role of VR/AVGs, only half of respondents with VR/AVG experience currently use any VR/AVG system, and logistics (i.e. time, space, cost) present significant barriers to integration.

Clinical Relevance: A greater understanding of clinical use of VR/AVGs, barriers and facilitators to use, and therapist learning needs is essential to inform logistical and educational interventions promoting the evidence-based adoption of these technologies into practice.
The role of the Modified Performance-Oriented Mobility Assessment tool in the evaluation of gait in adults with hypophosphatasia

Purpose/Hypothesis: Hypophosphatasia (HPP) is a rare inherited metabolic disorder characterized by a mutation of the ALPL gene, which encodes tissue non-specific alkaline phosphatase (ALP). Low levels of ALP result in a myriad of symptoms that may impair mobility, including seizures, pain, muscle weakness, pathological fractures, and fatigue. Physical therapists participate in the management of individuals with HPP across the lifespan. A 2016 commentary outlines the role of physical therapy (PT) in the care of infants and children with HPP. The Six-Minute Walk Test (6MWT) and Modified Performance-Oriented Mobility Assessment (MPOMA-G) have been validated in children with HPP. Surveys of adults with HPP indicate that 95% of affected individuals experience pain, 62% experience muscle weakness, 52% report unusual gait, and 60% require the use of assistive devices for mobility. However, little guidance is available related to the PT evaluation of adults with HPP. The purpose of this study is to assess the utility of the MPOMA-G in the assessment of adults with HPP.

Number of Subjects: 53

Materials/Methods: The MPOMA-G was administered via retrospective video gait analysis for all adult patients with HPP at an outpatient medical center for a two-year period. Scores were analyzed for correlation with selected medical history and other outcome measures.

Results: A statistically significant (p<0.05) moderate correlation (0.4<ρ<0.6) was noted between the MPOMA-G and the Functional Gait Assessment, preferred and maximal gait speed, and the 6MWT. A weak correlation (ρ<0.4) was noted between the MPOMA-G and fracture history, ALP level, use of enzyme replacement therapy, Five-Times Sit-to-Stand Test, and Sensory Organization Test score. A ceiling effect and poor sensitivity was also present, as 61% of patients scored 12/12 on the MPOMA-G and 79% scored at least 10/12.

Conclusions: The MPOMA-G did not correlate well with any medical history assessed, suggesting no significant relationship between MPOMA-G performance and disease severity. Significant correlation between the MPOMA-G and other gait measures indicates that the gait deviations assessed with the MPOMA-G are indirectly accounted for with measures of gait speed, endurance, and dynamic balance. A ceiling effect and low sensitivity of the MPOMA-G demonstrates a decreased ability to accurately assess the functional deficits of this population.

Clinical Relevance: The PT evaluation framework for adults with HPP at this clinic consists of standardized measurements of gait speed, static and dynamic balance, endurance, and transfers. These measurements can be reliaibly readministered to assess functional performance over time. An objective and standardized disease-specific measure of qualitative gait analysis may be a valuable tool in the care of individuals with HPP and in data collection to facilitate optimal management of the overall population of people with HPP. However, further research is necessary to develop a measure that is sensitive to the gait abnormalities common in the adult HPP population.
Purpose/Hypothesis: Parkinson’s disease (PD) is largely considered a movement disorder, but there is increased interest in the impact cognitive deficits have on the progression and burden of the disease. This study used Magnetic Resonance Imaging (MRI) to identify differences in local gyrification index (LGI) throughout the brain between subjects with PD with mild cognitive impairments (PD-MCI) and subjects with PD who are cognitively normal (PD-CN). Brain regions in which differences have been identified were correlated with multiple assessments of cognitive function.

Number of Subjects: 75 PD-CN (47m, 28f) and 34 PD-MCI (24m, 10f). Subjects were drug naïve and within 6 months of initial diagnosis of PD.

Materials/Methods: Subject MRI scans were collected and analyzed from the Parkinson’s Progressive Marker Initiative database and assessed for categorization into PD-CN and PD-MCI. The following cognitive exams were administered: Benton Judgement of Line Orientation (BJLO), Hopkins Verbal Learning Test (HVLT), Letter Number Sequencing (LNS), Semantic Fluency Test (SFT), and Symbol Digit Modality (SDM). The PD-CN group scored > 26 on MOCA, and no cognitive tests > 2 standard deviations (SD) from the mean, based on healthy controls. PD-MCI scored > 2 SD from the mean on 2 or more cognitive tests. MRI scans were preprocessed using Freesurfer v6.0 in order to quantify LGI. A between groups ANCOVA using permutation-based methods was performed in FSL/PALM with sex, age, years of education, and MDS UPDRS-III as covariates. Results were reported with an alpha < 0.05, corrected.

Results: We ran a correlation matrix between 33 brain regions and 19 cognitive measures. In the right hemisphere there were no significant correlations following corrections for multiple comparisons between any of the 33 brain regions and any of the 19 cognitive measurements. In the left hemisphere there were significant correlations between 11 of the cognitive assessments and 33 brain regions. In this analysis, we will focus on correlation coefficients greater than or equal to +0.3. Correlations found primarily in the left insula, frontal and temporal lobe were the most affected across four of the five cognitive domains. The left inferior insula (circular) showed the most robust correlation (-0.328, p<0.015, corrected) between LGI and the BJLO age-asses subscore.

Conclusions: We have provided clear evidence of a relationship between changes in the LGI of selected brain regions in the left hemisphere and selected measures of cognition. LGI in the Inferior insula (circular) demonstrated the strongest correlation with the BJLO age-asses subscore and relates visual-spatial impairment.

Clinical Relevance: Identification of brain regions affected in PD-MCI relative to PD-CN will better position us to facilitate multimodal treatment interventions that affect both the motor and specific cognitive deficits in PD. One such example is progressive resistance exercise, which has been shown to improve PD motor deficits and is hypothesized to improve cognitive function.
Purpose/Hypothesis: The use of online technology to deliver educational content has been shown to be effective in improving knowledge\(^1\) and practical skills\(^2\) in physical therapy (PT). E-learning has been shown to improve post-test scores after content delivery compared to pre-test scores in PT neurologic content areas.\(^3,4\) The use of Web-based education has been as effective as face-to-face educational delivery among healthcare professionals.\(^5\) The Academy of Neurologic Physical Therapy hosts an online course annually to assist individuals preparing to take the board specialty examination in neurologic PT. The online course includes special topics in neurologic PT practice, including Motor Control and Motor Learning (MC-ML). The purpose of this study was to determine whether the use of internet-based technology to deliver specific MC-ML content results in improved post-test scores compared to pre-test scores among participants of an online course.

Number of Subjects: 358 physical therapists enrolled and actively participated in the online course.

Materials/Methods: An online learning management system (Canvas) was used to deliver MC-ML content. The MC-ML module consisted of 6 topic areas including: Motor Control Theories, Motor Control & Motor Learning Neurological Impairment, Motor Learning & Recovery of Function, Motor Learning Theories, Plasticity & Physiology of Motor Learning, and a Framework for Neurologic Clinical Practice.

The module, including quizzes, was open to participants for review for approximately 4 months. The “Overview” pre- and post-test comprised 10 multiple-choice items representative of MC-ML module content as a whole. The quiz was administered at the beginning and end of the entire module. Pre- and posttests for the 6 MC-ML topic areas comprised 10 multiple-choice item quizzes. The same items were used for both pre- and post-tests. Participants were directed to take the pretest prior to viewing the online lecture and to complete the posttest after viewing the lecture.

Participant raw scores were extracted from the learning management system, and paired samples t-tests were applied to determine significant differences in mean posttest compared with pretest scores. Effect sizes were also calculated to determine the magnitude of the mean differences.

Results: Post-participation score improvements were observed in all 6 topic areas and on the Overview assessment. Paired samples t-tests demonstrated significant improvement on posttests compared with pretests in all 6 MC-ML topic areas (p<.001). Large effect sizes were found for all topics (Cohen’s d 0.704 to 1.039).

Conclusions: Participating in an online review course presenting MC-ML content may benefit PTs preparing for the neurologic board specialty examination. The results of this study may inform future development and use of online systems for exam preparation.

Clinical Relevance: The accessibility of cost-effective online courses to help PTs prepare for board specialty examinations may encourage more PTs to pursue board certification in neurologic PT.
Purpose/Hypothesis: Falls in the acute phase of recovery are a common adverse event in patients with cerebrovascular accident (CVA). The BBS is a routinely used outcome measure to assess static balance, postural control and quantify fall risk in individuals with acute CVA. The BBS has been highly recommended for clinical use by the APTA Stroke EDGE committee in the acute phase of stroke recovery, and has more recently been recommended as part of a core set of outcome measures to be utilized in all patients with neurologic dysfunction in all phases of the disease process. A recently presented clinical practice guideline for neurologic outcome measure utilization highlighted the need for additional research toward establishing the MCID value of the BBS in acute neurologic populations. The MCID is utilized clinically to assist clinicians with interpretation of change scores and to quantify meaningful clinical improvement for patients. Currently there is no established MCID value for the BBS in patients with acute CVA. This study aimed to close the current gap in the body of literature by establishing the MCID for the BBS in the acute stroke population. The minimum detectable change (MDC) for this sample has also been included in the reporting of the results.

Number of Subjects: 169 patients with acute stroke.

Materials/Methods: A retrospective data analysis was completed of 169 patients with a diagnosis of acute CVA admitted to an inpatient rehabilitation facility. A previously established REDCap database captured the admission and discharge scores for a core set of standardized assessments used in the interdisciplinary assessment of patients with acute stroke. Functional Independence Measure (FIM) motor score change was used as the gold standard to dichotomize patients into clinically improved groups and clinically unimproved groups, utilizing the established FIM MCID value of 17. BBS change score was used to predict the clinical improvement using ROC analysis. Youden index and minimum distance to point (0,1), with consideration of sensitivity and specificity, were used as the criteria to choose the optimum cut-off score. MDC was calculated using the standard formula.

Results: The area under AUC for the BBS change score was 0.6935 (fair test to predict clinical improvement). For BBS change score, 17 was chosen as the optimum cut-off point based on Youden index and 15 was chosen as the optimum cut-off point based on minimum distance to (0,1). The cut-off point with higher sensitivity (15) was chosen as BBS MCID value in this population. The MDC for BBS in this population is 16.61.

Conclusions: The MCID value for the routinely used BBS will assist with clinical interpretation of meaningful improvements in postural control, static balance and fall risk in patients with acute stroke.

Clinical Relevance: This study fills the gap in the published psychometric properties for the BBS in acute stroke, further supporting its use as a core outcome measure in this population.
Purpose/Hypothesis: Quantitative electroencephalogram (qEEG) is a non-invasive tool used to measure the functional state of the brain by measuring the activity of different frequency brain waves. It has been useful in the assessment of different neurological conditions, including traumatic brain injuries. The brain waves most commonly examined include, Delta, Theta, Alpha, Beta and Gamma waves. Previous research has established high test-retest reliability of wired qEEG systems, but these systems do not offer freedom for movement during recordings. Recently wireless qEEG systems have been developed, however, test-retest reliability for these systems has not been established. The purpose of this study is to evaluate the test-retest reliability of wireless qEEG in both static and dynamic conditions, in healthy adults.

Number of Subjects: 8 subjects (5 females), ages 22-30 (mean: 25.1, SD +/- 1.66), with no prior history of neurological conditions were included in this pilot study.

Materials/Methods: Data collection consisted of 2 sessions, 7 days apart. During each session, subjects were connected to the Smart BCI Wireless EEG system (NovaTech EEG, Mesa, AZ) and participated in 4 different conditions for 10 minutes each: seated eyes closed, seated eyes open, standing on a BOSU® ball, and walking on a treadmill (3.2mph). Test-retest reliability for 5 predetermined electrode points for Delta, Theta, Alpha, Beta 1, Beta 2, and Gamma waves, across all four conditions was examined using Pearson Correlation Coefficients.

Results: Delta waves exhibited high, statistically significant test-retest reliability as follows, eyes closed, 4/5, eyes open 3/5, BOSU 2/5, treadmill 2/5 reference points. Theta waves exhibited high, statistically significant test-retest reliability as follows: eyes closed 5/5, eyes open 3/5, BOSU, 3/5, treadmill 4/5 reference points. Alpha waves exhibited high, statistically significant test-retest reliability as follows: eyes closed 4/5, eyes open 4/5, BOSU 5/5, treadmill 0/5 reference points. Beta 1 waves exhibited high, statistically significant test-retest reliability as follows: eyes closed 4/5, eyes open 4/5, BOSU 3/5, walking on treadmill 3/5 reference points were significant. Beta 2: eyes closed 4/5, eyes open 2/5, BOSU 4/5, treadmill 0/5 reference points. Gamma waves exhibited high, statistically significant test-retest reliability as follows: eyes closed 4/5, eyes open 4/5, BOSU 4/5, treadmill 1/5 reference points.

Conclusions: Overall, the Smart BCI qEEG system has high, statistically significant test-retest reliability across conditions of eyes closed, eyes open, and standing on the BOSU ball. As expected, walking on a treadmill demonstrated the least amount of test-retest reliability. Theta waves appear to be the most reliable brain wave across all the conditions. Eyes closed is the most reliable condition across all wavelengths. Further testing should be conducted with a larger sample size.

Clinical Relevance: The establishment of test-retest reliability for wireless qEEG across multiple conditions allows for its use to assess brainwave activity over time.
Background & Purpose: Recent research outlines the negative impact of prolonged rest in individuals suffering from concussion. In addition, multiple studies have outlined the positive impact of aerobic exercise in recovery from post-concussion syndrome. Common protocol for cardiovascular exercise prescription includes use of equipment such as stationary bikes or treadmills to achieve the prescribed sub-threshold heart rate range. However, in individuals with chronic symptoms, additional psychological factors and elevated fear avoidance may also contribute to prolonged symptoms and resultant limitations in exercise tolerance. Circuit training is another mode of exercise that enables sustained elevation in heart rate through the performance of a series of exercises with minimal rest. The purpose of this case series is to demonstrate the feasibility of the use of circuit training as an alternative form of aerobic exercise in the highly fear avoidant patient with chronic post-concussion syndrome.

Case Description: Two individuals were treated in an outpatient physical therapy setting after having each sustained a concussion due to a motor vehicle accident (MVA). Both individuals were evaluated five to six months after their initial injury and demonstrated elevated fear avoidance based on the Fear Avoidance Belief Questionnaire-Physical Activity (FABQ-PA). They were both unable to tolerate traditional aerobic testing via the Buffalo Concussion Treadmill Test (BCTT) at initial evaluation. Balance was assessed using the Balance Error Scoring System (BESS) and vestibular and oculomotor impairments were evaluated using the Vestibulo-Oculomotor Screen (VOMS). Level of functional impairment was measured with Focus on Therapeutic Outcomes (FOTO). Both patients performed circuit training using resistive and callisthenic exercises as a part of their therapy session with a Polar FT1 heart rate monitor to track exertion and maintain the prescribed heart rate range.

Outcomes: Patient One and Two were seen for 13 and 32 visits respectively during their plan of cares. At discharge, both patients were able to complete the BCTT without onset of symptoms to age predicted heart rate max. They exceeded predicted functional improvements on FOTO by an average of 35 points. Both patients also demonstrated negative VOMS testing and BESS scores within normal range for their age, with an average improvement of 28 errors. FABQ-PA scores decreased from 24 to 5 and 0 respectively.

Discussion: Both patients demonstrated significant improvements on all outcome measures assessed and were able to return to all normal activities without onset of concussion symptoms. The outcome of this case series suggests that the use of circuit training may be a viable substitute for traditional aerobic exercise in individuals with post-concussion syndrome and a high level of fear avoidance. However, more research needs to be conducted in the form of a randomized controlled trial to demonstrate efficacy in treatment.
TITLE: Soft Landing: A Rehab to Home Transition Pilot and Future Programming

CURRENT SECTION: Neurology

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ABSTRACT BODY:

Purpose: Rehabilitation doesn’t end when a patient discharges from the hospital; he or she has continued and often lifelong challenges to face, beginning the day they arrive at home or the next step after inpatient rehabilitation. This abstract showcases the pilot program "Soft Landing" at Craig Hospital, a neurological rehabilitation hospital in Denver, CO. This unique program aimed to address the challenges commonly faced by individuals discharging from inpatient rehabilitation to home after a catastrophic neurological injury. The background for this program was based on responses from patients and families in a post rehab survey. The overall purpose of this presentation is to present both what was learned as a result of the pilot program, as well as how Craig Hospital used the results of these experiences to develop a peer mentor program aimed at improving the patient and family transition back to home and community life.

Description: Pilot program: The pilot program consisted of 10 supported discharges: 5 from inpatient spinal cord injury, and 5 from inpatient traumatic brain injury. Staff members accompanied each patient and their family members, traveling to 10 locations. Disciplines included Physical Therapists, Occupational Therapists, Respiratory Therapists, Nurses, Speech Therapists, Pharmacists, Psychologists, and Case Managers. Staff members documented the successful completion of education, the safety and accessibility of the home, and the safety and confidence of the patient and family when completing activities of daily living. Each soft landing revealed different gaps in education and comfort with various aspects of discharge, and also exposed several common themes of challenges our patients face upon discharge.

Current and future programs: Using recommendations from staff, patients, and families, hospital work groups were formed to address common themes from the supported discharges. Work groups focused on topics including: medication management, equipment, discharge education, and day of discharge preparation. In addition to tangible changes these working groups already have in place, future programming includes establishing a robust peer mentor program. A three year grant has been received from the Phillips Foundation, and will be used to better help support difficult discharges. Efficacy of the program will be analyzed using multiple outcome measures including, but not limited to, the Satisfaction with Life Scale (SWLS), the Caregiver Burden Inventory, and the Moorong Self Efficacy Scale.

Summary of Use: All patients and families who received supported discharges reported it being beneficial and recommended it for future patients. Research from similar rehabilitation hospitals has shown that individuals working with peer mentors upon discharge had positive experiences, including fewer unplanned hospital days and higher growth rates for self-efficacy.

Importance to Members: The Soft Landing program, lessons learned, and current program development can be used as an example for other rehabilitation hospitals throughout the nation and world.
The Effect of Transcranial Direct Current Stimulation on Lower Extremity Cortical Excitability and Ankle Tracking Accuracy

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Purpose/Hypothesis: Transcranial direct current stimulation (tDCS) is a type of noninvasive brain stimulation that alters the resting membrane potential of cortical neurons. Some studies have demonstrated that tDCS can influence cortical excitability and ankle tracking accuracy of the lower extremity in both healthy subjects and subjects who have suffered a stroke. However, electrode placement (montage) and conductance mediums used for tDCS that targets the lower extremity motor cortex are not consistent. The purpose of this study was to investigate how cortical excitability of the lower extremity motor cortex and ankle tracking accuracy are affected by various tDCS montage/medium combinations.

Number of Subjects: 18 (8 female) mean age 24.2 years

Materials/Methods: A triple-blind, randomized, repeated-measures study was employed where subjects performed an ankle tracking task followed by an assessment of lower extremity cortical excitability before and after subjects received anodal-tDCS at 2 mA for 20 minutes using either a M1-SO:Saline, M1-SO:Gel, C1-C2:Saline, C1-C2:Gel combination or sham-tDCS. Cortical excitability was assessed using progressively higher intensity of transcranial magnetic stimulation pulses to elicit motor evoked potentials (MEP) of the tibialis anterior muscle, which were used to establish recruitment curves. From the recruitment curves the maximum predicted MEP (MEPmax) and the slope of the curve were calculated. Performance on an ankle-tracking task was assessed using custom written LabView program, which provided biofeedback as the subject dorsiflexed or plantarflexed their foot attempting to match their joint angle with a computer generated wave. Post-test mean error scores / pre-test mean error scores were used to compute an accuracy ratio for the ankle tracking task.

Results: MEPmax difference scores were significantly lower in the M1-SO:Saline combination compared to sham-tDCS. No significant differences were found between the M1-SO:Saline, M1-SO:Gel, C1-C2:Saline, C1-C2:Gel, nor sham conditions regarding MEPmax and slope. No significant difference were found between the treatment conditions nor sham for the ankle-tracking task.

Conclusions: 1) A single application of anodal-tDCS did not significantly affect ankle-tracking accuracy no matter which electrode montage/medium was used. 2) Anodal-tDCS with an M1-SO:Saline combination at 2 mA for 20 minutes significantly decreases cortical excitability of the lower extremity motor cortex immediately after tDCS. Previous tDCS studies have demonstrated lower doses of anodal-tDCS increase cortical excitability; however, we found anodal-tDCS with an M1-SO:Saline combination at 2 mA for 20 minutes decreased cortical excitability of the lower extremity motor cortex. This paradox may be explained through the concept of homeostatic plasticity whereas a prolonged increase in postsynaptic activity eventually makes it more difficult for action potentials to occur.

Clinical Relevance: Further research on dosage and duration of tDCS are warranted prior to its use clinically.
ABSTRACT BODY:

Purpose/Hypothesis: Transcranial magnetic stimulation (TMS) is considered a useful tool for assessing brain function, and has been shown to be a valid and reliable tool for assessing motor outputs from the hand representation of the primary motor cortex. Additionally, TMS has been extensively used to explore changes that occur in the motor system after cortical injury. The relationship between music intervention using groove beats and cortical excitability is unclear. This study investigated the impact of music with and without motor commands on cortical excitability.

Number of Subjects: Twenty healthy adults (14F, 6M) were recruited with an average age of 24.45 years.

Materials/Methods: Subjects attended two, approximately 1-hour sessions. Session 1 was used to pre-screen subjects and obtain subject consent. Session 2 was a single pulse TMS mapping session where music intervention was administered. Single Pulse TMS was administered via a figure 8 coil, targeting the primary motor cortex of the hand. Motor-evoked potentials (MEPs) from the first dorsal interosseous (FDI) muscle were measured using EMG. The Visor2 Neuronavigation System was used to guide targeting for sites in the primary cortex representation that evoked the largest MEP (i.e. the "hot spot") in the FDI. The intervention consisted of 3 timed blocks of music, where each block contained a random arrangement of 3 sounds (white noise, high groove with a voice command music, and high groove music). Each of the three sounds were played for one minute and ten seconds, with a 15 second rest (silence) time in between the sounds. Eight baseline measurements were recorded before each block of music. During each block of music, TMS were delivered every six seconds targeting the “hot spot”. Five minute breaks were given between each timed block. The data was analyzed using ANOVA and Bonferroni post hoc pairwise comparisons.

Results: FDI muscle activation is significantly higher (p<.001) for high groove with voice commands compared to baseline. Mean activation values for the 4 conditions are as follows: Baseline: 1.7±0.37mV, High Groove with Voice Commands: 1.95±0.39mV, High Groove: 1.96±0.42mV, White Noise: 2.01±0.46mV. The variance for high groove and white noise were greater, therefore, they did not reach significance.

Conclusions: Listening to high groove music with voice commands increased motor cortex excitability leading to enhanced muscle activation in healthy subjects. In addition to studying the effect with a neurologic patient population, further investigation into different high groove with voice commands songs, using self-selected songs, and carry over effects would be beneficial in the future.

Clinical Relevance: Listening to high groove music with voice commands may be a simple and effective approach for facilitating motor cortex and muscle activation during neurologic rehabilitation.
Impaired transcallosal inhibition in cervical dystonia

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Purpose/Hypothesis: Cervical dystonia (CD) is a movement disorder characterized by involuntary neck muscle contractions. The pathology is unknown and treatments options are limited. In order to develop effective rehabilitative interventions for patients with focal dystonia, the pathology must first be better understood. In people with CD, brainstem excitability and intracortical inhibition have been shown to be impaired; however, transcallosal inhibition has not been evaluated in people with CD. The purpose of this study is to evaluate intracortical, transcallosal and brainstem excitability in people with CD and healthy controls (CTL). We hypothesized people with CD would have decreased cortical inhibition and enhanced brainstem excitability compared to CTL.

Number of Subjects: 31 participants (CD n=16, CTL n = 15)

Materials/Methods: Clinical evaluations of pain, disability and motor impairment were completed using the Toronto Western Spasmodic Torticollis Rating Scale (TWSTRS). Testing for intracortical and transcallosal inhibition was completed using transcranial magnetic stimulation delivered to the primary motor cortex with bilateral electromyographic recordings in the upper trapezius. Intracortical and transcallosal inhibition was assessed by evaluating the cortical silent period in contralateral (cSP) and ipsilateral (iSP) muscles to unilateral stimulation. Testing was completed at 4 stimulation intensities to assess the input-output properties of inhibitory pathways. Testing for brainstem interneuron excitability was completed using blink reflex recovery cycle (BRC). Data assessed using a mixed model ANOVA on cSP, iSP, BRC responses. Clinical measures were correlated using Pearson's correlation coefficient.

Results: Preliminary results indicate pain and disability are significantly correlated (r=0.80, p<0.01), while motor impairment was not correlated to either pain (r=0.43, p=0.113) or disability (r=0.42, p=0.123). Measures of intracortical inhibition revealed no significant effects, suggesting normal intracortical inhibition and input-output properties in the cohort with CD compared to CTL. In contrast, there was a significant effect of Group (p = 0.011) for transcallosal inhibition from the left hemisphere, but not for the right hemisphere (p = 0.71), indicating reduced transcallosal inhibition from the left to the right hemisphere in the cohort with CD compared to CTL. There were no significant effects when assessing BRC responses.

Conclusions: Preliminary findings suggest that people with CD have impaired and asymmetric transcallosal inhibition compared to controls. Brainstem excitability and intracortical inhibition was found to be normal in our cohort with CD. Treatment strategies utilizing movement practice and coordination training may be useful to improve voluntary control in people with CD as they may promote neuroplasticity and reorganization of transcallosal pathways.
Purpose/Hypothesis: Corticospinal tract (CST) development can be altered by perinatal stroke. Early assessments of CST connectivity may predict functional outcomes. We investigated CST connectivity using diffusion-weighted magnetic resonance imaging (dw-MRI) and resting state functional MRI (rs-fMRI) in an infant with perinatal stroke, and compared findings to a typically-developing (TD) infant. We hypothesized that perinatal stroke would lead to greater CST asymmetry than typical development. Additionally, we used transcranial magnetic stimulation (TMS) in the infant with perinatal stroke to further assess CST connectivity.

Number of Subjects: A 10-month old infant with perinatal stroke involving bilateral cerebral hemispheres and deep nuclei with greater right hemispheric involvement, and an age-matched TD infant.

Materials/Methods: MRI was performed using our Baby Connectome Project protocols on a Siemens 3-Tesla Prisma scanner during natural sleep. dw-MRI data were analyzed with probabilistic tractography, using the pre-central gyrus (obtained from 1-year old infant brain atlas) and a manually-defined region in the pons as seeds. Metrics analyzed included fractional anisotropy (FA), representing white matter structural organization (high FA indicates greater organization), and mean diffusivity (MD), representing water diffusion in tissue (high MD indicates less structural integrity). Asymmetry indices were calculated as (Left-Right)/(Left+Right), where 0 indicates CST symmetry. rs-fMRI data were analyzed using a seed-based approach to determine connectivity between motor regions. TMS was performed only with the infant with perinatal stroke to assess the presence of motor evoked potentials (MEP) in the upper limb.

Results: Both infants tolerated all assessments well, with no adverse events. dw-MRI revealed intact bilateral tracts from motor cortex to brainstem in both infants. The FA asymmetry index was 0.014 in the TD infant and 0.267 in the infant with perinatal stroke. The MD asymmetry index was <0.001 in the TD infant and -0.135 in the infant with perinatal stroke. rs-fMRI revealed contralateral activation from seeding each M1 in the TD infant, with significant correlations at Z=5 (p<0.0001). No significant contralateral activation was observed in the infant with perinatal stroke. No MEPs were measured from either hemisphere in the infant with perinatal stroke.

Conclusions: An infant with perinatal stroke demonstrated CST asymmetry and altered motor cortex functional connectivity compared to a TD infant. Lack of MEPs may reflect delayed maturation of CST and the maladaptive influence of perinatal stroke on CST connectivity. Longitudinal assessment may allow future detection of MEPs and correlation of TMS responses with CST connectivity measured from dw-MRI.

Clinical Relevance: dw-MRI and rs-fMRI reveal CST differences between TD infants and infants with pathology. Altered CST connectivity may result in motor impairment. Understanding CST development in the presence of pathology may promote early risk assessment for diagnosis of cerebral palsy.
ABSTRACT BODY:
Background & Purpose: Transcranial magnetic stimulation (TMS) can be safely used to non-invasively study corticospinal excitability and connectivity related to movement control in children with cerebral palsy. The electric field generated by TMS may have different properties in this population due to the presence of lesioned tissue. The purpose of this study was to 1) model the electric field generated by TMS in the lesioned and non-lesioned brain hemispheres in a child with cerebral palsy; 2) explore differences in the electric field between lesioned and non-lesioned hemispheres; and 3) examine relationships between the modeled electric field and physiologic responses to TMS.

Case Description: The participant was a 14 year old female with a diagnosis of cerebral palsy and right hemiparesis secondary to perinatal stroke in middle cerebral artery territory affecting cortical and subcortical regions. TMS assessment was performed using stereotactic neuronavigation guided by individual structural anatomy obtained from magnetic resonance imaging (MRI). The resting motor threshold (RMT) for the first dorsal interosseous (FDI) muscle was determined, and motor evoked potentials (MEP) were measured bilaterally via electromyography. Ten single TMS pulses were delivered to each hemisphere to assess MEP amplitude. Motor mapping was performed bilaterally with TMS using a circular grid with 81 map sites to assess the size of cortical FDI representation. Five researchers independently performed manual lesion segmentation from the T1 MRI, and resulting lesion masks were averaged. Surface meshes including the lesion mask were created using SimNIBS (Simulation of Non-Invasive Brain Stimulation). The electric fields generated by TMS were estimated in each hemisphere using the finite element method in SimNIBS.

Outcomes: All assessments were well tolerated, with no adverse events. RMT was 46% maximum stimulator output (MSO) in the lesioned hemisphere and 42% MSO in the non-lesioned hemisphere. In the non-lesioned hemisphere, contralateral MEP amplitude was 916±859 μV and there were 16 active map sites. In the lesioned hemisphere, MEP amplitude was 613±400 μV and there were 39 active map sites. TMS simulations indicated that the electric field at brain areas around the lesion was similar to the non-lesioned side; however, the electric field was greatly attenuated inside the lesion to approximately 10-20% of the maximum.

Discussion: Electric fields generated by TMS can be modeled in the presence of pathology such as brain lesions with SimNIBS software. The electric fields generated by TMS were diminished around the lesion compared to non-lesioned tissue. Modeling TMS in more children may clarify relationships between modeled electric field strength and physiologic responses. Individualized models of non-invasive brain stimulation may facilitate safe and effective clinical applications of TMS to rehabilitation in pediatric populations by optimizing protocols to individual patients.
Purpose/Hypothesis: The purpose of this study was to determine the most effective gait intervention to improve gait in patients with ataxia.

Number of Subjects: N/A

Materials/Methods: A literature search (2008-2018) of CINAHL, Health Source: Nursing/Academic Edition, MEDLINE/PubMed, and Proquest was conducted using the search terms: ataxia AND (gait training or locomotion training or gait rehabilitation). Search limits: English, human subjects and peer reviewed. Selection criteria: adults (≥18 years) with ataxia, objective gait measures, and gait intervention. Two reviewers independently assessed each study for methodologic quality and reached consensus using Sackett guidelines.

Results: 55 articles were evaluated for eligibility, yielding 9 studies after application of selection criteria. Sackett levels ranged from IB-V (1 RCT, 3 pre-post design, 5 case reports). Studies included subjects with ataxia (ages 19-81) due to: acquired brain injury (TBI, CVA or infection) or degenerative cerebellar changes. Samples ranged from 1-19 participants (n=58). Interventions included: treadmill training, body weight support, dynamic gait training, auditory cueing, and conventional gait training. Intervention parameters varied widely from 1-60 sessions lasting 10-240 minutes. Duration of the interventions ranged from 1 day-20 weeks. 9 studies found statistical and/or clinical improvements in objective gait measures such as spatio-temporal gait parameters (including 10MWT), complex gait (TUG, DGI), ataxia (Scale for Assessment and Rating of Ataxia), independence (Functional Ambulation Category) and gait quality (Rivermead Visual Gait Assessment).

Conclusions: Results of this systematic review reveal that there is mixed evidence supporting task-specific gait interventions for adults with ataxia. There is high quality evidence (IB) that therapist assisted gait training is equally as effective as robot assisted gait training in adults with ataxia to improve complex gait with reduced ataxia. There is low evidence (IV-V) that treadmill training (with and without obstacles), body weight support, auditory cueing, and dynamic gait training can improve gait in adults with ataxia as evidenced by significant improvements in complex gait (2 studies), spatio-temporal parameters (6 studies), ataxia (2 studies), independence (2 studies), and gait quality (1 study). Limitations included small samples, poorly defined gait interventions, and lack of uniform outcome measures, control groups and long-term follow up. Future research is needed to determine ataxia-specific gait outcome measures and interventions and address the above limitations.

Clinical Relevance: Historically, ataxia has been treated by weighting the patient’s trunk and lower limbs and through symptom management at the impairment level. This systematic review suggests that gait-specific rehabilitation strategies can be effective addressing ataxia at a functional level. When working with adults with ataxia, clinicians should consider task-specific gait training to address individual functional mobility deficits.
The Role of the Interdisciplinary Team in Subacute Rehabilitation for Central Pontine Myelinolysis: A Case Report

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Background & Purpose: This case report describes a 30 year-old female with Central Pontine Myelinolysis (CPM) presenting with incomplete locked-in syndrome. She improved during a 6 week course of post-acute rehabilitation utilizing progressive and individualized treatment interventions. Despite the acknowledgment of the need for rehabilitation for individuals with CPM, there are minimal descriptions in the literature at this time and no known evidence of therapeutic interventions that may benefit this population. The purpose of this report is to present the case of an individual with CPM and detail the interdisciplinary rehabilitation approach and recovery process in the post-acute phase.

Case Description:

The patient was admitted to inpatient rehabilitation following a 4 week acute hospitalization with CPM and history of alcoholism, high liver function, depression, anxiety, and a recent bout of influenza with a 30 pound weight loss. Upon evaluation, she was dependent for bed mobility, transfers, communication, swallowing and all activities of daily living (ADL). She presented with decreased range of motion, limited activity tolerance, weakness, absent voicing and muscle pain. These impairments limited her ability to be an autonomous individual, return to work, and participate in her relationships.

Primary treatment themes were identified by the therapy team to address her needs and goals for a comprehensive and progressive care plan. Treatments across disciplines emphasized tone management, activity tolerance, access to environment, and functional training. Routine collaboration between team members and the patient was a primary focus. With an interdisciplinary approach, each therapy played an essential role in fostering her recovery, independence and improving her quality of life.

Outcomes: At discharge, the patient was sustaining a modified oral diet, engaging in verbal conversation, requiring partial assist with ADLs, independent with trial powered mobility, and working towards independence with transfers and ambulation. She demonstrated improvement with the following outcome measures from initial evaluation to discharge in week 6: Nine-hole Peg Test [unable to R: 39sec, L: 32sec], Box and Blocks [unable to R: 37 blocks; L: 42blocks], Function In Sitting Test [0 to 39/56], and Functional Oral Intake Scale [Level 1 to Level 5]. With the Functional Independence Measure, her scores also improved for both motor [12 to 45] and cognitive [7 to 29] subscales.

Discussion: This case demonstrates the recovery potential and critical role of a patient-centered interdisciplinary team approach in the rehabilitation of an individual with CPM. Through clinical assessment by each discipline, interaction between team members, and involvement of the patient, an individualized and coordinated team approach was formulated. Establishing primary treatment themes provided structure in the plan of care, offered guidance to all disciplines, and allowed for an integrative and collaborative relationship between team members and the patient.
Title: Transcutaneous Spinal Cord Stimulation Decreases Reflexes Without Changing Motor Evoked Potentials in Neurologically Intact Subjects

Abstract Body:

Purpose/Hypothesis: Decreased motor control and functional impairments are common results of neurological damage. Daily function is hindered by spasticity, specifically hyperreflexia. Physical therapy plays a role in spasticity management through techniques including positioning, dry needling, therapeutic exercises and stretching. Limited results have shown that an additional technique, transcutaneous spinal cord stimulation (tSCS), decreases quadriceps spasticity in subjects with spinal cord injuries. The mechanism of action for the technique is unknown. Therefore, the purpose of this research is to examine the effects of tSCS on cutaneous sensation, motor evoked potentials (MEP) and posterior root muscle reflexes (PRMR) in neurologically intact subjects. We hypothesize that tSCS works at the spinal segmental level as opposed to supraspinal level which will result in altered reflexes, but no change in MEPs.

Number of Subjects: 33

Materials/Methods: Thirty-three healthy participants were recruited for this study. Electromyography (EMG) electrodes were placed over lower extremity (LE) muscles. Baseline PRMR and MEP values were obtained prior to receiving tonic tSCS for 15 minutes. tSCS intensity was set to elicit paresthesias in the feet or until participants reached maximal tolerance. PRMR and MEP values were then reassessed. Electrodes for PRMRs and tSCS were placed over the abdomen and T11/12 interspace. Transcranial magnetic stimulation (TMS) was used to elicit MEPs over the motor cortex specifically targeting the tibialis anterior (TA). Monofilament testing was performed on the great toe and repeated during and after tSCS. Reflexes and MEPs were averaged within each subject and then compared using a repeated measures ANOVA. A repeated measures ANOVA was used for sensory testing.

Results: The results of the study showed that the hamstring and soleus PRMRs were significantly reduced by an average of 10-15% immediately after a bout of tSCS. All muscles except the quadriceps showed a significant decrease in PRMR amplitude after a ten minute washout. Also, we found that the TA MEP and LE cutaneous sensation showed no change during or after tSCS.

Conclusions: Our findings are consistent with previous studies on tSCS and spasticity. We saw an overall decrease in LE reflex amplitude with no change in MEP amplitude. The results suggest that afferent input to the motoneurons is being altered without significant changes in corticomotor excitability, though we did see a trend of increased MEP amplitude. Further, the reduced reflex amplitudes after the washout period likely arise from more long-term neuromodulation mechanisms.

Clinical Relevance: Based on our results, tSCS offers a potentially effective intervention to diminish spasticity. Ultimately, this study shows that tSCS may be a viable option for physical therapists to use in conjunction with other treatments to help reduce spasticity and improve function in their patients.
ABSTRACT BODY:

**Purpose/Hypothesis:** Online-learning is progressively being used in health professions education and is comparable to traditional learning. Internet-based learning in health professions has been shown to have large positive effects compared to non-internet based learning. While use of Web-based learning to deliver content in pediatrics has positive effects on knowledge and test scores in medicine and nursing, there are no studies exploring the effectiveness of this type of learning in delivering pediatric content in physical therapy. The purpose of this study is to determine whether use of internet-based technology to deliver content in the area of pediatrics results in improved post-test scores compared to pre-test scores among participants of an online Neurologic Clinical Specialist board examination preparation course hosted by the Academy of Neurologic Physical Therapy.

**Number of Subjects:** 389 participants enrolled in the course, 126 completed both tests.

**Materials/Methods:** Using an online learning management system to deliver content, 6 experts in neurologic pediatric physical therapy created 9 pediatric specific modules: Assistive Technology, Cerebral Palsy (CP), Typical Development, Educational Service Delivery, Genetic Disorders, Myelomeningocele/Spinal Bifida, Pediatric Concussion, Pediatric Neurology, and Pediatric Outcome Measures. Pre-and posttests were designed for each module, consisting of identical multiple-choice questions. Participants were encouraged to take the pre-test prior to viewing the pediatric module and then to complete posttest after viewing online content.

Participants’ raw scores were obtained and statistical analysis using paired t-tests were performed for each specific topic. To determine the magnitude of the mean differences, effect sizes were also calculated.

**Results:** Post-test scores showed significant improvement in all areas with p<.03 for CP and p<.001 for all other areas. Effect size ranged from 0.27 (CP) to 1.4 (Genetics).

**Conclusions:** Those preparing for the Neurologic Specialist Examination may have limited pediatric practice and need to participate in a structured review of pediatric content. Following the delivery of pediatric knowledge through internet-based technology, a significant difference was found between the pre and posttest means in all pediatric modules. A relatively large, meaningful change occurred in 8 out of 9 modules. These changes suggest that delivery of pediatric practice education via an internet platform may improve content knowledge in physical therapists preparing for the Neurologic Specialist Examination.

**Clinical Relevance:** Pediatric neurological conditions are included in the Neurologic Description of Specialty Practice. However, most who sit for the NCS Examination do not regularly engage in pediatric practice. A module focused on this topic assists with identifying weaknesses and strengthens one’s pediatric knowledge base. A free, online course is an effective way to review unfamiliar content prior to sitting for a specialist examination.
**Purpose/Hypothesis:** Chronic pain is associated with long term changes in the brain\(^1,2\) which can affect learning and memory. For example, individuals with chronic low back pain (CLBP) are now recognized to have reduced working memory capacity\(^3,4\). Regions of the brain critical for motor learning and retention overlap with those involved in pain processing and thus also have the potential to interact\(^5\). Work in our lab suggests that acute, experimentally induced pain interferes with motor learning and retention, though the effects of CLBP on motor learning have not been systematically studied. Due to the known central effects of pain, it’s possible that the effects of chronic pain on motor learning may be even more pronounced. A better understanding of this is vital for providing best care for those with CLBP because interventions for these individuals commonly involve motor learning strategies to teach new movement patterns. This ongoing study is aimed at understanding how CLBP affects learning and retention of a novel locomotor pattern. We hypothesized that individuals with CLBP will demonstrate reduced retention of locomotor learning.

**Number of Subjects:** Adults with CLBP (>3 months duration, ≥ 3/10 pain at least 4 days of the week; n = 6) and healthy, pain-free age-matched controls (n = 5); anticipated total enrollment: 15 participants/group.

**Materials/Methods:** In this 2-day study, participants learned to alter their walking based on real-time visual feedback. On Day 1, visual feedback was presented during treadmill walking via a dynamic bar graph that displayed the step length of each leg and a target zone in which to aim each step. During learning, feedback was distorted so that in order to successfully step in the target zone, participants had to take larger steps with one leg and shorter steps with the other, thus learning a novel asymmetric gait pattern. Retention was measured on Day 2 by testing walking with the same visual feedback. T-tests were used to compare between groups at select time points. Bonferroni corrections were used to adjust for multiple comparisons.

**Results:** On Day 1, initial learning was slower for individuals with CLBP; they required more practice to correctly alter their step length symmetry (p=0.009), though by the end of practice both groups achieved similar gains. On Day 2, individuals with CLBP trended toward a greater decrease in accuracy (p=0.026). Also, while initial performance on Day 2 was significantly improved from Day 1 for the control group (p =0.013), there was no improvement for the group with CLBP.

**Conclusions:** Results indicate that both initial learning rate and retention of a recently learned locomotor task may be reduced in individuals with CLBP.

**Clinical Relevance:** Individuals with CLBP may have barriers to learning and remembering new motor patterns and may require increased time, practice or resources to maximize motor learning. Further study in a larger sample is warranted.
Attributes of Contributing Authors in the Journal of Neurologic Physical Therapy and Pediatric Physical Therapy

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Purpose/Hypothesis: The Journal of Neurologic Physical Therapy (JNPT) and Pediatric Physical Therapy (PPT) are quarterly, peer-reviewed, MEDLINE indexed journals of academies within the American Physical Therapy Association (APTA). Several studies have examined the physical therapy literature to identify the core journals, the types of studies published, the quality of the evidence, and most common statistical tests used. However, no studies have reviewed the literature to determine the credentials of authors publishing. Given the advancement of the profession, it is important that physical therapists take ownership of the evidence guiding their clinical decisions. The purpose of this study is to describe the credentials and other characteristics of authors contributing to current research in neurologic and pediatric physical therapy.

Number of Subjects: N/A

Materials/Methods: Data was collected using Qualtrics® data management system from all JNPT and PPT publications between January 2015 and December 2016. For each article the following was collected: type of study/article, funding source, author names, author credentials, author affiliation (academic or clinical, US or non-US), and corresponding author status. After all data was synthesized, codes were used to categorize various credentials and characteristics about the contributing authors. Data was analyzed using Microsoft Excel®.

Results: The total number of included articles was 47 from JNPT and 106 from PPT. In both journals over 75% of the articles were categorized as research studies. In JNPT 42.6% of articles had no PT authors while this only true for 22.6% of articles in PPT. The total number of unique contributing authors was 256 in JNPT and 375 in PPT. Only 5 individuals were authors on more than one article in JNPT, while 41 authors published in PPT more than once. Physical Therapists made up 48% and 59% of total authors in JNPT and PPT respectively. In both journals approximately 47% of all PT authors held a PhD. Only 10.1% of authors were pediatric specialists and 11.7% were neurologic specialists. 46.7% and 45.3% of corresponding authors were PTs with a PhD in JNPT and PPT respectively. The majority of authors were affiliated with an academic institution.

Conclusions: Physical therapists with and without an associated PhD are contributing to the literature in APTA section journals at nearly the same frequency. However, most authors in these 2 PT specific journals were not physical therapists and most of the studies emerged from academic settings. This suggests that the profession needs to increase the education and training of physical therapists to encourage clinical research and researchers.

Clinical Relevance: These journals serve to provide evidence for physical therapist practitioners to use in clinical practice. Based on this study, most published articles were from academic sources and had physical therapists with a PhD as a corresponding author. Including more clinician researchers may facilitate improved applicability of studies.
Purpose/Hypothesis: Functional Near-Infrared Spectrometry (fNIRS) is a novel neuroimaging method which can detect brain activities during dynamic walking tasks. Falls risk assessment instruments often include alterations in gait speed and aging may affect brain activity in the dorsolateral prefrontal cortex (DLPFC) and supplementary motor area (SMA) when walking in different gait speeds. The purpose of this study is to investigate the effect of aging on DLPFC and SMA activation during different walking.

Number of Subjects: 2 younger adults (mean age: 25 ± 1 y.o.) (YA) and 2 older healthy adults (mean age: 81 ± 8 y.o.) (OA) with right-hand dominance

Materials/Methods: All participants completed three visits in this pilot study. The subjects were screened to exclude individuals with any cognitive impairment (MMSE < 24), neurological, and orthopedic disorders during the first visit after the informed consent. Functional Near-Infrared Spectroscopy (fNIRS) (NIRSport, NIRx, Germany) was used to detect hemodynamic changes on right and left hemispheres over the DLPFC and SMA separately in the second and third visit. A block design (A-B-A) was used to elicit hemodynamic changes in the regions of interest (ROI). The subjects were asked to walk in three different conditions in random order: 1) standing-walking in preferred speed (WPS)-standing; 2) WPS-walking preferred fast speed (WFS)-WPS; and 3) WPS-walking in preferred slow speed (WSS)-WPS. East task was performed 10 times. fNIRS data were analyzed based on a spatial-temporal version of a general linear model. Group-level analysis across the subject was performed using a random-effects model of brain activity. The Mann-Whitney U test was used to compare the gait speeds between groups. The level of significance was set up at p < 0.05.

Results: The preliminary results showed significant increased DLPFC activity among older adults in all the test conditions compared to younger adults. The older adults displayed increased SMA activity during standing-WPS conditions, no changes in SMA activity during WSS condition, and decreased SMA activity during WFS condition when compared to younger adults. The WSS was statistical difference between YA (0.67 ± 0.1 m/s) and OA (0.52 ± 0.1 m/s) (p < 0.05).

Conclusions: Increased DLPFC activity among older adults when walking at different gait speeds compared to younger adults suggests increased executive function demands during walking compared to younger adults. Decreased SMA activity may be associated with decreased gait speed among older adults.

Clinical Relevance: The ability to safely change gait speed during walking is one of the assessment items in the Dynamic Gait Index and Functional Gait Assessment. Our preliminary results suggest brain activity in the SMA may be associated with the ability to change gait speed during walking. Further research is needed to determine this relationship and investigate if practicing fast walking improves gait speed and prevents falls in the elderly.
Purpose/Hypothesis: Threshold to detection of passive movement (TDPM) is the number of degrees a joint moves before you feel it. Typically based on the average score across several trials, it is a reliable and valid measure of kinesthetic sense. No standardized protocol for TDPM of the elbow is available. The purposes of this study were to develop and standardize a protocol for TDPM of the elbow and examine its test-retest reliability in healthy adults.

Number of Subjects: 20 healthy adults (mean age 29 years, range 23-58)

Materials/Methods: The TDPM protocol developed used standardized instructions and methods. An Artromot™ Elbow Continuous Passive Movement Machine, running at 0.26 degrees/second, caused the passive movement. A Biometric Ltd. electrogoniometer was used to quantify elbow angle, while Delsys® Trigno™ Electromyography (EMG) was used to insure participants were passive during testing. Vision of the arm being was occluded using a white cloth barrier and sound was dampened with headphones. Eight total trials (2 null) were conducted with each upper extremity. Participants signaled when they felt movement using a hand-held trigger associated with the electrogoniometer tracing. The difference between the start angle and stop angle were quantified. The middle 4 trials were averaged and considered the TDPM value. Participants completed the Edinburgh Handedness Questionnaire and underwent 2 days of testing, 1 week apart. Pseudorandomization was used to determine the order of testing. All participants provided written informed consent for participation in this IRB approved study. Data were analyzed using JMP 13.2.0.

Results: 20 participants completed testing on two days, there were no missing data. 19 participants were right handed. Mean (SD) TDPM for the right and left elbow were 1.15(0.98), 1.23(1.11) degrees respectively and were not statistically different (p = 0.85). To examine test-retest reliability, Pearson correlation and intraclass correlation coefficient were calculated on TDPM scores from testing days 1 and 2 (r = +0.71, p <0.001), (ICC (2,4) = 0.84, p <0.001).

Conclusions: In this sample the elbow TDPM scores were not different between the left and right side and the protocol developed demonstrated good reliability. The set-up and data analysis time and expertise make the TDPM clinically impractical. This measure is best reserved for research purposes.

Clinical Relevance: Developing improved research measures for examining kinesthetic sense will support the development of more accurate clinical measurement and impairment specific interventions for people with proprioception impairment.
Does a Single Session of Moderate Intensity Cycling Modulate Plasticity in Healthy Individuals?

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Purpose/Hypothesis: While known that maintaining a regular exercise program can enhance brain plasticity (an important component of an overall healthy brain), less is known about potential effects of a single exercise session. Brain plasticity can be measured non-invasively by using transcranial magnetic stimulation (TMS) with intermittent theta-burst stimulation (iTBS) (TMS-iTBS), a protocol that gives insights into mechanisms of plasticity associated with learning and memory, namely, long-term potentiation. A recent study demonstrated that a 30-minute high-intensity stationary cycling session was associated with a decreased response in TMS-iTBS plasticity. Taken together, examining the influence of aerobic exercise prescribed at a lower intensities, and other forms of exercise on cortical plasticity, is relevant. The current study investigates the effects of an acute bout of moderate intensity stationary cycling on TMS-iTBS plasticity. We hypothesized that an acute bout of moderate intensity cycling would be associated with a more robust response TMS-iTBS plasticity.

Number of Subjects: Fifteen healthy subjects (5 females, 25.4 ± 4.8 years, range 20-38 years).

Materials/Methods: Participants engaged in 2 study visits, one week apart. In visit 1, participants underwent a TMS-iTBS plasticity test, and in visit 2 they engaged in a single session of exercise, immediately followed by a TMS-iTBS plasticity test. The exercise condition consisted of 5 minutes of warm-up and 15 minutes of moderate intensity stationary cycling (65-75% of maximal age predicted heart rate). TMS-iTBS was administered over the primary motor cortex whereby single TMS pulses were applied prior to and following iTBS at regular intervals post-iTBS (T5, T10, T20 and T30) and the resulting motor evoked potential (MEP) amplitude was recorded using surface electromyography (EMG) electrodes placed on the first dorsal interosseous. Plasticity was defined as the iTBS-induced modulation of MEP amplitude and was expressed as a ratio (percentage change) relative to baseline MEP amplitude over post-iTBS intervals (T5-T20), and is expressed by using the mean ± standard deviation. Comparisons between plasticity in visits 1 and 2 were performed using paired t-tests. Significance was set at p<0.05.

Results: Individual plasticity responses varied greatly among participants, and did not seem to be altered by exercise. Group analyses revealed that plasticity remained stable between visits 1 and 2, as evidenced by the mean iTBS-induced modulation of MEPs (visit 1= 13.9%±35.5, visit 2=9.35%±43.8, p=0.77).

Conclusions: Contrary to our hypothesis, a moderate bout of cycling exercise did not significantly alter TMS-iTBS plasticity.

Clinical Relevance: While 20 minutes of moderate intensity cycling may not modulate cortical plasticity in the motor cortex, future studies should investigate other intensities and modalities that can potentially enhance plasticity. These findings have implications for the prescription of aerobic exercise prior to therapeutic exercises that harness neuroplasticity to promote motor learning.
Purpose/Hypothesis: Chronic headaches are debilitating. Self-efficacy, or the ability to manage and control headaches, in patients with chronic headaches is low. Specific elements of self-efficacy with chronic headaches has not been defined. The Chronic Headache Self-Efficacy Scale (CHASE) was developed. The purpose of this study was to characterize the measurement properties of the CHASE.

Number of Subjects: 22

Materials/Methods: Participants completed the Headache Impact Test (HIT6), Headache Management Self-Efficacy Scale (HMSE), and CHASE at the initial time-point (T1), 24-72 hours after initial time-point (T2), and 12 weeks after the initial (T3). The HIT6 measures the ability to function at a job, school, home, and in social situations. The HMSE measures self-efficacy of the psychosocial aspects of headache management. The CHASE is a 14-item scale for self-efficacy of headache management and belief to perform daily activities without causing or increasing a headache (0-100, 100=high self-efficacy). Reliability was assessed with the Interclass Correlation Coefficient (ICC3,1). Error was determined with the Standard Error of the Measurement (SEM) and Minimal Detectable Change at the 90% confidence interval (MDC90). Validity was assessed by the relationship between the CHASE, HIT6 and HMSE at T1, and the change (T1–T3) in CHASE compared to the HIT6 and HMSE. Global rating of change (GROC) at T3 was used to assess overall change. Responsiveness of the CHASE was assessed by comparing the score on the CHASE, HIT6, and HMSE between patients who reported at least moderate changes (GROC≥4) in their headache symptoms at T3 and patients who did not, and a receiving operating curve for the minimal clinically important difference (MCID).

Results: The ICC3,1 =0.87(CI: 0.62,0.96); SEM=7.3pts; MDC90=16.9pts. At T3 the CHASE was correlated with the HIT6 (r=-0.68, p<0.01), and the HMSE (r=0.70, p<0.01). The was also a correlation between the change scores (T1–T3) of the CHASE with the HIT6 (r=-0.41, p=0.06) and HMSE (r=0.45, p=0.04). Patients who reported at least moderate change in headache symptoms from T1 to T3 had high score on the HIT6 (mean difference [MD]=11.2; CI:-15.9, -6.3, p<0.01) and CHASE (MD=26.7, CI=12.8,40.6, p<0.01), but not the HMSE (MD=16.9, CI=-4.0,37.7, p=0.11). The MCID for the CHASE was 8.1 (sensitivity=0.5, specificity=0.82).

Conclusions: Preliminary results indicate excellent reliability, acceptable error, responsiveness, and validity. Participant recruitment continues to fully assess reliability, validity, error, and responsiveness of the CHASE. This study provides preliminary evidence of the CHASE scale to assess self-efficacy and behaviors specific to chronic headaches.

Clinical Relevance: Low levels of self-efficacy are associated with higher levels of disability in people with chronic headache. Identifying the aspects of low self-efficacy in patients with chronic headaches will assist clinicians in providing directed interventions towards improving management of chronic headaches.
Purpose/Hypothesis: Cognitive-motor interference (CMI) is the worsening in cognitive and/or motor function when cognitive and motor tasks are performed simultaneously (dual-task). As dual-task is present in many daily living activities, studies using dual-task paradigm are used to develop new rehabilitation techniques. Grip force control refers to the adjustments of grip force to grasp, lift and hold an object. Optimal control of grip force falls between not letting the object slip from the fingertips (not enough force), nor damaging the object (excessive force). Grip force is controlled: 1) Predictively – The estimated force to initiate lifting of an object. Optimal predictive force is achieved after 2-3 lifting trials of a novel object, as it relies on sensorimotor memory from previous trials; and 2) Reactively – Force adjustments triggered when object weight is perceived after being lifted (sensorimotor feedback). Thus, grip force control allows the assessment of brain networks involved in executing fine motor tasks – networks also used for cognitive tasks. The purpose of this study was to investigate CMI during simultaneous performance of precision grip force and cognitive tasks.

Number of Subjects: 16

Materials/Methods: Healthy right-handed young subjects (8 males, 24.31±0.95 years) with no history of upper limb injuries were recruited. A force sensor and an accelerometer were embedded in a cup-shaped object. Subjects used the opposition of thumb and both index and middle fingers to grasp, lift and hold the object. This task was also performed simultaneously to the Digit Span Test, which consisted in recalling a sequence of numbers. Single and dual-tasks were repeated 10 times with each hand. After the 5\textsuperscript{th} trial, the object weight cup was unpredictably changed to a heavier or lighter weight. Predictive force was measured by the Peak of Grip Force Rate (PGFR), while reactive force by Static Force. Differences between the 3\textsuperscript{rd} trials before and after weight change were calculated and compared between single and dual-task conditions using paired t-tests (significance level set at 0.05).

Results: Differences of 3\textsuperscript{rd} trials before and after weight change between single and dual-task were not significantly different for heavy to light on Peak of Grip Force Rate (left hand, p=0.29; right hand, p=0.87) and on Static Force (left hand, p=0.68; right hand, p=0.16). Similar results were found for light to heavy on PGFR (left hand, p=0.41; right hand, p=0.74) and Static Force (left hand, p=0.94; right hand, p=0.16).

Conclusions: Predictive and reactive grip force were not altered during dual-task involving Digit Span Test and precision grip force task with subtle change on object weight. This undetected CMI might be due our dual-task paradigm being similar to daily living activities performed by healthy young subjects. Yet, similar dual-task involving precision grip force might be more challenging to cognitively impaired populations, potentially causing CMI.

Clinical Relevance: Dual-task involving precision grip force may be used on cognitive assessment of elderly or neurological patients in future clinical protocols.
Improving high-intensity body weight-supported treadmill training mentorship using knowledge translation framework

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High-intensity body weight-supported treadmill training (HI-BWSTT) is underutilized despite evidence of its efficacy. Translating evidence to practice requires knowledge, motor skills, and self-efficacy to administer interventions that may be learned through practice and mentorship. We used knowledge translation framework to develop a mentoring intervention for physical therapists to improve fidelity of HI-BWSTT.

Seven themes emerged regarding administering HI-BWSTT: 1) confidence of one’s knowledge and skills are important; 2) developing motor skills is challenging; 3) mentees feel overwhelmed; 4) how mentoring is delivered is important; 5) the set-up of the treadmill session is challenging but of utmost importance; 6) knowledge is essential for clinical decision-making; and 7) clinicians’ attitudes towards the intervention can be influenced by knowledge.

Mentorship barriers included: scheduling logistics, need to identify a “gate keeper,” and the complexity of developing a motor skill assessment. Facilitators included: support from leadership, having expert clinicians as mentors, staff eager to participate, and number of patients who require maximal-total assistance. The average±SD baseline knowledge, motor skill assessment and self-efficacy scores were 74%±15, 77%±18, 74%±11, with final scores of 100%, 94%±3, 90%±9, respectively. An average of 6±2 sessions were needed for mentees to reach motor skill competence, with 3 mentees failing to reach competence at 10 sessions. Two motor skill assessment trajectories emerged: groups that (1) performed moderately well initially and required few mentoring sessions and (2) started with low competency and improved slowly with more mentoring sessions.

Knowledge-to-action cycle framework provided structure to guide development of a CMP to facilitate HI-BWSTT. Mentees improved knowledge, motor skills, and self-efficacy in the delivery of HI-BWSTT for patients with neurologic injury who require maximal-total assistance to ambulate.

Adequate learned competency among physical therapists is needed to implement high-intensity gait training. The CMP may help clinicians improve knowledge and motor skills, which may alter attitudes through self-efficacy.
Background & Purpose: Translation of knowledge into practice can take many years. The Knowledge to Action (KTA) framework provides a systematic process to drive efficient utilization of evidence-based practices (EBP). The American Physical Therapy Association has strategically supported the development of clinical practice guidelines (CPG's), as synthesized resources to be implemented by knowledge users. In 2018, a CPG was published with a recommended core set of standardized measures to track change in mobility of patients with neurologic disorders. The purpose of this case study is to describe one hospital system’s journey in the translation of this new CPG into acute and inpatient rehabilitation settings. This quality initiative is one step toward a long-term goal of assessing physical mobility outcomes across the continuum, from acute care through outpatient rehabilitation services.

Case Description: The case is a large, urban, academic medical center with a 60-bed inpatient rehabilitation (11 physical therapists (PTs)), and a 774-bed Level I trauma center/acute care hospital (heart, cancer, brain and spine hospitals) (37 PTs). The hospital serves a large volume of patients with neurologic diagnoses, many of whom transition through the continuum. In 2016, a 3-part team from the medical center attended the Knowledge Translation Summit at the Combined Sections Meeting with a proposed project to systematically implement standardized outcome measures (SOMs) for patients with neurologic diagnoses across the continuum of care. A survey was used to collect staff therapists’ perceptions of using SOMs, and an initial chart audit confirmed high variability in use and knowledge base related to SOMs. Early barriers and facilitators were identified and stakeholder groups were convened with the goal of increasing the use of the recommended core measures of the CPG. Specific implementation strategies were selected and utilized.

Outcomes: The KTA framework, related to implementation of the Core Measures CPG, will be discussed. Barriers included perceived lack of time, variable knowledge base, and lack of infrastructure. Facilitators included the neurologic residency, manager support, clinical/academic collaboration, and EBP leaders. Process and workflow modifications were optimized to support implementation (e.g., continuum committees, a staged approach, chart-audit and feedback, and clear expectations set from managers). Outcomes of the pilot PTs’ efforts will be described, along with future plans for KTA implementation among additional staff.

Discussion: This case study may provide insight to implementing the Core Measures CPG within other hospital systems. As each site has individual barriers and facilitators, the KTA framework can be a useful model to systematically approach the process. In large academic medical centers, this framework can also provide a common language among stakeholders, to expand the potential exchange of knowledge from one group to the other.
Purpose/Hypothesis: Robot-assisted gait training (RAGT) has emerged within the past 10 years as an approach to enhance walking motor recovery. RAGT has several distinguishing characteristics: it is highly specific with intense training durations promoting accurate, extensive repetitions. RAGT also provides an opportunity to measure these characteristics continuously. The purpose of this retrospective study was to evaluate the impact of variances in dosing parameters on changes in gait performance following RAGT for individuals with chronic stroke deficits.

Number of Subjects: 28 subjects post stroke (Average Age 59.2)

Materials/Methods: A licensed therapist applied an individualized treatment protocol using an end-effector robot (G-EO Reha Technology) to meet the gait recovery needs for each subject. Training protocols consisted of active and passive forward walking and stair climbing. Dosing parameters (intensity, repetitions) were captured continuously. Intensity was defined as speed and duration walked, while repetitions were defined as mean distance, steps per sessions, and total steps over the course of treatment. Each participant had a minimum of 4 sessions. Gait outcomes were assessed using a pressure sensor gait mat (ProtoKinetics Walkway) prior to and following treatment.

Results: Subjects were subdivided into two groups: improved or not improved based upon gait characteristics following treatment. Improvement was categorized as a positive change of 10% or greater in gait speed and step length, as well as a 3% change in stance/swing ratio. 14 patients post stroke showed positive improvement in all three categories. Independent t testing was used to compare between group differences in dosing. Comparisons between intensity parameters (speed, duration) and number of sessions were not statistically significant (p>0.05). Significant differences were found for repetitions: mean and total steps (p=.05) and stairs (p=.03).

Conclusions: Individuals post stroke demonstrated significant improvement in gait speed, step length and symmetry following RAGT. Dosing parameters that were statistically different for the individuals demonstrating clinical improvement were related to the amount of practice. The group demonstrating improvement averaged 158 more steps and 34 more stair steps per session. The average number of sessions for subjects in both groups equaled 10 but the group demonstrating significant gait improvement averaged 4000 more total steps by the 10th session.

Clinical Relevance: These findings support repetitions (the number of steps daily and in total) as a potential critical factor for gait improvement in individuals with chronic stroke. Previous literature and clinical trials have focused on speed/intensity, which were not significant. Daily accurate practice leading to a total cumulative effect was critical for these individuals when evaluating significant changes in gait outcomes. RAGT offers a gait training environment that enables therapists to monitor, collect and manage dosing parameters allowing for a more focused treatment approach.
Exploring the relationship between visuospatial abilities, attention, and motor learning in two virtual environments

Purpose/Hypothesis: Practice in virtual reality environments (VEs) can support movement skill learning, but the extent to which viewing medium (2D flat-screen display as compared to 3D head-mounted display [HMD]) influences motor skill learning, and whether skill improvement transfers between viewing mediums is underexplored. In addition, little is known about the influence of user visuospatial and attention abilities on performance in VEs. The study purpose was to determine the impact of 1) VE viewing medium and 2) visuospatial and attention abilities on motor learning and transfer of a novel motor task. We hypothesized that 1) participants practicing in the HMD would demonstrate greater retention and transfer as compared to participants who practiced in the flat-screen display; and 2) visuospatial and attention abilities would better predict performance in the HMD.

Number of Subjects: 18 healthy young adults (16 males and 4 females, mean age 23.9 years).

Materials/Methods: Participants completed standardized visuospatial and attention tests and were randomly assigned to practice 200 acquisition trials of the same ‘catch & throw’ task using their non-dominant hand in either a 2D (72” LCD screen; Microsoft Kinect) or 3D (HMD: HTC Vive) VE. They returned 1-3 days later for retention and transfer (opposite VE) tests. Statistical analyses used linear mixed effects models.

Results: The 2D group performed significantly better than the 3D group during practice (mean difference 45 points, t[df = 15.1] = -8.862, p < 0.001) and at retention (mean diff. 27 points, t[df = 16.7] = -5.01, p < 0.01). However, they performed more poorly in the opposite VE on transfer testing, while participants who practiced in the 3D VE significantly improved their performance on transfer to the 2D VE (t[df = 16.6] = 10.1, p < 0.001). There was a significant baseline difference in visuospatial abilities in favor of the 2D group (t[df 12.1] = 1.35, p = 0.046), but the effect of visuospatial abilities was only significant in transfer, with no between-group differences (t[df = 16.5] = 2.45, p = 0.025). There was no influence of attention abilities in any condition.

Conclusions: Inherent differences in virtual object presentation and dimensionality between 2D and 3D viewing mediums likely contributed to reduced task challenge in the 2D VE, which negatively influenced transfer to a more realistic 3D task. Practice in the 3D VE did not enhance retention. The poorer visuospatial abilities of participants in the 3D VE group may have negatively influenced their performance in this condition.

Clinical Relevance: Study results, which require replication with a larger sample and the addition of a real-life transfer task, suggest 1) caution in expectations of transfer from simplified 2D VE tasks to the 3D interactions of the real world and 2) the need for subsequent research involving clinical populations to evaluate the impact of visuospatial abilities, which may be impaired in neurological conditions, on the choice to use either 2D or 3D VEs within rehabilitation programs.
Purpose/Hypothesis: Gait speed predicts important functional outcomes and health related risk factors but is underutilized in the clinic. This study aimed to identify barriers to measuring gait speed and to determine if utilization of the 4 meter walk test (4MWT), an NIH Toolbox measure, could be influenced by providing education and resources. Frequency of gait speed measurement was hypothesized to increase following an inservice on the importance of gait speed measurement, provision of educational resources.

Number of Subjects: 17

Materials/Methods: Researchers educated 17 physical therapists employed at an inpatient rehabilitation center on the clinical importance of gait speed measurement. Resources provided include a 4 MWT app, paper handout including information on calculation and clinical importance, and dedicated test areas within the clinic. Frequency of gait speed measurement was collected two weeks before and two weeks after the presentation. Data was collected for the 17 physical therapists (PTs) that attended the presentation and was analyzed using a z-test. 14 PTs returned a pre-survey and 6 returned a post-survey, which assessed clinician’s perceptions of gait speed measurement. Survey results were evaluated using thematic analysis.

Results: Common barriers reported on pre-research surveys include time and facility constraints, not applicable for patient, patient too weak for 10MWT, status of patient, and patient required devices/assistance. 75% of responders to the post-survey reported that barriers were eliminated with the education session. A z-test indicated there was a significant increase (p=.01) in the frequency of gait speed measurements for ambulatory patients after the presentation and provision of resources.

Conclusions: These findings indicate that frequency of gait speed measurements may be increased by the identification and elimination of certain barriers within the clinic.

Clinical Relevance: Making gait speed easier for clinicians to measure may lead to greater utilization in the clinic.
Are we close enough? Establishing the inter-rater reliability of spinal cord damage manual-measurement using MRI.

Establishing a prognosis of motor and walking recovery following SCI is a complex task. Soon after SCI, edema develops within the damaged spinal cord. This edema is a hallmark of SCI, hindering axonal re-growth through the injury, and expressed as signal hyperintensity using sagittal T2 magnetic resonance imaging (MRI). Measures of this edema are used as prognostic tools for functional recovery.

Due to the subjective nature of manually quantifying edema, questions remain on these measures’ reliability, especially between experienced and novice raters. The purpose of this study was to establish the level of inter-rater reliability of five measures of edema following cervical incomplete spinal cord injury (SCI).

Cranial/Caudal edema boundaries, edema length, midsagittal tissue bridge (MTB) ratios, damage ratios, and edema volumes were examined in 10 participants with cervical incomplete SCI. As the most simple of measures requiring only 1-dimensional lines, cranial/caudal involvement and edema length were hypothesized to have high inter-rater reliability (ICC ≥ 0.90). The 2-dimensional measures, MTB ratios and damage ratios, were hypothesized to have moderate inter-rater reliability (0.75 ≤ ICC ≤ 0.90). The edema volume measurement was hypothesized to have less than a moderate inter-rater reliability due to its three-dimensional nature (ICC ≤ 0.75).

Number of Subjects: 10 participants with incomplete SCI.

Materials/Methods: This study used a cross-sectional design in a University research setting. MR images of 10 participants with SCI were collected. Novice raters were given two hours of training, and all five measures were performed using OsiriX Lite v9.0 (Pixmeo Sarl, Geneva, Switzerland). An intra-class correlation coefficient (ICC2,1) was computed for each measure to determine inter-rater reliability.

Results: ICC values for cranial/caudal level of involvement, edema length, MTB ratios, damage ratios, and edema volumes were found to be 0.99, 0.98, 0.90, 0.84, and 0.93 respectively. These values demonstrate high to excellent inter-rater reliability for all five measures.

Conclusions: With minimal training, across both novice and experienced raters, these five measures of spinal cord damage demonstrated a high level of inter-rater reliability. In the future, rehabilitation professionals may be able to use MRI measures of edema to inform clinical practice and anticipate the degree of functional return following SCI, including motor, sensory, and walking recovery.

Clinical Relevance: Following continued validation studies, including those with larger sample sizes, these measures may be used to prognosticate functional return post-SCI. This information will be meaningful in forming individualized rehabilitation plans of care and aid professionals in determining whether to employ interventions emphasizing neuroplasticity versus compensation.
Spared neural tissue is associated with ambulatory function following spinal cord injury: a magnetic resonance imaging study of midsagittal tissue bridges.

**Purpose/Hypothesis**: Prediction of future walking status following spinal cord injury (SCI) is challenging. Assuming motor return in the early stages is indicative of future ambulatory capacity, various factors (e.g. spinal shock, sedation, impending surgery, secondary long bone fracture) prohibit such assessment, making such prediction a challenge. Accurate and independent, objective biomarkers could inform targeted management strategies on a patient-by-patient basis, enhancing both patient and family expectations around future mobility status. Using magnetic resonance imaging (MRI) and specifically a mid-sagittal T2-weighted image, the amount of tissue bridging (measured as spared spinal cord tissue) shows potential to serve as such a biomarker.

**Number of Subjects**: 10 participants with incomplete SCI.

**Materials/Methods**: This study used a cross-sectional design in a University research setting. Ten participants with incomplete SCI received MRI of the spinal cord. Using the midsagittal T2-weighted image, anterior and posterior tissue bridges were calculated as the distance from cerebrospinal fluid to the damage. Then, the midsagittal tissue bridge ratio was calculated as the sum of anterior and posterior tissue bridges divided by the spinal cord diameter. Each participant also performed a 6-minute walk test, where the total distance walked was measured within six minutes.

**Results**: The midsagittal tissue bridge ratio measure demonstrated a high level of inter-rater reliability (ICC = 0.90). Midsagittal tissue bridge ratios were significantly related to distance walked in six minutes (R = 0.68, p = 0.03).

**Conclusions**: We uniquely demonstrated that mid-sagittal tissue bridge ratios were correlated with walking ability. These preliminary findings suggest potential for this measure to be considered a prognostic biomarker of residual walking ability following spinal cord injury.

**Clinical Relevance**: In addition to serving as a potential biomarker for functional recovery, mid-sagittal tissue bridge ratios may differentiate responders versus non-responders to intensive locomotor training or other experimental procedures such as epidural stimulation and stem-cell therapies. This preliminary work provides foundation for this line of translational enquiry.
The Application of Externally-Paced Locomotor Training for the Recovery of Ambulation in a Patient with Acute Transverse Myelitis

Background & Purpose: Transverse myelitis is an inflammatory disorder of the spinal cord, often causing sensory and motor dysfunction below the level of the spinal cord lesion and subsequent impairments in functional mobility. Previous studies have shown improved ability to ambulate in individuals with incomplete spinal cord injury following locomotor training over-ground or on a treadmill with partial body-weight support. Several studies have demonstrated the importance of training speed, with improved spatiotemporal and kinematic gait parameters following locomotor training at speeds faster than self-selected speed. However, little is known about this effect in individuals with transverse myelitis. The purpose of this case report is to explore the application of externally-paced fast locomotor training for the recovery of ambulation in a patient with acute transverse myelitis.

Case Description: A 19 year old female with acute lower thoracic transverse myelitis participated in 6 training sessions combining externally-paced fast locomotor training over-ground without body-weight support and on a treadmill with partial body-weight support throughout the course of 8 days in an inpatient rehabilitation facility. Multiple 3-6 minute bouts of stepping were performed on the treadmill, with progression of speed up to 2.6 mph and body-weight support down to 0%. During over-ground locomotor training, the patient performed multiple one minute bouts of stepping, progressing from bilateral hand held assist to supervision without an assistive device.

Outcomes: Spatiotemporal gait parameters captured during locomotor training at an externally-paced fast speed were superior beyond measurement error compared to spatiotemporal parameters captured during training at self-selected speed. The patient’s self-selected gait speed, distance, and amount of assistance needed during ambulation improved following training as evidenced by improvements exceeding the minimal detectible change in the 10 Meter Walk Test and the Walking Index for Spinal Cord Injury II. The patient made substantial gains in her Spinal Cord Independence Measure III score, primarily through progress within the mobility subsection. Lastly, her self-perceived walking ability score using a subjective rating scale doubled following training.

Discussion: These results suggest that a paradigm shift from locomotor training at self-selected speeds to training at externally forced faster speeds may be beneficial in the recovery of ambulation following transverse myelitis. This may be because training at speeds faster than self-selected speed more closely aligns with “normal” over-ground walking velocity, allows for greater automaticity of walking, and promotes task-specific, repetitive, and intense training in keeping with the principles of neuroplasticity. Additional research is needed to further examine this effect.
Purpose/Hypothesis: Approximately 65% of individuals with spinal cord injury (SCI) develop spasticity that interferes with functional performance, quality of life, and social participation. Spasticity is a sensorimotor disorder characterized by intermittent or sustained involuntary muscle activation with variable clinical manifestations, including hyperreflexia. A number of physiologic and environmental variables are believed to increase spasticity based on self-reported measures, however, there is limited objective evidence about the influence of these variables on spasticity. We investigated the relationship between physiologic/environmental variables and level of spasticity (as represented by stretch reflex excitability) in individuals with SCI.

Number of Subjects: Fifty-six individuals with SCI (American Spinal Injury Association Impairment Scale [AIS] grade B=6%, C=38%, and D=56%) participated in the study. The mean age was 46.1 years, 84% of the participants were male.

Materials/Methods: This study was conducted at a specialty rehabilitation hospital. Demographic characteristics and medical history were obtained via interview. As the literature indicates that environmental variables influence spasticity, temperature, humidity, and barometric pressure information were recorded. Spasticity was assessed using the pendulum test to quantify stretch-induced reflex excitability in the quadriceps muscle. The first swing excursion (FSE) was the index of interest, wherein lower FSE values suggested higher spasticity levels. To categorize participants based on spasticity level, cluster analysis was applied on FSE data. Multivariate stepwise regression was used to determine independent variables predicting spasticity level. Independent variables included in the model were: age at the time of injury, time elapsed since injury, gender, AIS classification, ability to ambulate, intake of antispasmodic medication, temperature, humidity, and pressure. The significance level was set at p <0.05.

Results: Three spasticity groups were identified based on severity level: low, moderate, and high. The regression analysis revealed that only walking ability and temperature were significant variables predicting spasticity in the moderate and high spasticity groups. For the low spasticity group, none of the independent variables of interest significantly contributed to the model.

Conclusions: Individuals with SCI who are able to walk have the greatest likelihood of experiencing high levels of spasticity. This study confirms that low temperatures increase stretch reflex excitability, validating reports of cold weather as a patient-reported variable that worsens spasticity. This study supports prior quantitative and self-reported literature suggesting that spasticity severity level can be high despite the use of antispasmodic medication.

Clinical Relevance: Identifying variables that influence spasticity may help clinicians design more effective rehabilitation plans, and improve functional performance in ambulatory individuals with SCI.
TITLE: Transcutaneous spinal stimulation and intensive exercise to improve upper extremity function after cervical spinal cord injury

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ABSTRACT BODY:

Purpose/Hypothesis: Objectives: To investigate the benefits of transcutaneous spinal cord stimulation combined with Physical Therapy (PT) on upper extremity function in a chronic cervical spinal cord injury (SCI) population. Hypotheses: Non-invasive transcutaneous electrical spinal cord stimulation combined with intense PT will improve muscle strength and coordination, upper extremity function and neurophysiological measures of connectivity for people with incomplete cervical SCI.

Number of Subjects: Two participants (motor level C3–C6, ASIA Scale B&D) completed a randomized cross-over intervention of (A) PT only and (B) PT+ transcutaneous spinal stimulation. Each treatment block provided 12-20 sessions over 4 weeks.

Materials/Methods: Outcome Measures: (1) Graded and Redefined Assessment of Strength, Sensibility and Prehension (GRASSP) test (Kalsi-Ryan 2014), (2) grip & pinch strength dynamometry, (3) muscle co-contraction ratios during the GRASSP peg task, (4) muscle synergies during reaching, and (5) spinal evoked potentials recorded in upper extremity muscles.

Results: Participant #1 (C3 ASIA D) improved by a substantial 51 points in the GRASSP test from baseline to last follow-up, with the majority of improvements occurring during stimulation treatment. He also doubled his grip force and improved pinch strength by 2-7 fold (Inanici 2018). Participant #2 (C5-6 ASIA B) showed some improvement in the GRASSP test, and his ability to pinch returned from 0 N to 4N bi-laterally during the stimulation treatment. This participant also improved activation of triceps muscles bi-laterally such that muscle co-contraction ratios improved during functional testing. This participant predominantly relied on a single muscle synergy during reaching and grasping, and that synergy became more pronounced during stimulation treatment (Steele 2015). Both participants exhibited significant changes in spinal evoked potentials over the course of the stimulation intervention, with changes observed in 3 and 8 of 16 muscles for participant 1 and participant 2, respectively (Sayenko 2015).

Conclusions: The combination of transcutaneous stimulation and PT is effective in improving hand strength and function for individuals with chronic cervical SCI. The re-emergence of bi-lateral pinch force for participant #2 during stimulation treatment despite complete paralysis of both hands at baseline and during PT only interventions suggests that stimulation can restore movement after motor-complete SCI (cf: Gad 2018). Even for participants with motor-incomplete injury, stimulation produced a dramatic gain in hand function as measured by the validated GRASSP test. Improvements measured in both participants persisted for 2-3 months of follow-up with no further treatment. Further studies are needed to determine the optimal treatment paradigms to combine transcutaneous spinal stimulation and PT to restore function following SCI.

Clinical Relevance: Transcutaneous stimulation combined with PT improves upper extremity strength and function after incomplete spinal cord injury.
Background & Purpose: Motor learning and neuroplasticity have become increasingly relevant topics in stroke rehabilitation literature; however, there is currently little research available that looks at the implications of motor learning on rehabilitation for incomplete spinal cord injury. While performance improvements are temporary changes that are observable in a practice session, motor learning relates to long-term changes in behavior that are transferrable to different contexts and environments. The purpose of this case report is to describe a program guided by the principles of motor learning and neuroplasticity, for a patient with an incomplete SCI and measure the impact of these strategies on ambulatory capacity and independence with functional mobility.

Case Description: The patient was a 61-year-old male who was 7-months post-motor vehicle accident resulting in an incomplete spinal cord injury. His injury was classified according to the American Spinal Injury Association (ASIA) International Standards for Neurological and Functional Classification of SCI as C4, ASIA Impairment Scale (AIS) ‘D’. Patient was dependent on a power wheelchair for all household and community mobility and required moderate to maximum assistance to transfer from wheelchair to mat table. Patient was seen for 30, 60-minute sessions over the course 12 weeks. Interventions were performed in an aquatic environment, over-ground, and on a treadmill. Interventions emphasized load-bearing stepping and were guided by the principles of motor learning and neuroplasticity. The program emphasized variability, random practice, discovery learning through intrinsic feedback, and motor priming.

Outcomes: At the conclusion of this report, the patient was performing all transfers and bed mobility with modified independence. He was performing ambulatory transfers to bed every night using a rolling walker and was able to walk independently in the home and with supervision in the community using a front wheeled walker. Changes were seen in ambulation as assessed using the WISCI-II (III to XVII), 10-MWT (unable to 0.42 m/s), and 6-MWT (unable to 121.31 m). Functional mobility was measured using the Spinal Cord Independence Measure (52 to 72/100). Balance was assessed using the Trunk Impairment Scale (19 to 21/23) and Berg Balance Scale (0 to 28/56).

Discussion: This case report describes a multi-modal, multi-directional, and multi-environmental step training program for a patient with a motor-incomplete cervical SCI. The objective with this patient was to facilitate motor learning through a discovery process that relied on trial-error learning, intrinsic feedback, and self-correction. For this patient, the use of motor learning principles during rehabilitation helped to facilitate load-bearing stepping and assisted in the return of independence with functional mobility. Future research may need to rely on serial case studies to determine effective strategies for incorporating motor learning principles into SCI rehabilitation.
Purpose/Hypothesis: This study’s purpose is to determine the clinically diagnosed first instance of upper extremity (UE) pain/pathology in individuals with traumatic spinal cord injury (SCI) utilizing information available in the medical record.

Number of Subjects: 44

Materials/Methods: The Rochester Epidemiology Project (REP) was used to identify a population-based cohort from Olmsted County that experienced traumatic SCI between 1997 and 2016. Researchers confirmed traumatic SCI by searching the REP and medical records. Time following SCI was reviewed to identify clinical diagnoses suggesting UE pain/pathology. Kaplan Meier survival analysis was performed to determine pain-free time, defined as length of time between SCI and first diagnosis of UE pain/pathology or time from SCI to end of follow-up period. Descriptive statistics characterized the cohort by gender, age at SCI, neurological level of injury (NLI), and American Spinal Injury Association (ASIA) Impairment Scale (AIS) grade. Follow-up time available, proportion of subjects with UE pain/pathology, and diagnosing provider type were determined.

Results: Forty-four individuals (median age: 40 years [range 18-85], 68% male) experienced traumatic SCI (43% with paraplegia, 57% with tetraplegia). Median follow-up time after SCI was 7.4 years (range: 1 week to 20 years). Median pain-free time following SCI was 3.7 years (95% CI: 1.2-8.7). Fifty-seven percent had clinical diagnoses of UE pain/pathology. The most common location of the first instance of UE pain/pathology was the shoulder (52% of those who developed pain). Physical medicine and rehabilitation physicians and primary care providers diagnosed the majority of the cases (accounting for 60% combined).

Conclusions: Clinical diagnosis rates of UE pain/pathology appear comparable to rates previously reported on surveys. Median pain-free time following SCI indicates a need to inquire about UE pain/pathology early and often following traumatic SCI.

Clinical Relevance: Physical therapists can help ensure timely diagnosis and treatment of UE pain/pathology in individuals with SCI through intentional clinical evaluation.
Knowledge of biopsychosocial determinants of shoulder pain is directly applicable to a prospective surveillance model of clinical management promoting early detection, intervention, and prevention of secondary disability. The interdependence among psychosocial factors, biological factors and musculoskeletal pain is unknown in individuals with spinal cord injury (SCI) from onset of rehabilitation through the first year following injury.

This longitudinal study is investigating biopsychosocial factors associated with shoulder pain in individuals with acute SCI (N=34) compared with age and gender-matched controls. The purpose is to determine the relationship and temporal characteristics of shoulder pain, musculoskeletal factors, psychosocial factors, and QoL during the first year following SCI. The current data provide a preliminary investigation of these factors.

Six individuals participating in inpatient SCI rehabilitation

Demographics, Musculoskeletal Pain Survey upper extremity (MPS), muscle strength, pectoralis minor extensibility, shoulder range of motion (ROM), musculoskeletal ultrasound (Ultrasound Pathology Shoulder Rating Scale (USPRS)).

Psychosocial measures were Tampa Kinesiophobia Scale-11 (TSK), Pain Catastrophizing Scale (PCS), Fear of Pain Questionnaire (FPQ), Subjective Quality of Life Questionnaire (SQoL), Chronic Pain Coping Inventory (CPCI-42).

Upper extremity pain was reported in 3 of 6 participants. Mean strength of shoulder flexor, extensor and abductor was below age-specific norms. Pectoralis minor extensibility was reduced to 13.7% in non-dominant limb with greatest reduction in older participants (> 50 years age) and those reporting pain. ROM was symmetrical and within normal limits with USPRS scores indicating minimal structural impairment. PCS and TSK scores higher than other populations. SQoL=4.3/7 was lower than other groups with SCI. The most common pain coping strategy was seeking social support.

Preliminary data indicate individuals with new SCI demonstrate physical impairments of pain, reduced shoulder muscle strength with older individuals demonstrating reduced pectoralis minor muscle extensibility. Minimal structural changes in tissue integrity are noted. Maladaptive psychosocial pain factors were elevated and present in all 6 participants with 50% reporting pain with reduced SQoL.

Management of shoulder pain in the SCI population is reactive rather than proactive. Interventions focusing on impairments occur after the onset of pain as opposed to providing regular screens to identify and treat pain-related factors prior to the development of pain and dysfunction. Early identification of pain-related factors may ameliorate pain related reduction of activity and participation for individuals with SCI. To facilitate this goal, this longitudinal study aims to identify these biopsychosocial determinants of shoulder pain in the initial year following SCI.
TITLE: Association of psychosocial factors, musculoskeletal pain and activity in active manual wheelchair users with spinal cord injury: A pilot study

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: SCI SIG

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ABSTRACT BODY:

Purpose/Hypothesis: Limited evidence examines the interdependence (modulation) of psychosocial factors such as fear of movement and pain catastrophizing with musculoskeletal pain patterns in manual wheelchair users with spinal cord injury (SCI). This study investigated the relationship among musculoskeletal pain, psychosocial factors, quality of life (QoL), activity limitations and duration of manual wheelchair use in individuals with SCI. We hypothesized maladaptive psychosocial factors would be associated with greater musculoskeletal pain, greater activity limitations, reduced QoL, and longer duration of manual wheelchair use.

Number of Subjects: Twenty-six individuals with SCI (age=42±14 years, duration manual wheelchair use= 17±13 years, work/school/volunteer hours/week=31±14; recreation/sports hours/week 10±12).

Materials/Methods: Participants provided demographics and self-report measures including the Musculoskeletal Pain Survey (MPS), Wheelchair Users Shoulder Pain Index (WUSPI, task-specific pain), Tampa Scale of Kinesiophobia Scale (TSK-11), Pain Catastrophizing Scale (PCS), Fear of Pain (FPQ), Subjective Quality of Life Questionnaire (SQoL), and the Social Interaction Inventory (SII). Spearman's rho (ρ) assessed correlation among measures as weak (ρ≤0.30), moderate (ρ=0.30-0.50), and strong (ρ>0.50).

Results: Strong association existed between age and duration of injury (ρ=0.66, p<0.001). SQoL offered a strong, direct correlation with age (ρ=0.63, p=0.01), duration of manual wheelchair use (ρ=0.70, p =0.001), and strong, inverse relationship with MPStotal (ρ = -0.66, p=0.003), and MPS shoulder subscore (ρ = -0.64, p=0.004). WUSPI demonstrated a strong, inverse association with self-reported work hours (ρ=-0.52, p=0.02) and a strong, direct relationship to PCS (ρ=0.79, p=<0001). PCS also demonstrated a strong, inverse relationship to work/school/volunteer hours (ρ=-0.71, p<0.001) and a strong association to TSK-11_total (ρ=0.61, p=0.001). A moderate, inverse relationship was identified for recreational/sports hours and FPQ (ρ=0.48, p=0.03).

Conclusions: While increased age and duration of wheelchair use following SCI promoted greater SQoL, musculoskeletal pain significantly reduced quality of life. Furthermore, increased musculoskeletal pain was strongly associated with maladaptive psychosocial behaviors of pain catastrophizing and kinesiophobia. Limited activity aligned with a reduction in work hours with increased task-specific pain and higher levels of pain catastrophizing.

Clinical Relevance: Our cyclical relationship of reduced activity, musculoskeletal pain and maladaptive psychosocial factors demonstrates interdependence of factors supporting the multidisciplinary approach to care. Thus, in clinical management of these individuals, we need to be aware of possible comorbid psychosocial factors with potential referral as indicated.
Diaphragm pacing and respiratory outcomes in a patient with cervical spinal cord injury

Background & Purpose: Respiratory complications are a leading cause of illness and death in individuals with cervical spinal cord injuries (SCIs). Intramuscular diaphragm stimulation, or diaphragm pacing (DP), is an emerging strategy to promote weaning from mechanical ventilation (MV). Recent reports suggest that DP may promote recovery of independent respiration and one third of individuals who use DP demonstrate increased respiratory function and no longer require DP to sustain ventilation. Guidelines and respiratory criteria to determine readiness to wean from DP have not been established. Criteria for weaning from MV are well-established and may be useful in determining readiness to wean from DP. Further, since the intramuscular DP wires allow for recording of diaphragm electromyograms (EMGs) and this assessment is useful for predicting MV weaning, examination of diaphragm EMGs also may help determine readiness to wean from DP. The purpose of the case report is to describe the progression and recovery of independent respiration in a patient with cervical SCI who received DP and subsequently recovered independent respiration without use of DP.

Case Description: The patient was a 25-year-old female who sustained a traumatic cervical SCI (C-4, ASIA Impairment Scale B, motor complete). Following 3 weeks of unsuccessful weaning from MV, she received a DP. She weaned from MV within 3 weeks and used DP to sustain ventilation. She underwent inpatient rehabilitation (3 hours/day, 5 days per week) which included respiratory strength training. Standard respiratory measures were conducted immediately after initiating DP and at regular intervals throughout her rehabilitation. Diaphragm EMGs also were recorded to examine changes in diaphragm activation.

Outcomes: Tidal volumes at the time of initial DP use were 574ml or 72% of predicted. Her forced vital capacity (FVC) was 1413ml and maximal inspiratory pressure generation was -22cmH2O. Diaphragm EMGs showed clear rhythmic bursting and activation during tidal breathing was 0.14mV. Following 6 weeks of continuous diaphragm pacing and 3 weeks of inpatient rehabilitation, gains in respiratory function were evident and weaning from DP was initiated. Tidal volume increased to 710ml or 89% of predicted; FVC was 1699ml and maximal inspiratory pressure was -41cmH2O. Diaphragm activation increased in amplitude to 0.18mV. At the time DP weaning was initiated, measures of tidal volume and FVC were consistent (within 5%) with criteria used to predict successful MV weaning. Maximal inspiratory pressure generation, however, exceeded MV weaning criteria by 30%. Following 10 days of weaning from DP, the patient regained independent respiratory function.

Discussion: DP may contribute to respiratory recovery after cervical SCI and some patients may demonstrate the ability to wean from DP and achieve independent respiration. This case suggests that MV weaning criteria may be useful in determining readiness to wean from DP. Assessment of diaphragm activation also may provide insight regarding respiratory recovery after SCI.
ABSTRACT BODY:

**Purpose/Hypothesis**: After neurological injury, recovery of hand and arm function is a top priority for individuals who have sustained a spinal cord injury (SCI). Rehabilitation provided by therapists improves motor function following SCI, but more research regarding each individual’s specific muscle activation patterns, and how to use those patterns for activities of daily living is needed. The goal of this study was to compare static and dynamic hand and wrist muscle activation patterns during functional tasks between subjects with and without SCI. We hypothesized that [1] a similarity index (SI) analysis could reliably distinguish activation patterns from different static and dynamic tasks and that [2] this SI analysis would show decreased similarity within the same task following SCI.

**Number of Subjects**: 9 subjects with spinal cord injury; 13 subjects without injury

**Materials/Methods**: The non-injured subjects (NI group) and the subjects with incomplete cervical SCI (SCI group) performed seated unilateral trials of static wrist flexion, wrist extension, closing the hand, opening the hand, radial deviation, and ulnar deviation. During these trials, electromyographic (EMG) data was collected from an 8-sensor, low-cost armband around the subject’s forearm. Trials were then repeated contralaterally when possible. Six SCI and five NI subjects were asked to rhythmically move between wrist flexion and extension for 20 seconds and then open and close the hand for 20 seconds to assess dynamic muscle activations. After data collection, muscle activation patterns were compared using a cosine Similarity Index (SI). Static data was rectified and averaged while dynamic data was divided into 50 ms bins SI analysis. An ANOVA was used to evaluate statistical differences between groups.

**Results**: For the NI group, SI analysis could discriminate between movements yielding reproducible and reliable results across subjects. The SCI group demonstrated lower pattern similarity compared to the NI group in 5 of the 6 tasks. For the dynamic tasks, the SI analysis could reliably indicate which movement was being performed for the NI group for each task. For the SCI group, the movements had lower SI values and the transition phases between movements were broader and less distinguishable.

**Conclusions**: Our hypothesis that muscle activation patterns could be differentiated across movements and after SCI these patterns would be disrupted was confirmed. The results from our subjects with SCI support the use of a similarity index to assess muscle recruitment patterns, and to potentially be used in a post-therapy home setting to further improve function.

**Clinical Relevance**: After SCI, functional independence is impacted by the degree of volitional hand and forearm impairment. This study provides data on altered forearm muscle activation patterns following SCI. We plan to use this data in conjunction with development of a software application that will identify a patient’s unique muscle activation patterns in order to help patients regain coordinated, functional upper extremity use.
The physical therapist’s role in regenerative medicine: rehabilitation following neurological stem cell transplantation for SCI

Purpose/Hypothesis: Regenerative medicine (RM), specifically the use of biological materials to restore function of damaged tissue, is a rapidly developing field of interest in physical rehabilitation. A growing body of evidence supports the use of neural stem cell transplantation to improve function of tissues once thought relatively irreversibly damaged. These medical advancements suggest the need for evaluation of current physical therapy rehabilitation strategies to adapt to changing medical care. The purpose of this narrative review was to analyze the efficacy of neural stem cell implantation in restoring function in individuals with SCI, explore the implications for developing rehabilitation strategies, and discuss the role of the physical therapist on the RM team.

Number of Subjects: Ten published manuscripts were selected for this narrative review.

Materials/Methods: Searches were conducted electronically on EBSCOhost to include the following databases: Academic Search Premier, MEDLINE, CINAHL Complete, and SPORTDiscus. Search terms used included: regenerative med*, stem cell*, rehab*, physiotherapy, physical therapy, spinal cord, treadmill training, spinal cord injur*, and human. Of 110 articles included in the screening phase of the selection process, 10 articles were included in this narrative review. Studies were selected if they were published within the last ten years, were available in English, and if they met one of the following criteria: provided insight into the efficacy of stem cell transplantation for SCI, discussed rehabilitation protocols for patients undergoing these procedures, or highlighted physical therapists’ role on the RM team.

Results: Results of the reviewed studies indicated that stem cell transplantation is effective in improving functional mobility for patients with SCI and that exercise therapy is an important key to success for these patients. It is hypothesized within this review that physical therapists represent a crucial role on the multidisciplinary team and will be important to optimize outcomes for individuals with SCI undergoing stem cell transplantation.

Conclusions: The combined findings suggest stem cell transplantation may be effective in providing improved volitional control of muscles below the level of SCI, even in severe cases. Success of these procedures may be augmented by exercise, suggesting physical therapy may enhance post-stem cell procedure outcomes. Further research should target the nature and dosage of physical therapy interventions for individuals undergoing neural stem cell procedures.

Clinical Relevance: This narrative review examined the current research regarding stem cell procedures for patients with SCI and implications for rehabilitation. Additionally, this review highlights the ability of emerging technologies such as RM to facilitate augmented roles for physical therapists.
ABSTRACT BODY:

**Background & Purpose**: Virtual reality (VR) is an emerging treatment to engage in environments that appear and feel similar to real-world objects and events\(^{1}\). There are various levels of evidence that VR can potentially promote functional activity and brain plasticity in patients with neurological disorders like spinal cord injury (SCI)\(^{2-5}\). We explore the feasibility of using VR with a head-mount display in an inpatient facility and identify the type of patient with SCI who would most benefit from VR training.

**Case Description**: 3 participants were recruited: 39 y/o male, C5 ASIA B SCI; 37 y/o male, congenital spinal stenosis resulting in tetraparesis; and 37 y/o male, ASIA C SCI. VR games were from Oculus VR, LLC (Menlo Park, CA).

Training included reaching activities simulating real-life, wrist rotation, gripping the game controller, and thumb movement to activate buttons.

**Outcomes**: Pre-treatment manual muscle test (MMT) of major UE muscle groups (shoulder flexor/abductors elbow flexor/extensor, finger flexor/abductor and wrist flexor) were added for a composite score, grip/pinch strength, and the 9-HPT (9 hold peg test) were measured. Each participant received a 40-minute VR treatment twice/week plus regular physical therapy and were followed for at least 2 months. Outcome measures were recorded every other week. A questionnaire regarding their experience with VR training was administered at the end.

All participants had relative improvement in muscle strength and functional activity like grip, pinch and 9-HPT. The changes from pre-test to post-test changes in the composite MMT score were 2, 4.5 and 13.5 individually. As participants had a relative weaker side and a stronger side, the opposite side was a self control. For one participant, most change occurred in his stronger side while the other participant showed more change in his weaker side. However, functional level at MMT 1/2 showed more potential to change and this is consistent with these 2 participants regardless of stronger or weaker side. The participant with high MMT before the treatment had minimal change; however his 9-HPT test was close to normal in both hands at the end of treatment. The biggest change in 9-HPT test was in the same participant who scored the highest MMT change. He was unable to perform at baseline and finished the test in 1 minute at discharge. Participants had smaller levels of improvement in pinch and grip strength. We received positive feedback from participants verbally and in the structured questionnaire. Participants identified the level of realness in the game was high and expressed huge interest in the training.

**Discussion**: Strength measures and 9-HPT all improved after VR plus regular physical therapy. Patients with relatively lower strength could benefit more from VR to improve strength and hand dexterity, whereas others with relatively higher function may improve more in hand dexterity. VR training appears to be a possible adjunct to physical therapy as a method of muscle strengthening and improving upper extremity function.

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Purpose/Hypothesis: Epidural spinal cord stimulation (ESCS) is a developing surgical intervention used to improve function in patients with spinal cord injury (SCI). Electrodes are implanted into dorsal structures of the spinal cord and are believed to activate neural circuits, thus affecting motor performance. This systematic review assesses the degree of locomotor recovery in patients with SCI.

Number of Subjects: Subjects: 12 male subjects (average age 34 years old) with chronic SCI.

Materials/Methods: A literature search was performed using Pubmed, Google Scholar, Scopus, and CINAHL. Terms used for the search were: epidural stimulation, spinal cord stimulation, neuromodulation, spinal cord injury, and spinal cord injuries. For this systematic review, articles were included if subjects received ESCS to assess impact on locomotion and if the subjects had a chronic (>1 year) SCI (complete or incomplete injury). Articles were excluded if they were classified as expert opinion or if ESCS was performed on non-human subjects. Articles were also excluded if subjects had pre-existing neurological conditions or if they were concurrently receiving other treatment interventions. A multi-step process was used. Once duplicates were removed, titles were screened, followed by abstract content. The remaining seven full-text articles 1-7 were appraised for study quality using the checklist developed by Downs and Black8.

Results: From the total search results, 1962 articles were found after removing duplicates. Once eliminating articles by title, 479 articles remained. After viewing abstracts, 37 articles were kept. In reviewing the abstracts’ outcomes for ESCS, the topic was narrowed to only include locomotor outcomes. Nineteen articles were excluded due to their reports solely on autonomic and non-voluntary results of ESCS within the abstracts, leaving 18 articles for full text review, after which 7 articles fulfilled the inclusion/exclusion criteria and were appraised.

Conclusions: Most research on ESCS in the SCI population is based on level IV and V evidence. Outcomes show that ESCS may be effective for patients with SCI resulting in improved locomotor function. The studies focused on locomotor outcomes including rhythmic and volitional muscle activation via EMG, walking speed, standing tolerance, and perceived exertion. Further research is needed with higher quality evidence to determine the efficacy of locomotor outcomes from ESCS in patients with SCI.

Clinical Relevance: ESCS serves as an alternative method of stimulating lower motor neurons (LMNs) in persons with an inability to transmit volitional motor signals from the brain to the LMNs to control their muscles. In persons with SCI, this may help to restore a degree of locomotor function, which may improve their quality of life. While ESCS may help regain motor activation, rehabilitation and physical therapy play an essential role in facilitating the recovery of controlled functional movement patterns for locomotor purposes.
Purpose/Hypothesis: The Wheelchair Propulsion Test (WPT) is a quick outcome measure for assessing the mobility of wheelchair (WC) users. There is no evidence to suggest, however a functional/typical value that can be used as a reference. The purpose of this study was to determine the typical values of the WPT at comfortable (C), and fast (F) speed conditions in various WCs among high-functioning WC users.

Number of Subjects: 27 high-functioning, community-dwelling WC dependent users aged between 16-55 years old. Pathologies included but were not limited to: thoracic and lumbar spinal cord injury, lower limb amputation(s), spina bifida, cerebral palsy.

Materials/Methods: WPT was done using 3 wheelchairs – their personal WC (mean weight, 11.9kg), an ultra-light WC (12.5kg) and a standard light-weight WC (18.6kg). Participants propelled WCs at C and F speeds. Each trial was measured over 10m with an acceleration and deceleration distance of 2m each. Three trials were performed for each speed in each WC (total of 18 trials) with a 60s rest between trials. Order of propulsion was randomized for condition and WC type. Testers recorded time with a stopwatch and counted the number of pushes per trial. A 2-way ANOVA was used.

Results: There was a significant difference in speed at both C and F conditions between the personal WC (C mean = 1.71m/s, F mean = 2.78m/s) and the ultra-light WC (C mean = 1.60m/s, F mean = 2.51m/s; p = 0.003) as well as between the personal WC and the standard light weight WC (C mean = 1.57m/s, F mean = 2.37m/s; p = 0.001). For cadence, there was a significant difference between the personal WC (C mean = 5.4 pushes, F mean = 6.4 pushes) and the ultra-light weight WC (C mean = 6 pushes, F mean = 6.8 pushes; p = 0.01), as well as between the personal WC and the standard light weight WC (C mean = 6.5 pushes, F mean = 7 pushes; p = < 0.001). There was no significant difference between the ultra-light WC and the standard light weight WC for either speed and cadence. Overall, there was an interaction between condition (C vs. F) and WC type for speed (p = 0.003) but there was no interaction between condition and WC type for cadence (p = 0.273).

Conclusions: Results indicate that the speed an individual is able to propel is affected by the type of WC; evidenced by the significant differences between the personal WC and the other WCs for both speed and cadence. The most plausible explanations for this difference are the customized nature of the personal WC and the experience of the individual using their WC. The physical weight of the WC appears to not be a major factor in the differences in performance. The differences during WC propulsion between C and F conditions depended on the type of WC used during testing.

Clinical Relevance: The typical data values established from this study can be useful when integrating the WPT as an outcome measure. Furthermore, these results can be utilized in articulating the importance of having a customized WC for an individual who will be using it as their primary means of mobility.
Purpose/Hypothesis: Robotic exoskeleton devices enable individuals with lower extremity weakness (i.e. people with stroke or spinal cord injury) to stand and walk over ground with a full weight bearing and reciprocal gait. Gait is achieved by the user’s weight shifts to activate sensors to initiate the device for normalized steps. However, no information is available on how an exoskeleton robotic suit affects gait parameters. Therefore, the purpose of this study was to examine whether wearing a robotic exoskeleton affects kinematics and temporospatial parameters during gait in people with incomplete spinal cord injury (SCI).

Number of Subjects: Nine ambulatory adults (age: 39.6±12.7 years, 8 men) with incomplete SCI completed the study. Average time since injury was 7.3±5.4 years with a Walking Index for Spinal Cord Injury – revised (WISCI-II) score of 14.3±2.9.

Materials/Methods: Each participant performed walking under two conditions, with and without wearing the robotic exoskeleton (EKSO). A 10-camera motion capture system synchronized with 6 force plates was used to capture kinematic and temporospatial gait parameters. Ten good-quality walking trials (20 feet) were collected for each condition, of which best five for each condition were included for data analysis. Each participant was given one practice trial when wearing the EKSO before data collection began. As there was no difference between left and right lower extremities, the average of gait parameters for both lower extremities was used for statistical analysis. Two separate repeated measures MANOVAs were used to analyze kinematic gait parameters, one for stance, and one for swing phase. Temporospatial parameters were analyzed using paired t-tests.

Results: The statistical analysis showed significant differences between the two conditions in the temporospatial gait parameters of stride length (p=0.003; no EKSO 1.04±0.26m, with EKSO 0.65±0.07m) and gait speed (p=0.013, no EKSO 0.55±0.35m/s, with EKSO 0.20±0.03m/s), but not double limb support time (p=0.679, no EKSO 0.75±0.76s, with EKSO 0.86±0.22s) or cycle time (p=0.402, no EKSO 2.77±1.89s, with EKSO 3.27±0.47s). When wearing EKSO, ankle motion was significantly reduced during the stance phase (p=0.025), but not knee (p=0.225) or hip (p=0.644) motion. During swing phase, no significant differences were observed in ankle (p=0.055), knee (p=0.349), or hip (p=0.167) motion while wearing EKSO.

Conclusions: Wearing EKSO significantly altered temporospatial parameters during gait in adults with incomplete SCI. Participants walked slower with shorter stride length when walking with the exoskeleton. Although kinematics were unaffected in hip and knee motions, ankle plantarflexion was decreased primarily due to EKSO’s footplate which limits ankle motions.

Clinical Relevance: The EKSO frame appears to limit ankle motion in stance phase which may contribute to slower gait speed and decreased stride length in people with SCI. Despite these limitations, future studies should assess whether gait training with EKSO can be a useful intervention for people with neurological disorders.
Purpose/Hypothesis: Robotic exoskeletons are designed and intended to replicate normal walking. Following a spinal cord injury (SCI), there is significant disruption to the muscle activity below the level of injury. The purpose of this study was to determine whether wearing a robotic exoskeleton (EKSO) affects muscle activity in the lower extremities during gait in people with spinal cord injuries.

Number of Subjects: Nine ambulatory adults (age: 39.6±12.7 years, 8 men) with incomplete SCI completed the study. Average time since injury was 7.3±5.4 years with a Walking Index for Spinal Cord Injury – revised (WISCI-II) score of 14.3±2.9.

Materials/Methods: Surface electromyographic (EMG) activity was collected from the bilateral gluteus medius (GM), rectus femoris (RF), medial hamstrings (MH), tibialis anterior (TA), and soleus (Sol) muscles. In addition, a 10-camera motion capture system synchronized with 6 force plates and surface EMG system was used to obtain the temporospatial gait parameters, including speed, stride length and double-limb support time. All participants completed walking trials in a single session under two conditions: with and without EKSO. For each condition, participants walked a minimum of 5 trials of 20 feet at a self-selected speed. Each participant was given one practice trial when wearing the EKSO before data collection began. Due to laterality differences in EMG, each limb was analyzed separately for stance and swing phases. Root-mean-square (RMS) values of EMG were used to quantify the amount of EMG activity for each walking trial. The peak EMG value of the corresponding stance or swing phase of each walking trial was used for EMG normalization. The average EMG RMS values of the five walking trials were included in statistical analysis.

Results: Participants demonstrated significant differences between conditions on temporospatial gait parameters of stride length (p=0.003; no EKSO 1.04±0.26m, with EKSO 0.65±0.07m) and gait speed (p=0.013, no EKSO 0.55±0.35m/s, with EKSO 0.20±0.03m/s), but not double limb support time (p=0.679, no EKSO 0.75±0.76s, with EKSO 0.86±0.22s). EMG activity was 5% lower when walking in EKSO. However, there were no statistically significant differences in EMG activity between conditions in stance and swing phases for any of the five muscle groups. In addition, standard deviations were much smaller when walking in EKSO.

Conclusions: Gait was slower with shorter steps in EKSO, but muscle activity was not significantly different. Although all of the participants were ambulatory, the extent of weakness and use of assistive device varied, thus affecting non-significant EMG finding. However, EKSO may promote a standardized gait pattern among people with SCI with heterogeneous gait limitations.

Clinical Relevance: EKSO appears to promote a type of gait that is disparate from gait observed in people with incomplete SCI. More research will be necessary to determine the utility in gait training with EKSO on muscle activity in people with SCI.
ABSTRACT BODY:

Purpose: The overall purpose of this platform is to create a guideline for other community-based hospitals in how to build a Locomotor Training Program from scratch, while addressing all barriers when doing so.

Description: After attending a formal Locomotor training course, offered by Neuro-Recovery Network, one is then left with the task of establishing a formal locomotor program in a community-based hospital, which at times may not have all the needed resources. The objective of Neuro-Recovery Network training is to establish specific handling techniques through Locomotor training, which is an activity based therapeutic intervention for standing and walking, that emphasizes activation of the neuromuscular system in SCI and other neurological impaired patients, while using a body weight supported treadmill. 1-3

When approaching administrative staff about the possibilities of creating a Locomotor Program, one can be questioned of the program's viability or sustainability, while meeting productivity needs. For cost efficiency, the team should be led by one trained physical therapist, two students and one volunteer. Students will greatly benefit from training, as treadmill session will emphasize detailed gait kinematics and techniques on how to correct these gait abnormalities.3,4

Other challenges that will arise are purchasing the correct equipment; including most ergonomically correct body weight support treadmill, effective gait training harnesses and proper over ground walking devices. 3,4 Selecting an ergonomically correct treadmill system can be more rigorous than expected, due to different seating positions for therapist, height of treadmill from ground level, option of ramp, cost of treadmill system and comfort of patient. Adjustable seat height and adjustable foot plate to compensate for different therapist leg length and trunk length are crucial for avoiding any future injuries to trainer and or therapist.4 Selection of proper functional outcomes measures is vital for research data collection and the reliability and validity of such data. 5,6

Selecting appropriate patient inclusion and exclusion criteria, according to one's specific clinical setting is important in formatting the foundation of one's Locomotor program. When selecting patients in a community-based hospital, consider neurological impaired patients vs orthopedic patients. 1-4

Summary of Use: For this platform, a general flow sheet will be presented with the foundation on creating a program, proposal letter for administration approval, options to look for in treadmill to meet clinic's needs, harness selection, variety of most reliable outcomes measures and the recommended trainer set up and training for optimal use of a Locomotor Program.

Importance to Members: This platform is designed to create a guideline or blueprint to community-based hospitals, when creating a Locomotor program, in a community based rehabilitation center that is not a model SCI center, for overall improved patient functional outcomes.
Purpose/Hypothesis: The Interdisciplinary Comprehensive Arm Rehabilitation Evaluation (ICARE) stroke initiative was designed to accelerate arm recovery in a manner that addressed calls for a more patient-centered experience. The investigational Accelerated Skill Acquisition Program (ASAP) involved motivational enhancements including patients’ customized task selection to address dexterity, bimanual, and strength-related skills. We describe the breadth of and exemplar tasks chosen, and relationships to rehabilitation outcomes.

Number of Subjects: 361 participants (60.7 ±12.5 years old) with mild to moderate upper extremity impairment (45.8 ± 22.4 days from stroke onset) were stratified and randomized into three outpatient therapy groups: ASAP, dose-equivalent usual and customary occupational therapy care or monitoring-only usual care.

Materials/Methods: Participants completed measures of impairment, activity, and participation at baseline and following intervention. Exit questionnaires were administered after therapy to address perceptions of impacts, intervention fidelity, and patient-centered care, including the Health Care Climate Questionnaire (HCCQ). ASAP treatment records were examined to identify participants’ task selections. Per protocol, ASAP participants and therapists collaborated to generate an initial list of at least six tasks across task categories, including a designated “priority” task; more tasks could be added as desired. Each session, ASAP participants selected specific tasks and their order of practice, and collaborated to identify current movement problems and solutions.

Results: ASAP participants generated a total of 2006 specific tasks (median 19, range 7 to 33). 54% of priority tasks fell in the dexterity category. ASAP tasks varied widely, from buttoning clothing; to work-specific skills; to picking up a phone, swiping to unlock, and dialing a phone number in 10 seconds; to lifting a 25-lb dog food bag off the floor in the pantry and putting it on the countertop. ASAP participants rated their therapy experience as significantly more patient-centered than both usual care groups, with higher HCCQ scores, perceptions of greater opportunity for task choice and focus on key problems, and more control over session activity (ps < .003). Perceptions of greater choice in activities were related to the perception of more emphasis on key problems in therapy (r = .599, p < .0001). These perceptions in turn were significantly, positively, and mildly related to outcomes across the ICF spectrum. Perceptions of greater control over everyday therapy activities were related to participants’ perceptions of improved ability to return to work or hobbies and greater impact of the therapy on overall quality of life post-intervention.

Conclusions: Patient choices for therapy tasks varied widely. Experiences of choice, collaboration, and control in therapy were related to a variety of positive outcomes in stroke rehabilitation.

Clinical Relevance: Provision of more pervasive patient choice and collaboration in problem solving may enhance rehabilitation outcomes.
Purpose/Hypothesis: Patients with stroke discharged from inpatient rehabilitation facilities (IRFs) are at increased risk for falls. Community ambulators with stroke who fall have a high risk of hip fracture and other serious consequences. In IRFs, standardized assessments are used to determine discharge disposition and the potential for post-discharge function. These assessments have been used to predict falls, but the results have been mixed. The purpose of this project was to determine if measures of function at discharge could predict falls in patients with stroke within 6 months of discharge from an IRF. We evaluated predictors in their continuous scales and controlled for confounding factors to address limitations of previous studies.

Number of Subjects: Patients with stroke (n=105) discharged from an IRF at an urban academic medical center from July, 2012 to August, 2016.

Materials/Methods: Data were extracted from the electronic medical record. Data included demographics, clinical and diagnostic measures, and a variety of standardized assessments administered prior to discharge. The outcome was assessed during a 6-month follow-up phone interview where patients were asked if they had fallen. Logistic regression (with robust standard errors) was used to estimate the effect of the assessments on the odds of falls within 6 months. We reported univariate and adjusted odds ratios (ORs) controlling for age, sex, days post stroke and the National Institutes of Health Stroke Severity (NIHSS) score. The ORs represented the change in odds of falls associated with a one unit change in predictor and were considered significant when P<=.01 to control for the family-wise type I error rate. Non-parametric receiver operating characteristic (ROC) curves were plotted for predictors with the area under the curve (AUC) used as a measure of predictive ability.

Results: Of 185 patients discharged to their homes from the IRF, 105 patients responded to the 6-month follow-up (57%). The mean (SD) age was 67.7 (14.9) years with 45 females (43%) and 60 males (57%). The mean NIHSS score was 7.0 (7.3). Twenty-nine patients (28%) reported falling. Significant, adjusted ORs were found for the following measures: Berg Balance Scale (OR=0.89, 95% CI=0.80-0.99), Activity Measure for Post-Acute Care (AM-PAC) basic mobility (OR=0.89, 95% CI=0.82-0.87), Motricity Index (OR=0.96, 95% CI=0.93-0.98) and Trunk Control (OR=0.97, 95% CI=0.95-0.99). Non-parametric AUC ranged from .62 (Trunk Control) to .70 (Motricity).

Conclusions: Standardized assessments at discharge are associated with the risk of falls within 6 months. The role of lower extremity strength (Motricity) deserves more attention. The AM-PAC basic mobility scale, Berg Balance Scale and the Trunk Control Test may also be important predictors.

Clinical Relevance: Standardized assessments can be useful in determining who is at increased risk for falls and can aid in discharge clinical decision making. However, falls are multi-factorial and patient status, activity levels, and environmental hazards vary over time. Precise prediction therefore remains a challenge.
Purpose/Hypothesis: High-intensity interval training (HIT) is a promising strategy for improving gait and aerobic fitness after stroke, that involves bursts of concentrated effort alternated with recovery periods. However, interval durations have varied widely across previous research and no stroke studies have compared short and long interval HIT. Therefore, the purpose of this study was to compare within-session exercise responses for short versus long interval HIT in persons with chronic stroke.

Number of Subjects: Ten participants (mean ± SD) 59.8 ± 6.8 years old and 2.4 ± 1.7 years post stroke with comfortable gait speed of 0.41 ± 0.33 m/s, who passed a symptom-limited treadmill exercise stress test with electrocardiographic monitoring.

Materials/Methods: Participants performed 12 sessions of HIT over 4 weeks, alternating between short and long interval HIT sessions, with the first session randomized across participants. Both HIT protocols included 10 minutes of over-ground HIT (OG1), then 20 minutes of treadmill HIT, followed by another 10 minutes of over-ground HIT (OG2). Short interval HIT involved 30 second bursts at maximum safe speed and 30-60 second rest periods. Long interval HIT involved 4-minute bursts at ~90% of peak heart rate (HRpeak) from the exercise test and 3-minute recovery periods at ~70% HRpeak. Variables recorded each session included: gait training speed (OG1, treadmill and OG2); heart rate (OG1, treadmill and OG2); step count (full session); and rating of perceived exertion (full session RPE). Mixed effects models compared short and long interval protocols.

Results: Short interval HIT had faster OG1 speed (0.73 vs 0.66 m/s, p=0.001), peak treadmill speed (0.98 vs 0.57 m/s, p<0.001) and OG2 speed (0.77 vs 0.66 m/s, p<0.001) and a greater gait speed increase from OG1 to OG2 (0.05 vs 0.00 m/s, p=0.03). Long interval HIT had higher OG1 mean heart rate (76.0 vs 72.7 %HRpeak, p<0.001), OG2 mean heart rate (86.3 vs 84.2 %HRpeak, p=0.03) and full session step count (1,678 vs 1,484 steps, p=0.01). Short and long interval HIT, respectively, had similar treadmill mean heart rate (82.9 vs 81.8 %HRpeak, p=0.25) and full session RPE (16.3 vs 16.3, p=0.91).

Conclusions: For HIT in chronic stroke, short intervals appear to enable greater gait training speeds and within-session improvement in gait speed, while long intervals appear to provide higher aerobic intensity during over-ground training and a greater overall quantity of stepping activity. A combination of short and long interval HIT may be optimal for improving gait and aerobic capacity in future studies.

Clinical Relevance: Both short and long interval HIT are promising strategies for stroke rehabilitation, that can be used to emphasize different exercise dosing parameters.
Effectiveness of Visual Biofeedback on Improving Standing Balance in Individuals Living with Subacute and Chronic Stroke: A Systematic Review of the Literature

Purpose/Hypothesis: Stroke is the leading cause of long-term disability in the United States and standing balance deficits are a common residual impairment. There are a variety of physical therapy interventions that are implemented with the goal of improving balance for individuals who are post-stroke. Recently there has been increasing interest in the integration of biofeedback into balance therapy in the clinic. The purpose of this review is to compare forceplate biofeedback standing balance interventions to standard care in a population of patients with subacute and chronic stroke.

Number of Subjects: Eight published research articles.

Materials/Methods: A systematic literature search was completed using CINAHL, PubMed, Scopus, and OVID. The inclusion criteria were: subacute or chronic stroke, cortical or subcortical stroke, visual biofeedback used as a standing balance intervention, instantaneous feedback, standing balance outcome measure, peer reviewed original search, and standard care comparison. The exclusion criteria were: Pusher’s Syndrome and/or ataxic stroke. A PEDro analysis was used to assess risk of bias.

Results: The average PEDro score for the included articles was 5.88±1.89. Seven of the 8 articles reported a statistically significant improvement in balance after the biofeedback intervention, compared to standard care. There were multiple limitations associated with the positive results. Two of the 7 articles provided the intervention groups with greater total treatment time than the standard care groups. Two of the remaining 5 articles were only able to show significant improvement in balance outcomes in the treatment group at one point in time, despite multiple post-intervention measurements. The remaining 4 articles measured standard balance in static, dynamic, and functional ways, and none of these articles were able to demonstrate consistent improvement across multiple measures. Thus, the overall results were inconclusive.

Conclusions: This review did not find evidence to conclude that forceplate visual biofeedback interventions are more effective than standard care at improving standing balance in patients with subacute and chronic stroke. However, these interventions can be used as part of a viable treatment approach for balance impairment post-stroke, as they often result in comparable improvements. In 2004, Barclay-Goddard et al. performed a similar systematic review which found, in contrast to our findings, significant improvements only in static standing balance in response to biofeedback interventions. Continued research using randomized controlled trials may help clarify these ongoing discrepancies.

Clinical Relevance: Biofeedback-based balance interventions should not replace standard care for patients post-stroke. There is evidence that they can be an effective and safe component of a comprehensive post-stroke balance program. Moreover, some studies show greater patient enjoyment and adherence with biofeedback-based interventions, which will likely further enhance positive outcomes.
Purpose/Hypothesis: This study examined the effect of a technology enhanced real-time action observation therapy (TERTAOT) utilizing movement observation and imagery of mirrored bilateral motor activities, in combination with physical practice of movements in chronic stroke. We hypothesize that subjects would improve functional outcomes following TERTAOT intervention.

Number of Subjects: 13

Materials/Methods: Twelve subjects completed the intervention (mean age= 63±8.7 years; 10 with left-sided weakness; 9 males). Inclusion criteria: age >= 40 years, >= 6-months post stroke, no other neurologic diagnoses, the ability to stand up from a chair (16-18”), and pain in arms/legs and spine < 6/10 on Verbal Numerical Pain Rating Scale. TERTAOT used Kinect to project visual feedback of the weaker limb (i.e. mirror image of the non-paretic limb) as subjects moved both limbs synchronously during bilateral activities. The study session included 30-minutes of conventional physical therapy, followed by 30-minutes TERTAOT. TERTAOT protocol included seated bilateral reaching, seated bilateral knee flexion/extension and hip abduction/adduction, sit-to-stand, squats, and standing bilateral reaching. Subjects participated 3x/week at an outpatient clinic for 8 weeks. Outcome measures with established psychometric properties in the stroke population were used, including Five Times Sit to Stand (5TSTS), Timed Up and Go (TUG), Motor Activity Log (MAL), Functional Reach Test (FRT), and 10-Meter Walk Test (10MWT). Outcomes were assessed at the initial evaluation (T0), 4 weeks (T4), and 8 weeks (T8). Repeated measures ANOVA with measurement time (T0, T4, and T8) as the within-subjects factor was used to examine whether outcomes differed across time points. Tukey's LSD was used for post-hoc analyses to identify which time points differed significantly. Two-tailed significant level was p<0.05

Results: Outcomes as measured by 5TSTS (T0=18.32±9.72 s, T4=14.40±7.57 s, T8=13.07±6.80, p=0.002) and MAL (T0=1.04±1.51, T4=1.50±1.90, T8=1.59±1.50, p=0.013) differed significantly across time points. Post-hoc analyses revealed that outcomes improved significantly from T0 to T4 for 5TSTS (p=0.007) and MAL (p=0.023), and from T0 to T8 for 5TSTS (p=0.011), and MAL (p=0.008). FRT (T0=21.52±11.38 cm, T4=25.58±8.42 cm, T8=25.39±10.49 cm, p=0.304) and TUG (T0=27.81±19.88 s, T4=26.7±22.10 s T8=25.49±24.36 s, p=0.355) did not differ significantly with time. Differences in 10MWT across time points approached the significance level (T0=0.34±0.21 m/s, T4=0.39±0.23 m/s, T8=0.39±0.27 m/s, p=0.062).

Conclusions: TERTAOT may be effective to optimize functional outcomes and reduce disability in persons with residual stroke symptoms.

Clinical Relevance: The results demonstrate that the TERTAOT intervention significantly improved outcomes in gait speed, functional lower extremity strength, balance, and fall risk. Additionally, there was a significant increase in participation of the weaker arm while performing daily activities.
Purpose/Hypothesis: Standardized assessment measures are required for reimbursement of rehabilitative services. They provide documentation of patient progression essential for treatment justification. The pitfalls in measures currently employed to assess transfers in inpatient rehabilitative facilities (IRFs) are numerous, including lack of sensitivity to change, assumption of independence and validation in community dwelling adults. A new transfer assessment tool is warranted and should incorporate level of assistance, orthotics, assistive devices, adaptations needed for success and movement strategies. We developed such a tool, the Comprehensive Inpatient Transfer Tool (CITT). We report the interrater reliability (IRR) of the CITT.

Number of Subjects: Six patients with neurological diagnoses undergoing rehabilitation in an IRF were studied.

Materials/Methods: An interdisciplinary team consisting of 2 PTs, 2 OTs, 1 PT faculty member & 1 neuropsychologist developed the CITT. The CITT was revised after discussion by 1 PT & 1 OT member of the development staff. These 2 members were deemed the experts (E1, E2).

Two experts along with 1 PT & 1 OT staff rater (R1, R2) participated in the IRR testing. To determine IRR, 6 patients with varying levels of transfer assistance were scored on one occasion while performing wheelchair/chair to bed and return transfers. Two scores for each patient were obtained for a total of 12 transfers. Each expert was randomly assigned 3 of the patients to transfer. E1 performed the transfers on 3 patients. E2, R1 & R2 observed the transfers. All 4 individuals scored each patient after transfer completion. The same procedure for performing and scoring was repeated using the remaining 3 patients; E2 performed transfers and E1, R1 & R2 observed transfers. Percent agreement was calculated for each scorer. E1 to E2 scores established expert IRR. R1 & R2 scores were compared to the expert who performed the transfers on the patient. An 85% agreement was deemed acceptable IRR.

Results: Overall E1/E2 IRR for the CITT was 88%. R1/expert IRR was 92% and R2/expert IRR was 90%. Acceptable reliability was found for 7/9 sections of the CITT. Sections for cueing and level of assistance were <85%.

Conclusions: This new tool, developed by an interdisciplinary team, addresses limitations of the existing transfer measures utilized in IRFs. The CITT demonstrated good overall IRR. Further staff training with operational definition modification may enhance IRR of sections with <85% agreement. Further psychometric evaluation of the CITT is warranted.

Clinical Relevance: The newly developed transfer tool, CITT, addresses the limitations of the assessments currently used in IRFs. The CITT offers an alternative measure for use in IRF patient populations, as the Centers of Medicare & Medicaid Services are phasing out the Functional Independence Measure.
Abstract Body:

Purpose/Hypothesis: Research has suggested that the dorsal lateral prefrontal cortex (DLPFC) and supplementary motor area (SMA) may play an integral role in dual-task walking and could be a potential target for non-invasive brain stimulation such as repetitive transcranial magnetic stimulation (rTMS). The primary purpose of the study was to examine the efficacy of rTMS applied to different neural loci in dual-task walking in individuals post-stroke. The secondary purpose was to explore the relationship between the changes in dual-task gait and clinical measures. The hypothesis was that 5 Hz rTMS applied to SMA and DLPFC would significantly improve dual-task gait speed in individuals post-stroke.

Number of Subjects: 11

Materials/Methods: 11 participants with prior left hemispheric stroke (>6 months) performed single and dual-task walking before and after receiving rTMS applied to different cortical areas. Participants attended 3 sessions (7 ± 2 days apart) in which high frequency rTMS was applied to either left primary motor cortex (M1), SMA, or DLPFC. The rTMS protocol was set at 5 Hz, 90% of resting motor threshold of the right tibialis anterior muscle. The order of stimulation areas was pseudo-randomized and counterbalanced among participants. Gait parameters were collected using the GaitRite walkway. Outcomes included gait speed, step length, and cadence under single and dual-task conditions. Dual-task cost (DTC) in gait speed was computed as \((\text{Speed}_{\text{single}} - \text{Speed}_{\text{dual}}) / \text{Speed}_{\text{single}} \times 100\%\). Individuals’ Fugl-Meyer Lower Extremity Motor Assessment (FM-LEMA), Mini Mental State Exam (MMSE), Trail Making Test (TMT), and motor evoked potentials (MEP) were recorded.

Results: All participants showed a significant reduction in gait speed under dual-task conditions (all \(p < .01\)). 5 Hz rTMS applied to left DLPFC reduced DTC from 40% to 33%; rTMS applied to left SMA, however, increased DTC from 33% to 34% (site x time \(p = .06\)). DTC remained unchanged after rTMS to left M1 (pre=32%; post=32%). Dual-task gait speed increased after rTMS to left DPFC (0.47m/s to 0.53m/s, \(p = .07\)) and 5 out of 11 participants showed a clinically meaningful increase (> 0.1 m/s). Analysis showed that rTMS to DLPFC tended to increase both cadence (\(p = .07\)) and right step length (\(p = .06\)). Individuals with less motor impairment (higher FM-LEMA score) and those who demonstrated greater changes in corticospinal excitability after rTMS (greater changes in MEP) showed greater improvements in dual-task gait after rTMS.

Conclusions: Results of this preliminary report indicate single session 5 Hz rTMS administered to the left DLPFC may improve dual-task walking. Further investigation with a large sample size is ongoing.

Clinical Relevance: Results of this study suggest rTMS to DLPFC may be beneficial in reducing dual-task gait deficits in those who have experienced a stroke. Individuals with less motor impairment and who are more responsive to rTMS seem to benefit most from this intervention.
Purpose/Hypothesis: Although the Minimal Clinically Important Difference (MCID) of GS has been estimated the impact of different anchors and initial GS on the MCID has not been examined. The purpose of this study was to estimate the MCID of GS in people undergoing rehabilitation post stroke using two anchors of importance and at different initial GS values post stroke.

Number of Subjects: 248 participants, 2 months post stroke.

Materials/Methods: Secondary analysis of data from a large rehabilitation intervention trial. Participants underwent rehabilitation between 2 to 6 months post stroke. GS was measured before and after the episode of care. Two anchors of importance were used: the modified Rankin Scale (mRS) and Functional Ambulation Categories (FAC). The MCID of GS was estimated using receiver operator characteristic curves for both anchors for all participants and for subgroups based on their initial gait speed (<0.49 m/s and >=0.49 m/s) at the start of the episode of care.

Results: The estimated MCID of GS ranged from 0.15 m/s to 0.20 m/s and the Area Under the Curve ranged from 0.54 to 0.75 depending on the anchor of importance and initial GS. The estimated MCID values were most accurate for participants whose initial gait speed was <0.49 m/s. For some subgroups and anchors of importance an accurate MCID could not be determined.

Conclusions: Clinicians and researchers should be cautious when using an estimated MCID for gait speed when interpreting change in walking ability in people post stroke. Our results indicate that there are differences in MCID values and the accuracy of these values across different initial gait speeds and anchors.

Clinical Relevance: Estimated MCID values for GS in people with stroke should be interpreted within the context of the anchor of importance and may vary depending on initial walking function. A change of 0.15 to 0.20 m/s in GS over the course of rehabilitation at 2 months post stroke may indicate an important improvement in disability and independence in walking.
Purpose/Hypothesis: Recovery of walking ability is a primary goal for people with stroke. Identifying prognostic factors that predict walking disability can be useful for physical therapists when developing a plan of care. The purpose of this study was to determine what factors at 20 days post stroke predict walking disability 1 year later.

Number of Subjects: 293 participants at 20 days and 1-year post stroke.

Materials/Methods: Longitudinal, secondary data analyses from a large stroke rehabilitation trial. Independent variables that may predict walking disability collected at 20 days post stroke included: gait speed (GS), LE Fugl Meyer, modified Rankin Scale, Orpington Prognostic Scale (OPS), NIH Stroke Scale, pre-morbid Barthel Index, PHQ-9 Depression Scale, Physical Functioning Scale (PFS), gender, marital status, age, and living situation. The dependent variable of walking disability at 1 year post stroke was defined as household (100–2499 steps/day), limited community (2500–7,499 steps/day), and full community (≥7500 steps/day) walking. Walking activity was measured with a StepWatch Activity Monitor. Univariate analysis was initially used to determine if there were any differences among the 3 walking categories for each of the independent variables. Next multivariate analysis using Bootstrap method (1,000 samples) combined with all subset method and Bayesian information criterion were performed to select the most stable model to identify factors at 20 days post stroke for predicting community versus home and full versus limited community walking categories. Based on the selected model, predicted values were generated using a linear combination of the selected subset weighted by the regression coefficients. Receiver-operating characteristic (ROC) curves were then used to plot the value for sensitivity against the false-positive rate. The area under ROC curve (AUC) reflected the predictive ability of the selected variables.

Results: In the multivariate analysis for predicting community versus home walking categories a linear combination of GS, PFS, and OPS were ranked at the top most frequently (158 out of 1,000 Bootstrap samples), which was suggested as the best subset of independent variables for predicting walking disability. The AUC for these 3 variables combined was 0.74. The AUC for GS as a single factor was 0.66. In the multivariate analysis for predicting full community versus limited community walking categories GS was ranked at the top most frequently (544 out of 1,000 Bootstrap samples), which was suggested as the best independent variable. The AUC for GS was 0.66.

Conclusions: Stroke severity, physical functioning, and walking ability early after stroke are factors that can be used to predict walking disability one year after stroke. Although gait speed by itself was a statistically significant variable in predicting between different levels of community walking activity, its accuracy was not likely clinically useful.

Clinical Relevance: These findings can assist physical therapists in developing a prognosis early after stroke for the recovery of walking ability.
Purpose/Hypothesis: Fractional anisotropy (FA) of the corticospinal tract (CST) can be used to quantify the extent of damage to the motor system, to predict motor outcomes, and to investigate response to intervention. However, reliability and minimal detectable change (MDC) values of CST FA are unknown. The purpose of this study was to establish the test-retest reliability and MDC values of CST FA using three different methods.

Number of Subjects: Seventeen individuals with chronic stroke (mean±SD): age (57.9±10.4); Upper Extremity Fugl-Meyer (UE FM) motor score (43.1±14.5); months post-stroke (41.8±41.7).

Materials/Methods: Participants underwent diffusion tensor imaging on the same MRI scanner four days apart. Three methods for determining CST FA were analyzed in FSL. In Method 1, a researcher drew masks of the CST at cerebral peduncle (3 slices). In Method 2, a researcher transformed a standard sensorimotor area tract template (S-MATT) of the CST into native space. In Method 3, a third researcher used probabilistic tractography seeded in the cortex with waypoints in the posterior limb of the internal capsule and the cerebral peduncle. All researchers were blinded to participant and day of data collection in all methods. FA was extracted, and reliability was determined by calculating an intraclass correlation (ICC). Minimal detectable change at the 95% confidence interval (MDC95) were calculated.

Results: As expected, mean FA of the ipsilesional CST was significantly lower than that of the contralesional CST in all methods. For Method 1, good reliability was found for ipsilesional CST FA (ICC=.85 [.64-.94]) and contralesional CST FA (ICC=.81 [.56-.93]). For Method 2, excellent reliability was found for ipsilesional CST FA (ICC=.97 [.92-.99]) and contralesional CST FA (ICC=.93 [.82-.98]). For Method 3, excellent reliability was found for ipsilesional CST FA (ICC=.96 [.90-.99]) and contralesional CST FA (ICC=.95 [.87-.98]). For the ipsilesional CST FA, MDC95 values were .060, .012, and .015, for Methods 1, 2, and 3, respectively. For the contralesional CST FA, MDC95 values were .056, .013, and .011 for Methods 1, 2, and 3, respectively. Ipsilesional FA correlated with the UE FM score for Methods 1 and 3, but not for Method 2.

Conclusions: All methods were found to have good to excellent test-retest reliability. Method 3 (tractography) was found to have excellent reliability while capturing CST integrity well (FA correlated with motor impairment); however, this method requires time and expertise to complete. Method 2 (tract template approach) had excellent reliability; however, FA values did not correlate with motor impairment suggesting this method may lack specificity in capturing true CST integrity due to noise in transformation processes. Overall, our results suggest that there is a trade-off between reliability, validity, and the expertise required to obtain FA.

Clinical Relevance: The ICCs and MDCs reported may be useful for future research that aims to measure CST FA in order to predict motor outcomes or report changes in FA over time or in response to intervention.
Feasibility of Conducting a High-Repetition, Dual-Task Upper Extremity Intervention in Individuals with Stroke

There is currently a paucity of literature examining the effects of dual-task (DT) training on upper extremity (UE) function in individuals post-stroke. One of the very few studies that have addressed DT conditions in UE movement post-stroke found that DT practice may have therapeutic effects (Pohl et al. 2011). Interventions that have created neuroplastic changes in UE function have identified task repetition as a major component to creating neural adaptation (Birkenmeier, Prager, Lang 2010). While there are numerous interventions that incorporate UE motor tasks as part of a DT training intervention in individuals with stroke, the current literature lacks outcome measures that assess UE function and performance (Silsupadol et al. 2009; He et al. 2018). The purpose of this study was to examine the feasibility of implementing a DT intervention directed towards high-repetition UE functional activities in individuals following a stroke.

Four subjects with chronic upper extremity paresis due to stroke were recruited for this intervention in order to understand feasibility in a small, controlled group. Modeled after the short-duration and intensive reach training protocol set forth by Park et al., four subjects with chronic upper extremity paresis secondary to stroke underwent two, two-hour sessions of interventions aimed at high repetition, individualized UE training with progressive difficulty in DT situations (2016). The number of repetitions for single-task and DT activities in one hour, as well as the total number of UE repetitions in one hour were recorded and assessed after intervention to measure feasibility.

All four subjects completed the two, two-hour sessions performing an average of 410 bilateral UE repetitions in one hour. Sixty percent of these were in DT activity, with the remaining consisting of single task activities. It is feasible to perform a high-repetition, DT training intervention protocol dedicated to UE function in individuals with stroke. Future research should consider the dose-response relationship between therapy time and function. Further investigation on the potential benefits of intense bouts of DT practice on UE function in individuals post-stroke is warranted.

DT training has the potential to increase the functional ability of individuals with stroke to complete activities with their affected UE. Based on the current study, it is feasible to initiate a high-repetition DT training program in order to encourage motor learning in the presence of cognitive-motor interference.
Background & Purpose: Individuals post stroke have poor cardiorespiratory fitness.1 The benefits of aerobic exercise post stroke are well established; improving aerobic capacity, managing modifiable stroke risk factors and facilitating neuroplasticity.2-4 However, patients receiving rehabilitation are not adequately prescribed aerobic exercise.5,6 Reasons include lack of time, poor understanding of exercise prescription, and focus on neuromuscular and functional retraining by therapists.6 We explored the feasibility of an aerobic exercise class for patients with acute stroke receiving inpatient rehabilitation and whether the group improved aerobic capacity and exercise self-efficacy.

Case Description: The group was in addition to the patient’s 3 hours of therapy. Criteria was as follows; 1) medically stable with stroke; 2) able to follow basic directions; 3) able to report concerns; 4) required no more than minimal assistance for transfers and 5) completed submaximal exercise testing, adapted from previous work.7 The total body recumbent stepper (TBRS) submaximal exercise test calculated VO2 peak.8 Exercise self-efficacy was determined via the Short Self-Efficacy for Exercise (SSEE) and Short Outcome Expectations for Exercise (SOEE).9 Exercise prescription followed the American College of Sports Medicine (ACSM) principles for aerobic training.10 Classes were 60 minutes, utilizing Nu-steps and lower body ergometer and were facilitated by a PT and assisted by an aide. Vitals and Rate of Perceived Exertion ensured appropriate aerobic intensity.

Outcomes: Eighty-six patients participated. Complete data was available for 45 patients. Paired t-tests to compare the mean difference in pre VO2 peak (32.04 mg/kg/min ± 13.01), to post VO2 peak (33.80 mg/kg/min±12.66) demonstrated a non-significant increase of 1.76 mg/kg/min (95% CI,-4.93-1.42) (p=.271). Paired t-tests to compare mean pre SSEE/SOEE (35.39±6.41) to post SSEE/SOEE (38.75±5.14) demonstrated a statistically significant change of 3.36(95% CI,1.80-4.92) (p=.000). There were no adverse reactions.

Discussion: The case series suggests that an exercise class for patients with acute stroke receiving inpatient rehabilitation is feasible without adverse reaction and that participation improves exercise self-efficacy. There were a number of limitations. Participation was limited to those who required minimal assistance for transfers. These patients had a shorter length of stay and participated in the group for fewer sessions affecting opportunity to improve aerobic capacity. Staff compliance and unexpected discharges impacted data collection. Neuromuscular impairment occasionally limited ability to maintain cadence under the constant power setting potentially affecting VO2 peak calculations. Future endeavors include extracting data on intensity and time performing aerobic exercise to ensure adherence to ACSM guidelines. A randomized control trial comparing the group to standard care could determine whether aerobic exercise class has an additional benefit.
CONTROL ID: 3026057

TITLE: Pairing sensor technology with the Berg Balance Scale to quantify muscle activation and postural sway after stroke

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Stroke SIG

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ABSTRACT BODY:

Purpose: This report describes the use of wearable sensor technology to obtain physiological data of an individual with stroke (CVA) during the Berg Balance Scale (BBS).

Description: Improving balance is a common goal of individuals with CVA. Following CVA, balance improves due to neurologic recovery and emergence of compensatory motor patterns. As an activity-level outcome measure, the BBS cannot differentiate the two. Instead, physiological data is required to precisely and quantifiably measure changes in body structure and function. Commercially-available wireless sensors have potential in this role. These small, flexible devices can be applied to a person’s skin to capture multi-modal data including electromyogram (EMG) to measure muscle activity and tri-axial acceleration to measure postural sway.

A 62-year-old female in inpatient rehabilitation for a right basal ganglia ischemic stroke was assessed on the BBS with sensors donned on post-stroke day 8 (T1) and 18 (T2). The patient’s BBS improved from 38 to 47/56.

Summary of Use: Sensor data were collected and processed to quantify: 1. Muscle activity of rectus femoris (RF), tibialis anterior (TA), and gastrocnemius (GST), 2. Magnitude, velocity, and acceleration of postural sway in the coronal and sagittal planes. EMG and postural sway characteristics differed between BBS items and testing time points. At T1, the patient generally demonstrated lesser activity of paretic muscles, yielding asymmetric activation favoring her right side. At T2, muscle recruitment of TA and GST but not RF was more symmetrical. The patient’s weakest muscle at baseline, left TA, demonstrated the greatest EMG improvements.

During static standing items, nearly all measures of postural sway decreased between T1 and T2. At both time points, the patient demonstrated greater magnitude and velocity of anterior-posterior (AP) than medial-lateral (ML) postural sway. The ratio of AP to ML sway decreased at T2, yielding a more consistent sway pattern across the two planes.

Sensor data reveals the patient did adopt some compensatory muscle activation patterns and also demonstrated signs suggestive of neurologic recovery. For example, while the patient improved her score on the forward reach item, at T2 she demonstrated increased asymmetry in EMG and postural sway parameters, illustrating increased reliance on her non-paretic side. Conversely, improvement on other items, such as standing with feet together, correlated with improved physiological data, including a relative increase in recruitment of paretic muscles.

Importance to Members: Wearable sensor technology was used to measure physiological components of balance and to inform the understanding of mechanisms underlying balance improvement after CVA. This technology captured outcomes that the BBS is not sensitive to, providing useful information a clinician can apply to the patient’s treatment plan. Further research is warranted to determine how to optimally integrate sensor technology into physical therapy practice.

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**ABSTRACT BODY:**

**Purpose/Hypothesis:** Gait speed is a common metric to measure progress in rehabilitation and an important predictor to achievement of community ambulation post-stroke. People post-stroke demonstrate functional reserve to increase their self-selected or natural speed when required. This is accomplished by a reduction in cycle duration and an increase in stride length of both the paretic and non-paretic limbs. Asymmetry is a common feature of post-stroke gait which contributes to poor balance and greater cardiovascular effort. Previous studies in those with subacute stroke, have demonstrated that walking at an increased speed compared to their preferred speed can improve temporal symmetry. However, whether this speed-related improvement in temporal symmetry persist in chronic stroke is unknown. Our aim was to analyze the underlying spatiotemporal changes associated with fastest comfortable speed post-stroke and determine if these changes alter gait symmetry.

**Number of Subjects:** Thirty community-dwelling adults (12 females; 15 R hemisphere lesion; mean age 58.4±10.8 years, mean time post-stroke 12.4±5.2 months; mean Lower Extremity Fugl-Meyer Motor score 23.7±4.4) enrolled in an ongoing randomized controlled trial of walking recovery, provided written informed consent to participate. Participants were able to walk at least 10 feet with no more than one person assist but with a gait speed < 0.8m/s.

**Materials/Methods:** Participants walked for two trials each at their preferred and fastest comfortable speed over a GAITRite instrumented walkway. Spatiotemporal gait parameters included step length, stance time and swing time. Cadence was also measured. Symmetry Indices were used to calculate asymmetry of step length, step time, and swing time – [(NP-P)/ (NP+P)] X 100, expressed as a percentage. Paired t-tests were used to compare the differences at preferred and fast speeds in gait velocity, the three symmetry indices, step lengths and cadence (Bonferroni correction - p<0.007).

**Results:** Participants significantly increased their walking speed from 0.49±0.23m/s (self-selected) to 0.69±0.32m/s (fastest comfortable); p<0.001. This increase occurred due to both an increase in cadence (70.3±23.7 to 84.6±27.8 steps per minute; p<0.001) as well as step lengths of the paretic (39.7±10.8 to 46.0±13.5 cm; p<0.001) and non-paretic 34.4±11.2 to 39.7±15.3; p=0.002) limbs. In contrast, there were no significant differences in either the spatial or temporal symmetry indices between the two walking speeds.

**Conclusions:** Although patients post-stroke demonstrated the capacity to increase their walking speed using both mechanisms of increased cadence and increased bilateral step lengths, the asymmetrical gait pattern persisted.

**Clinical Relevance:** Increased gait speed is an oft-cited rehabilitation goal; however, quality and symmetry of gait may not necessarily accompany this functional improvement. Clinicians should be mindful to not solely focus on gait speed during rehabilitation interventions, but also need to incorporate strategies that will address this persistent gait asymmetry.
CONTROL ID: 3026671
TITLE: Backward Walking Training for Individuals with Chronic Stroke
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
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ABSTRACT BODY:
Purpose/Hypothesis: Achievement of meaningful functional improvements for those with chronic stroke presents a challenge in current physical therapy practice. Interventions that can address persistent gait deficits are currently limited. Our previous work in acute stroke revealed training in Backward Walking (BW) was successful in improving forward gait speed. The effect of this novel intervention in a chronic stroke population is not well known. In this study we compared the effect of BW training to a more traditional Forward Walking (FW) training on forward gait speed in individuals with chronic stroke.

Number of Subjects: 31
Materials/Methods: Thirty-one community-dwelling adults with first time stroke (19 male; 16 left hemisphere; mean time post-stroke 12.9±5.6 months; mean age 58.0±10.5 years; mean Lower Extremity Fugl-Meyer (LEFM) score 22.3±5.5) provided written informed consent prior to study enrollment. Fifteen participants were randomized to FW training and 16 to BW training. All completed 18 sessions (3x/week for six weeks) of training with a physical therapist-led team. Training sessions included 20 minutes each of training on the treadmill with body weight support and overground gait training. Facilitation and assistance were provided at the pelvis and the paretic lower extremity as needed. Participants were progressed by increasing gait speed, bout duration, and decreasing body weight support and assistance. Outcome measures assessed pre- and post- intervention by assessors blinded to group assignment included the 10 Meter Walk Test (10MWT) and LEFM.

Results: Six of sixteen participants randomized to BW training demonstrated an increase in forward gait speed (10MWT), greater than the minimal clinically importance difference (MCID) of 0.16 m/s, at the post-assessment. In contrast, just two of fifteen participants randomized to FW training demonstrated a MCID in forward gait speed. We investigated characteristics of the BW training cohort to potentially identify responders (gait speed increase >0.16 m/s) and non-responders (gait speed increase <0.16 m/s). However, we found no difference in age, time since stroke, baseline gait speed, or baseline LEFM score in the responders and non-responders (p>0.05).

Conclusions: A greater number of participants randomized to BW training attained a MCID increase in forward gait speed compared to the FW training group. This suggests that BW training should be included in the rehabilitation plan of those with chronic stroke. Further investigation is needed to identify those who would most optimally benefit from BW training.

Clinical Relevance: Compared to FW, BW may impose unique therapeutic demands such as greater cardiovascular effort, muscle activation, balance, and postural control during gait training. Additionally, BW requires lower extremity muscle activation outside of the inefficient abnormal synergistic pattern often observed following stroke. These features may be important ingredients in the recovery of gait speed in the chronic phase of post-stroke recovery.
Purpose/Hypothesis: Walking while performing a second task typically results in a decrement in performance in one or both of the tasks, particularly for those with stroke. Few have examined dual task effects in hand movements in adults with stroke. One study reported that those with stroke moved their less affected hand faster when speaking but moved their more affected hand slower. The purpose of this study was to examine if hand movements can be facilitated with the performance of a second activity in adults with stroke.

Number of Subjects: 14 adults 50 years of age and older without stroke and 8 with chronic stroke. All were right-handed (pre-morbidly for those with stroke) and able to ambulate independently without an assistive device.

Materials/Methods: Baseline function was quantified with the Montreal Cognitive Assessment (MoCA), Berg Balance Score (BBS), and 6-meter gait velocity. Participants performed the Figure-of-8 Walk Test, hand movements to audibly sound a hand-held noisemaker, serial subtraction by three, and speaking in response to a question, e.g., “Tell me about a favorite vacation”. Each task was completed for 20 s as a single task and then activities were performed simultaneously as pairs. The order of the dual task activities was randomized. Instructions were to perform activities at a comfortable pace. No instructions were given to prioritize one task over another. Video and audio recordings were made to analyze performance. Data included the distance walked, and the number of hand movements, subtractions, and words spoken. The performance of the right hand of controls and the less affected hand of those with stroke was compared, as was the left hand of controls and the affected hand of those with stroke. Dual task costs (DTC) were calculated for each pair of activities: [(Dual task – Single Task)/Single Task] X 100. Group differences were analyzed with independent sample t-tests.

Results: Age and MoCA scores were not different between groups with an average of 65.6 (8.3) years and 26.6 (2.7). Controls had significantly higher Berg Balance Scores, 54.7 (2.4) and faster gait velocities, 1.29 m/s (0.14) than those with stroke, 49.8 (5.3) and 0.82 m/s (0.42) respectively. Significant group differences (p’s < 0.05) in DTC were found for hand movements during speech and the number of subtractions during movements with each hand. For each significant difference, the controls performed faster in the dual task condition compared to the single condition. No other group differences in DTC were significant.

Conclusions: Those with stroke did not alter the speed of hand movements by simultaneously walking a constrained path, a subtraction task, or speaking. More empirical work on dual task effects with hand movements with larger sample sizes is needed to elucidate these relationships.

Clinical Relevance: Adults with stroke appear to demonstrate limited flexibility in the rate of hand movements and do not show the dual task benefit seen in controls. Clinical use of dual task training with the goal of increasing the rate of hand movements may be effective in healthy older adults, but not those with stroke.
Lesion Localization of Post-Stroke Lateropulsion

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ABSTRACT BODY:

Purpose/Hypothesis: To determine whether lateropulsion (pusher syndrome) localizes to specific brain regions across patients with stroke using a case-control design.

Number of Subjects: Fifty patients with lateropulsion following stroke were matched with 50 stroke patients without lateropulsion using age, time since onset of stroke, admission motor FIM score, lesion side and gender.

Materials/Methods: The primary analysis included multivariate lesion symptom mapping using sparse canonical correlations to identify regions most associated with lateropulsion as assessed with the Burke Lateropulsion Scale. Secondary analyses included evaluating paired comparisons for lesion volume, degree of motor impairment, motor and cognitive Functional Independence Measure scores, and duration of inpatient rehabilitation.

Results: The lesion symptom mapping analysis of all lesions mapped onto a common hemisphere produced an overall significant model (p < 5 x 10^-5) with a regional peak at the inferior parietal lobe at the junction of the post-central gyrus (Brodmann Area 2) and Brodmann Area 40 as the lesion locations most associated with lateropulsion. Lesion volume was larger for patients with lateropulsion when data were pooled. Despite adequate matching, motor performance and motor and total Functional Independence Measure scores differed between patients with and without lateropulsion when right brain lesions were present.

Conclusions: Findings about lesion location volume and impairments were consistent with prior work. This analysis implicated lesion involvement of the inferior parietal lobe as a key neuroanatomical determinant of developing lateropulsion.

Clinical Relevance: A better understanding of the anatomical underpinnings of lateropulsion may improve rehabilitation efforts, including the potential for informing noninvasive neuromodulation approaches.
TITLE: Effects of Non-Invasive Brain Stimulation on Pain Among Individuals with Central Post-Stroke Pain: A Systematic Review

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ABSTRACT BODY:

Purpose/Hypothesis: Central post-stroke pain (CPSP) is a neuropathic pain disorder affecting up to one third of the post-stroke population resulting in pain interference, disability, and decreased quality of life. An emerging non-pharmacological treatment for CPSP is non-invasive brain stimulation, specifically transcranial direct current stimulation (tDCS) and repetitive transcranial magnetic stimulation (rTMS). This systematic review aims to analyze the efficacy and quality of non-invasive brain stimulation intervention studies for CPSP in the chronic stroke population (> 6 months post stroke).

Number of Subjects: 109 chronic stroke participants across 6 studies with duration of CPSP ranging from 3 to 180 months.

Materials/Methods: Clinical studies were sought from three research databases published between 2007 and 2017. Experimental and observational studies of CPSP participants were included if non-invasive brain stimulation (tDCS or rTMS) was the sole intervention and pain the primary outcome. Studies were assessed for both clinical pain (e.g. visual analog scale (VAS)) and experimental pain (e.g. quantitative sensory testing (QST)) outcome measures. The Modified Downs and Black Instrument qualitatively assessed for risk of bias in the included studies.

Results: Of the initial 1107 articles, six were eligible for inclusion. Five studies found a decrease in clinical pain intensity (p<.05) from immediately after, to 3 weeks after, rTMS or tDCS delivered over the primary motor cortex. One study tested rTMS to the left premotor/dorsolateral prefrontal cortex and failed to find a treatment effect for clinical pain (p>.05). For experimental pain, one study found thermal pain thresholds improved for those receiving tDCS compared to sham (p<.05); while another study found normalization of the cold detection threshold only after rTMS (p<.05). Qualitative assessment revealed only one study to be of ‘excellent/good’ quality, while the other five were rated as either ‘fair’ or ‘poor.’

Conclusions: Non-invasive brain stimulation may have a therapeutic effect on pain level for individuals with CPSP, as evidenced by significant decreases in VAS and QST scores. Although, caution must be taken in generalizing the findings due to the quality of the studies reviewed. Moreover, significant variation existed across the 6 studies in participant characteristics and the parameters of stimulation provided. Future studies should aim to improve the homogeneity of participants with CPSP and standardization of treatment parameters, as well as consider the measurement of both clinical and experimental pain. Lastly, since only one study assessed treatment effects beyond 3 weeks, future studies should consider long-term follow-up.

Clinical Relevance: This systematic review demonstrates that rTMS and tDCS may be effective noninvasive treatment options to reduce pain in persons with CPSP post stroke; though clinicians should strongly consider the paucity and quality of available evidence, as well limited duration of follow-up.
Purpose: Most stroke survivors have very low levels of cardiovascular fitness, which limits mobility and leads to further physical deconditioning, sedentary behavior, and heightened risk of recurrent stroke. Aerobic exercise (AE) can break this relentless cycle by increasing aerobic capacity, reducing risk of comorbidities, and enhancing quality of life of stroke survivors. Although clinical guidelines recommend that AE be a part of routine stroke rehabilitation, specific protocols are needed because some clinicians lack confidence in screening for, and prescribing, safe and effective AE programs. The Aerobic Exercise Recommendations to Optimize Best Practices In Care after Stroke (AEROBICS) were developed in 2013 by an international group of stroke rehabilitation experts and have recently been updated. The purpose of AEROBICS 2018 is to provide a concise and user-friendly set of recommendations for rehabilitation professionals to guide AE screening and prescription for people after stroke or TIA. The ultimate objective is to promote clinical implementation of aerobic exercise interventions in stroke rehabilitation.

Description: Development of AEROBICS 2018 was guided by the Appraisal of Guidelines Research and Evaluation Consortium. The first step was to conduct a systematic review of the literature on issues related to AE post-stroke: physiological and functional benefits, indications and contraindications for AE stress testing and interventions after stroke, as well as considerations regarding implementation of training across stroke severity and continuum of care. The AEROBICS working group drafted 7 screening and 13 prescription recommendations for implementation of AE post-stroke. Underlying rationale, system implications, performance measures, and summary of the evidence for each recommendation were also written, adding 128 new references to replace or augment those in the original AEROBICS document. An iterative process using the Appraisal of Guidelines Research and Evaluation II was implemented to achieve consensus among working group members and the entire consensus panel.

Summary of Use: Target audiences for AEROBICS 2018 are health professionals who are involved in care of patients post-stroke and TIA across the health care continuum (from acute to home and community) as well as health administrators and managers responsible for the coordination and delivery of services. AEROBICS 2018 will be available online and will be used to update e-AEROBICS (https://www.strokengine.ca/elearning/eaerobics/), a web-based educational program currently based on the original AEROBICS document. An iterative process using the Appraisal of Guidelines Research and Evaluation II was implemented to achieve consensus among working group members and the entire consensus panel.

Importance to Members: The historic lack of utilization of AE in stroke rehabilitation has resulted in some stroke survivors being deprived of an intervention with demonstrated potency to restore and maintain physical and mental functions. Clinical implementation of the AEROBICS 2018 Recommendations will help not only narrow gaps between evidence and practice but also reduce current variability and uncertainty regarding use of AE in clinical practice.
Purpose/Hypothesis: The purpose of this study was to determine the effectiveness of intramuscular functional electrical stimulation (IM-FES) for improving gait in adults with chronic stroke.

Number of Subjects: N/A

Materials/Methods: A literature search of PubMed, CINAHL, ProQuest, SAGE Journals, and Cochrane library was conducted using search terms: (implant* FES OR neuroprosthetic OR neuroprosthesis OR implant* stimulator) AND (lower leg OR lower extremity OR ankle) AND (gait OR ambulat* OR walk*) NOT microprocessor. Search limits included: human subjects, peer-reviewed, English language. Selection criteria: RCTs, adults (18 and older) with chronic (>6 months) stroke, use of IM-FES, and objective gait outcomes. Two reviewers independently assessed each study for methodological quality and came to consensus using PEDro guidelines.

Results: A total of 367 articles were screened. After detailed appraisals, 4 RCTs met criteria. PEDro scores ranged from 5-7/10 (avg 6/10). Samples included a total of 124 adults with chronic stroke. Intervention groups received IM-FES on lower extremity muscles or peroneal nerves; control groups received no FES. Adverse effects of IM-FES included mild discomfort, erythema; no infections were reported. In 3 studies, BWSTT and gait training were used for all groups for 1.5 hrs, 4x/wk, 12 wks. 1 study compared IM-FES to conventional walking devices. Outcomes were assessed pre- and post-treatment, with follow-up at 6 months for 2 studies. IM-FES targeted pelvic stability, knee ext, ankle dorsiflexion (DF), knee flex, and knee ext during swing. All IM-FES groups had statistically significant improvements in gait outcomes compared to controls in areas of temporal-distance [Gait Assessment and Intervention Tool (G.A.I.T.), TG, OGA], kinematics (reduced stance and double support on paretic side, longer single support on non-paretic side, improved timing/range of DF during swing,) and self-reported functional mobility. Retention occurred 6 months after IM-FES removal in coordinated gait components, while controls worsened significantly at follow-up.

Conclusions: There is moderate evidence to support IM-FES for improving gait in patients with chronic stroke vs. BWSTT or gait training alone. Studies showed retention in gait kinematics 6 months post-treatment following removal of IM-FES. Limitations included small sample sizes, invasive surgery, co-interventions, and varied outcome measures and protocols. Future research should compare IM-FES to transdermal FES with gait training using standardized testing/training, including larger sample sizes and other populations.

Clinical Relevance: Clinicians should consider using IM-FES to promote greater retention of gait improvements vs. gait training alone in adults with chronic stroke. IM-FES resulted in normalized initial loading responses compared with a conventional walking device, which is likely to reduce stumbling in persons with drop foot. IM-FES is a safe and feasible intervention which may enhance carry-over and reduce falls following 12 weeks of intensive gait training.
ABSTRACT BODY:

**Purpose/Hypothesis** : Identifying neural correlates of motor function after stroke may improve motor recovery prognosis and inform more targeted interventions. Motor outcomes have been associated with measures of white matter integrity and/or lesion overlap within descending motor tracks. Advances in neuroimaging have allowed a more comprehensive assessment of structural brain connectivity post-stroke, revealing associations between disconnection of the ipsilesional primary motor cortex and reduced upper limb strength/dexterity and gait speed in chronic stroke. Little is known, however, about structural connectivity damage and fine motor deficits post-stroke. The purpose of this study was to investigate the relationship between structural connectivity among cortical/subcortical motor regions and upper and lower extremity (UE/LE) coordination in persons with chronic (>6 months) stroke. We hypothesized that structural connectivity between cortical/subcortical motor-relevant regions of interest would be positively associated with coordination performance, with interhemispheric connectivity playing a greater role in bilateral coordination.

**Number of Subjects** : Forty-five individuals with chronic, left-hemisphere stroke (mean age 60.2 ±10.9 years; time post-stroke 64.6 ±57.8 months).

**Materials/Methods** : Participants underwent diffusion tensor imaging and a comprehensive behavioral assessment that included UE/LE coordination tasks (e.g., unilateral/bilateral tapping). Inter-rater reliability of tapping counts was assessed using intraclass correlation coefficients (ICC’s), and relationships between structural connectivity amid a motor subnetwork and coordination tasks were examined using Spearman’s correlations.

**Results** : Inter-rater reliability for tapping counts was excellent, with ICC’s ranging from 0.96-0.99. Correlations between structural connectivity and coordination tasks were strongest involving cortico-subcortical connectivity between ipsilesional primary motor cortex/subplementary motor area and the cerebral peduncle/thalamus, and between the primary sensory and anterior cingulate cortex and thalamus (all p≤0.002). Premotor cortex<->cerebral peduncle connectivity was specific to UE coordination, while putamen<->thalamus connectivity was specific to LE coordination. Interhemispheric connectivity between homologous cortical motor regions was not correlated with bilateral coordination tasks.

**Conclusions** : Structural connectivity between key motor regions, especially cortico-subcortical connectivity, is positively related to UE/LE coordination tasks post-stroke, with certain anatomical connections specific to upper or lower limb coordination. There is a large degree of overlap between gross motor neural connections and those related to coordination, suggesting these tasks share similar motor networks.

**Clinical Relevance** : Coordination impairments post-stroke can be detrimental to performance of activities of daily living. This study provides insight into neural substrates of coordination post-stroke, an important step towards understanding mechanisms that support motor function and recovery in chronic stroke.
BACKGROUND & PURPOSE: Approximately 795,000 people in the United States have a stroke every year and 73 percent experience long-term disability. Impairments in motor control, lower extremity strength, and muscle power generation are the primary contributors to post-stroke dysfunction and disability. Current literature focuses on strength training of the hemiparetic limb and the functional consequences, however there are some studies assessing the effects of power training post-stroke. This research shows that power training correlates with significant changes in gait speed and functional capacity. There are limited studies demonstrating the effects of power training on running and higher level balance in individual with a chronic stroke. The purpose of this study was to investigate the effectiveness of the use of power and speed training on gait speed, running and jumping distance in a patient with a chronic stroke.

CASE DESCRIPTION: Patient was a 33 year old female post-atriovenous malformation (AVM) stroke in 2008 with left-sided hemiparesis and impaired functional mobility, limiting participation in daily activities with her family. She required use of single point cane to ambulate limited community distances, and demonstrated decreased strength in bilateral lower extremities and overall decreased functional endurance. She participated in 15 physical therapy sessions (two 60 minute sessions a week) that focused primarily on power and speed training exercises. These exercises included leg press, calf raises, jump training and speed and agility training (skipping, high velocity stepping, bounding).

OUTCOMES: Following 15 sessions, she demonstrated a 48.7% increase her running speed over 10 meters from 1.80 m/s to 2.96 m/s, and a 26.3% increase in distance jumped during a broad jump from 31 inches to 40.4 inches. The patient also demonstrated a clinically meaningful change in her HiMAT score with an increase from 14 to 27/54 (MDC: 4 points), as well as in her LEFS score which improved from 40 to 64/80 (MDC: 9 points).

DISCUSSION: Following 15 sessions of power and speed training, this patient demonstrated improvement in gait speed, higher level functional activities and ability to achieve running. These results indicate that power in both the unaffected and affected limb improved as demonstrated by increase in jumping distance and increase in HiMAT score. An increase in running speed may be attributed to increase in power, but also an improvement in coordination and motor control. Intensive task-specific training for power and speed were effective in improving the patient's running speed and jumping distance allowing for ability to participate in activities with her child. Future research should examine use of power and speed training in the acute versus chronic stroke patient population.
CONTROL ID: 3029713

TITLE: Visuospatial and memory impairments correlate with upper limb tracking performance in chronic stroke: a rehabilitation robotics approach

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG

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ABSTRACT BODY:

Purpose/Hypothesis: 15 million people suffer from stroke each year (World Health Organization). Approximately a third will have lifelong disabilities performing activities of daily living and regaining independence. In the field of rehabilitation robotics, motor and cognitive deficits are assessed and targeted as separate domains yet; functional activities require the use of both. However, the extent of the interplay of cognitive impairment on motor performance is not clearly understood. We hypothesize that the integrity of particular cognitive domains, memory, attention, and visuospatial processing, are significantly correlated to motor performance in tracking tasks. This pilot study explores this relationship by analyzing both clinical and robot-based assessments of subjects in a Rehabilitation Robotics Lab’s Haptic TheraDrive study.

Number of Subjects: 17 subjects with upper-extremity hemiparesis ranging from 4 months to 19 years post stroke onset and 35 to 75 years of age.

Materials/Methods: Each subject received a clinical evaluation including the Montreal Cognitive Assessment, Fugl-Meyer Assessment - Upper Extremity, Box and Block Test, and Grip Strength Test to determine the extent of their motor and cognitive impairments. The study then employed a single-degree-of-freedom, haptic force-feedback robotic system used to assess motor performance. A series of sessions consisting of a tracking task “game” facilitated by the device called Haptic “TheraDrive” was administered by asking subjects to follow a pseudo-random curve on a computer screen using a crank/wheel actuator. The robot provided a zero impedance manipulator which recorded the performance of the subject. Motor performance was calculated by taking the root mean square error between actual performance and ideal performance, generating a performance error metric (RMSE). A higher RMSE score indicated poor accuracy. Clinical and robot-based data was analyzed using the Spearman’s correlation test.

Results: Statistical analysis shows a correlation between RMSE and both visuospatial/executive functioning (ρ= -0.5807, p= 0.0145) and delayed recall (ρ= -0.4888, p= 0.0465). A correlation was seen between FM-UE scores and both visuospatial/executive functioning (ρ= 0.5284, p= 0.0292) and delayed recall (ρ= 0.5302, p= 0.0286). The statistical analysis fails to show a correlation between RMSE and any other cognitive domains.

Conclusions: The results support that motor capabilities are jointly affected by cognitive and motor acuity. The specific cognitive domains that were essential in tracking tasks were visuospatial/executive functioning and delayed recall. Further analysis uncovers the capacity of cognitive deficit to effect the functional outcomes of individuals who have high motor ability but decreased cognitive function.

Clinical Relevance: These results could influence future robot-based rehabilitation programs by supporting cognitive interventions to optimize motor recovery.
Objective Assessment of Sedentary Behavior in Survivors of Stroke: A Systematic Review and Meta-Analysis

Purpose/Hypothesis: There are over 33 million survivors of stroke (SoS) worldwide and the majority are physically inactive. In addition to low physical activity levels, the amount of time a person spends sedentary (sitting, lying or reclining with low energy expenditure) may be an independent risk factor for cardiovascular disease and mortality. Therefore, sedentary behavior (SB) likely increases the risk of subsequent stroke, which accounts for a quarter of all strokes in the United States. The purpose of the present study was to determine the amount of time SoS spend sedentary each day, compare this value to age and sex-matched individuals without stroke, and determine if there are differences in SB across different countries.

Number of Subjects: 595 individuals with chronic stroke. 639 age and sex-matched controls.

Materials/Methods: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed. Searched databases included PubMed, EMBASE, PsycINFO, the Cochrane Library, Web of Science, and Cumulative Index to Nursing and Allied Health Literature (CINAHL). Study inclusion criteria: published in English and accessible online, included individuals with chronic (> 6 months) stroke, and used a device to objectively measure SB. One reviewer screened titles and abstracts for eligible studies. Two reviewers then independently screened full texts and extracted data for the selected studies. Methodological quality of each selected study was assessed using a modified version of the Downs and Black Checklist.

Results: Eleven studies were meta analyzed using a random effects model. Four additional studies were included in the systematic review. During waking hours, SoS spent 11.2, 95% CI [10.1, 12.3] hours per day engaged in SB which was not significantly different from healthy age and sex-matched controls (p = 0.2347). Additionally, no statistically significant differences in SB was found between the seven countries investigated (p = 0.0617).

Conclusions: SoS spend a large amount of each day (> 11 hours) sedentary, though this may not be different than their age and sex-matched peers. Additionally, there are no apparent differences in SB between the countries studied. Still, the potential harm of SB may be amplified for SoS, who already face increased health risks. SB may be an independent risk factor for subsequent stroke and will benefit from further investigation to determine the relationship between SB and overall health.

Clinical Relevance: Understanding SB in SoS is important as these individuals are at a greater risk for subsequent stroke, independent of physical activity levels. As Physical Therapists we are expected to address the health, wellness, and preventive needs of individuals after stroke. One way to accomplish this is through the promotion of movement and exercise after stroke both in clinical and community settings. Assessing the problem of SB in SoS is the crucial first step in developing interventions aimed at reducing SB.

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ABSTRACT BODY:

Purpose: Investigate the role of social support in a community-based exercise program for survivors of stroke (SoS) and their care partners (CP).

Description: Over half of the 6.8 million SoS in the U.S. require the assistance of another person, often from informal CP. Both SoS and CP are at an increased risk for depression and cardiovascular disease and both of these risks can be reduced with physical activity (PA). Unfortunately, SoS are significantly less active than the general population, and over half of CP are not meeting national PA guidelines.

Barriers to PA for SoS and CP include financial costs, lack of knowledge and qualified instructors, and limited social support. Additionally, while community-based PA programs after stroke are becoming more common, the involvement of CP is often passive, and does not take into account the need for PA amongst CP. An innovative way to address these issues is through community-based group exercise. The NExT (Neurological Exercise and Training) program provided participants with: 1) free seven month YMCA membership, 2) 15 exercise and education sessions led by licensed physical therapists (PTs), 3) monthly recreational outings in the community, and 4) the opportunity to exercise alongside other SoS and CP. Each session was 1.5 hours with a focus on strength, balance and aerobic training at an appropriate intensity for each individuals’ goals and capabilities. During the 8-week group class, participants were encouraged to participate in additional exercise at the YMCA either through other classes or independently. While participants were encouraged to attend each group session, there was no attendance requirement.

Summary of Use: Of the 19 participants there were 6 dyads (SoS and their CP) and 7 SoS without CP. As a group, dyads had significantly higher attendance and reported larger increases in mobility and exercise ability (p = 0.04, 0.04, and 0.03 respectively). While both parties in the dyads reported increased familial social support, CP had the largest gains (38% increase from baseline). Following the 8 weeks of group classes, SoS without CP reported significantly higher social support from friends compared to dyads (p = 0.03). While physical measures such as the Timed Up and Go and 2 Minute Walk Test remained stable, these findings imply that the common barrier of social support can be addressed through community-based group exercise programs.

Importance to Members: PTs have a social responsibility to advocate for the health needs of people with and without disability. PTs are uniquely qualified to provide exercise and PA interventions that promote not only physical health, but overall wellness. Social support is a common barrier to PA and involving CP is a simple and innovative way to facilitate a more active lifestyle after stroke.
ABSTRACT BODY:
Purpose/Hypothesis: The stroke survivors show remarkable asymmetry of trunk and decreased balance in sitting and standing [1, 2]. One of the effective techniques to improve the trunk stability is trunk stabilization exercises [3], the respiratory muscles are included in trunk musculature, it may influence on the trunk balance [5].

The aim of this study was to investigate the effects of respiratory muscle training combined with trunk stabilization exercise on abdominal muscles thickness, respiratory muscle functions, and trunk stability in chronic stroke survivors.

Number of Subjects: 33 hemiplegic stroke survivors

Materials/Methods: The study was a randomized controlled trial. Thirty three hemiplegic stroke survivors were randomly allocated to either the respiratory muscle training with trunk stabilization exercise group (RMTG) (n=17) and trunk stabilization exercise (TSEG) (n=16). The RMTG underwent respiratory muscle training for 20 minutes and trunk stabilization exercise program for 20 minutes that was proceeded by weekly progressed schedule per day, 3 times a week during 6 weeks. The TSEG conducted trunk stabilization exercise program for 40 minutes per day, 3 times a week during 6 weeks. The thickness of abdominal muscles was measured by using ultrasonography during resting and contraction. Maximal expiratory pressure (MEP), peak expiratory flow (PEF) and forceful expiratory volume 1 sec (FEV1) for forceful expiratory muscle function; maximal inspiratory pressure (MIP), peak inspiratory flow (PIF) and vital capacity (VC) for inspiratory muscle function were examined. Trunk stability was estimated by maximal velocity and path length of center of pressure (COP) by using a balance board with sitting posture.

Results: The RMTG showed significantly increased thickness of transverse abdominis and diaphragm in affected side. The MEP, PEF, MIP and PIF of RMTG were significantly increased than TSEG, however FEV1 and VC were not significantly different between RMTG and TSEG. Trunk stability for maximal velocity of COP of extension and affected side bending was significantly increased in RMTG. In addition, maximal path length of COP of flexion, extension, affected/less affected side bending was significantly increased in RMTG.

Conclusions: The results of this study demonstrated that the resting thickness of diaphragm increased in the RMTG. In respiratory muscle functions were confirmed that the RMTG showed significant improvement than TSEG and the trunk balance measured by the velocity and path length of the COP were significantly increased after the intervention in RMTG than TSEG. Therefore, respiratory muscle training can be suggested as an effective method to improve the respiratory muscle functions and trunk stability in chronic stroke survivors.

Clinical Relevance: Progressive respiratory muscle training can be easily implemented in clinical settings. In addition, progressive respiratory muscle training may be particularly suitable given the recent trend towards moving rehabilitation out of the hospital environment.
ABSTRACT BODY:

Purpose/Hypothesis: Although instructional cues provided during functional task training may impact performance and learning1-3, research in stroke populations is limited4-8. Recent findings showed external focus (EF) rather than internal focus (IF) instructions produced greater lateral excursion performance during a seated weight shifting task to unaffected side in adults 1-2 months post stroke with impaired sitting balance.1 We extended this work to include: training and retention phases; movement bilaterally; and form assessment.

Number of Subjects: 26 adults (mean age 61.8±17, 1-10 weeks post unilateral stroke), with good trunk control (mean score 51.3±4.4 out of 56 for function in sitting test-FIST) were randomly assigned to receive IF or EF instructions and feedback during seated balance training. Exclusion criteria was severe hemineglect or inability to sit without support or follow multistep commands.

Materials/Methods: 3 trials were performed per side for baseline (BASE), short term retention (STR, 5 min) and long term retention (LTR, 5-7 days later) phases of experiment; training or acquisition (ACQ) phase included 6 trials per side. A video of proper weight shifting technique was viewed prior to ACQ phase. During ACQ, EF had targets at shoulder height 2 inches beyond their furthest lateral lean. Adults were asked if they could touch the target (EF) or lean any further (IF). During STR and LTR adults were told to shift their body weight as much as possible towards their right or left without using their arms. Mean scores per phase were computed for COP excursion (horizontal, vertical) measures (pressure mat) and quality of form (video analysis, Body Align Pro).

Results: No group differences (P>.05) emerged for demographics, FIST, and BASE phase measures per side. Paired t tests showed form significantly improved (P<.05) from BASE to ACQ phases per side; excursion measures were not significant. 2 (IF,EF) x 2 (BASE, ACQ) ANOVAs showed form significantly improved (P<.05) from BASE to ACQ for affected side; no significant effects (main or interactions) were noted for form or excursion measures. 2 (IF,EF) x 2 (ACQ, STR) showed no significant main effects or interaction for excursion or form measures. Separate independent t tests for LTR per side showed no significant group effects (P>.05) for excursion or form measures.

Conclusions: Adults with acute stroke improved form per side during training which was more pronounced for movement to the affected side. Both groups produced similar weight shift performance and learning regardless of instructional cues. Mean excursion and form scores were retained by adults regardless of group and movement direction during STR and LTR. Results will be discussed in lieu of recent findings and methodological differences in prior work.

Clinical Relevance: Impact of IF or EF instructions on automatic control processes and/or working memory load5-8 remains unresolved in this population and requires further study. This work differs from recent findings that EF is more effective than IF instruction in this population.
Can stroke survivors learn and retain a new walking pattern through an explicit learning task?

Purpose/Hypothesis: Most of our understanding of locomotor learning post stroke is from implicit learning paradigms, such as the split belt treadmill; however, rehabilitation primarily uses explicit forms of learning. Few studies have examined explicit locomotor learning using distorted visual feedback (DVF). These studies found that healthy individuals could learn and retain a new walking pattern through DVF. It is unclear if stroke survivors can learn in this manner. The purpose of this study is to determine if stroke survivors can learn and retain a new walking pattern through DVF.

Number of Subjects: Chronic stroke survivors between the age of 18 and 80 were included.

Materials/Methods: Subjects walked on a treadmill for 2 consecutive days. Day 1 consisted of Baseline, Learning, and Retention (Ret1). Day 2 was 24 hours later and consisted of Retention (Ret2). During Baseline, subjects walked normally. During the 12 minutes of Learning, a bar graph with information about each leg’s SL and a target line for each bar was displayed in front of the subject. Subjects were instructed to get each bar to hit the target line on each step. The feedback for the leg with the shorter SL was distorted so that subjects needed to take a longer step in order to get the bar to hit the target line. During Ret1 and Ret2, no VF was provided and subjects were asked to continue walking with the learned pattern. SL of the leg with the shorter SL at Baseline (ShortSL) was the primary outcome measure. A paired t-test was used to compare average ShortSL during Baseline to the last 10 steps of Learning to determine if they learned a new walking pattern. Paired t-tests were also used to compare ShortSL during both Baseline and Learning to the first 5 steps of Ret1 and the first 5 steps of Ret2 to determine if subjects were able to retain the learned pattern immediately and 24 hours after Learning.

Results: Seven stroke survivors (69 ±7.6; 4M) have been tested to date. At the end of Learning, subjects walked with significantly longer ShortSL than at Baseline (p=0.004). ShortSL was significantly larger during Ret1 and Ret2 than during Baseline (p=0.016 and p=0.013, respectively). Lastly, ShortSL during Ret1 and Ret2 was not significantly different than the end of Learning (p=0.72 and p=0.13, respectively).

Conclusions: Stroke survivors were able to learn and retain a new walking pattern through an explicit learning paradigm using DVF. This result is surprising given that during rehabilitation patients often have difficulty retaining new walking patterns. The amount of practice (i.e. number of steps) during Learning (x = 416) was greater than what typically occurs during rehabilitation (x = 357), which could explain this difference. Additionally, the feedback provided during this study was highly specific, which is often not the case during rehabilitation.

Clinical Relevance: Stroke survivors were able to learn and retain a new walking pattern during an explicit learning task. The amount of practice and type of feedback provided may be important to promoting the retention of the learned walking pattern.
ABSTRACT BODY:

Purpose/Hypothesis: Stroke is a leading cause of serious long-term disability leading to significant economic and caregiver burden in the United States. Financial, geographic, and personal factors can limit access to rehabilitation services post stroke. In North Carolina, an adult Medicaid beneficiary may have one evaluation visit and three therapy treatment visits per calendar year. Research suggests that the use of intensive task-specific practice promotes functional gains in individuals within the subacute and chronic phase of stroke recovery. This study aimed to examine the impact of a short-term intensive task-specific rehabilitation program on functional outcomes in persons post stroke with limited access to therapy services.

Number of Subjects: 13

Materials/Methods: Participants post-stroke with limited access to rehabilitation services were recruited from the local community to participate in a one-week, intensive stroke rehabilitation program. Thirteen stroke survivors 52.0±14.3 (mean±SD) years of age, 21.3±15.1 months post-stroke, 76.9% male. Type of stroke: 69.2% ischemic and 76.9% left-sided. Participant characteristics: 92.3% used an assistive device, 53.8% used lower extremity bracing, and 46.2% had aphasia. Over 6 consecutive days, 4 hours of assessment, 29 hours of intervention, and 1 hour of education were completed. Interventions included individually tailored mat exercises, gait training, neuromuscular re-education, task-specific upper extremity training, and functional activities. Data collected across two rehabilitation programs was analyzed using a Wilcoxon Signed-Rank Test to determine the significance of the difference between pre and post-treatment outcome values for the following outcome measures: Berg Balance Scale (BBS), Functional Gait Assessment (FGA), 6-Minute Walk Test (6MWT), 10-meter Walk Test (10mWT), Timed Up and Go (TUG) Test, Fugl-Meyer Assessment for Upper Extremity (FMA-UE), Stroke Impact Scale 16 (SIS-16), and Stroke Recovery Scale. Effect size was calculated for each comparison.

Results: Significant differences from pre to post-treatment were found for all outcome measures at follow-up (p<0.05). Large effect sizes were identified in all outcomes measures (range; r=0.55-0.64). The minimal clinically important difference (MCID) was met for 6MWT. The minimal detectable change (MDC) was met for BBS, FGA, and TUG.

Conclusions: Individuals in the subacute and chronic phase of stroke recovery are responsive to a short-term intensive task-specific rehabilitation program. Participants achieved meaningful improvement in walking endurance, balance, and functional gait. Limitations of this study include a small, heterogeneous sample and lack of long-term follow-up data. Further research is needed to determine the retention of functional outcomes after one or more episodes of short-term intensive rehabilitation program.

Clinical Relevance: A short-term intensive task-specific rehabilitation program could be an effective alternative to conventional rehabilitation models for stroke survivors with limited access to therapy services.
Feasibility and Validity of a 3-minute All-Out Treadmill Test for Measuring Critical Velocity in Healthy Adults and Persons with Stroke

Purpose/Hypothesis: Critical velocity (CV) is an individual’s fastest gait speed that is sustainable through aerobic metabolism. This measure could be useful in stroke rehabilitation for assessing the degree to which walking capacity is limited by aerobic deconditioning and for prescribing the intensity of locomotor exercise. Based on previous lower body cycling research among healthy adults, we developed a novel treadmill CV-test involving 3-minutes of all-out effort. This study aimed to: 1) assess the validity of the treadmill CV-test among healthy adults; and 2) evaluate CV-test feasibility post-stroke.

Number of Subjects: Fifteen healthy adults (age, 22.7 +/- 1.2 years; BMI, 25.3 +/- 4.4 kg/m²) and ten adults with stroke (age, 59.8 +/- 6.8 years; 2.4 +/- 1.7 years post-stroke; comfortable gait speed, 0.41 +/- 0.33 m/s; BMI, 30.2 +/- 4.2 kg/m²).

Materials/Methods: Healthy participants performed symptom-limited treadmill graded exercise testing (GXT), then the CV-test, followed by two randomly-ordered 20-minute endurance trials (10% above and below measured CV), all on separate days. CV-test validity was assessed by comparing the sustainability and metabolic responses among the endurance trials and GXT. Participants with stroke attempted the CV-test 15 minutes after a symptom-limited GXT, and repeated the visit 3 times in 4-week intervals. Feasibility was evaluated by CV-test completion and metabolic responses in relation to the GXT.

Results: Healthy participants sustained CV-10% significantly longer than CV+10% (16.4 +/- 3.4 vs 6.7 +/- 3.0 min, p<0.001), with 15/15 (100%) versus 1/15 (7%) participants tolerating >10 minutes. CV-10% had significantly lower peak oxygen consumption and respiratory exchange ratio than the GXT (VO₂, 43.9 +/- 5.5 vs 48.6 +/- 5.5 ml/kg/min, RER, 0.95 +/- 0.05 vs 1.04 +/- 0.06, p<0.001), whereas CV+10% was not significantly different from the GXT (VO₂, 47.4 +/- 5.1 vs 48.6 +/- 5.5, p=0.053; RER, 1.02 +/- 0.05 vs 1.04 +/- 0.06, p=0.59). Participants with stroke completed the CVT (15 minutes post-GXT) on 24/30 (80%) attempts, with no significant peak metabolic differences from the GXT (VO₂, 13.7 +/- 3.6 vs 14.1 +/- 4.1, p=0.24; RER 0.97 +/- 0.09 vs 0.97 +/- 0.07, p=0.77; includes all 30 CV-test attempts).

Conclusions: A novel 3-minute all-out effort treadmill test appears to validly measure critical velocity among healthy adults and seems to be reasonably feasible for ambulatory persons with stroke. In future studies, greater post-GXT recovery time might further improve feasibility.

Clinical Relevance: The CV-test does not require metabolic measurement and has potential utility for diagnosing, monitoring and treating aerobic limitations to walking capacity post-stroke. Future studies are warranted to further assess CV measurement properties in this population.
The effect of transcranial direct current stimulation (tDCS) on improving upper extremity use following a cerebral vascular accident (CVA)

Purpose/Hypothesis: Transcranial direct current stimulation was used as a primer prior to upper extremity circuit training, while a control group received peripheral facilitation via Kinesiotape (KT) prior to the same training. The use of tDCS as a primer was expected to outweigh the benefit of (KT) on the arm during upper extremity circuit training. Specifically, this effect was expected to be demonstrated through all measures along the ICF spectrum, leading to an overall increase in arm usage for the affected upper extremity.

Number of Subjects: Seven chronic post stroke individuals, ranging from 30 to 60 years old were initially matched by functional level (as determined by the Upper Extremity Fugl-Meyer assessment (UEFMA)), and then randomly assigned to either of the 2 groups.

Materials/Methods: A crossover design was used with 7 subjects initially completing one method, and then after a 4 month washout interval, completing the other one (n= 14). Patients wore activity monitors for three days prior to 12 training sessions to establish baseline use of the affected upper extremity. The use of tDCS was applied to the affected pre-motor cortex prior to training, while the control group received kinesiotape to the arm prior to training. Repeated proper placement for each application was ensured with measurements and re-application at each visit. Transcranial direct current protocol: first 20 minutes of the session using parameters of anodal tDCS at an amplitude of 2 milliamperes. After 12 sessions, 2-3 times a week for 4-6 weeks, the subjects again wore activity monitors for 3 days. Additional outcome measures collected pre- and post- training included UEFMA, Wolf Motor Function (WMFT), active range of motion (AROM) of shoulder and elbow, and Stroke Specific Quality of Life Questionnaire (SSQL). Circuit training sessions were based on the principles of task related training and included a minimum of 200 functional movements with the affected upper extremity. All training was performed while standing, much included bilateral activities, and subjects were pushed to work continuously for the 45 minute session.

Results: A 2 (Training Group) x 2 (Pre-/Posttests) ANOVA was used to reveal clinically relevant improvements, with the following findings: main effects for WMFT movement quality (p<.029) and SSQL (p<.007), with interactions by group for WMFT time (p<.028) and elbow AROM (p<.05); indicating improved time to complete tasks and greater elbow extension post training for the tDCS group only. No change was evident for the actigraph findings or the the UEFMA; the latter indicating equal impairments pre-training.

Conclusions: Transcranial direct current stimulation to the affected pre-motor cortex led to improvements in activity and impairment measures. The benefit of the upper extremity circuit training was apparent for both groups according to movement quality and participation.

Clinical Relevance: This study demonstrated the feasibility of using tDCS clinically and in future research, prior to upper extremity circuit training.
Purpose/Hypothesis: About 70% of people with stroke are unable to use their hand in daily life. Most upper limb motor scales for stroke evaluate speed or distance of movements, and allow for compensatory movements, which may lead to secondary complications in joints and muscles. Further, body awareness plays an important role in understanding and improving movement patterns. The “Awareness of Functional tasks with Arm and hand in Stroke” (AFAS) evaluates quality of movement (motor section) and a person’s ability to describe how well the movement was performed (body awareness section). The purpose of this study is to evaluate inter-rater reliability and construct validity of the AFAS scale, functional tasks with the arm subsection.

Number of Subjects: 27

Materials/Methods: We recruited participants with stroke via consecutive sampling through our database from previous research; fliers; and website announcements. Inclusion criteria were: 18-99 years of age; ischemic or hemorrhagic stroke; upper limb hemiplegia; good cognitive function; no severe neglect, aphasia, or apraxia. Inter-rater reliability was tested with intra-class coefficient (ICC) and weighted kappa. Construct (convergent) validity was tested with Spearman correlations between the AFAS ‘motor section’ and the Motor Evaluation Scale for Upper Extremity in Stroke Patients (MESUPES); between the AFAS ‘body awareness section’ and the Multidimensional Assessment of Interoceptive Awareness (MAIA); and between AFAS ‘motor section’ and ‘body awareness section’.

Results: We evaluated 27 adults (mean age 55 ± 13 years, range 25-81; 9 females; 4.79 ± 3.11 years post-stroke; 22 with ischemic brain lesions). AFAS inter-rater reliability was good to excellent (ICC=0.97-0.99; κw=0.69-0.98). AFAS motor section was highly correlated with MESUPES (p=0.96, p<0.0001). There was a fair correlation between AFAS body awareness section and MAIA (p=0.44, p=0.02). The AFAS motor section was moderately correlated with the AFAS body awareness section (p=0.57, p=0.002), strengthening the assumption of the importance of body awareness during movements.

Conclusions: The AFAS scale, functional tasks with the arm subsection, is a reliable scale with excellent construct validity for the ‘motor section’ and fair construct validity for the ‘body awareness section’.

Clinical Relevance: This study demonstrates high inter-rater reliability of the AFAS scale in measuring post-stroke quality of movement and body awareness of the upper limb during functional tasks. We recommend its use in the evaluation of upper extremity functional tasks after stroke.
Purpose/Hypothesis: Evaluate aerobic exercise interventions for stroke survivors that are similar in dosing and activity to cardiac rehabilitation (CR) programs in the United States. The aim is to determine the potential application and efficacy for stroke survivors who remain deconditioned after rehabilitation.

Number of Subjects: 498 stroke survivors across 18 studies with 22 subgroups spanning acute, subacute and chronic stages post-stroke.

Materials/Methods: A review of clinical trials and pilot studies of group exercise interventions with a primary aerobic focus was completed. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were utilized. Searched databases included: PubMed, Web of Science, Cochrane Trials, and CINAHL. References were screened and selected using Covidence software. Included studies had between 18-36 visits over 8-18 weeks to match Medicare guidelines for CR in the U.S. Measures of aerobic capacity included the 6-minute walk test (6MWT), VO2 maximum and walking speed. Pooled effect sizes (ES) (Hedges g) and mean differences (SMD) were calculated for pre to post intervention, and post intervention to follow-up. Comprehensive Analysis Software was used for statistical calculations. Analysis for sensitivity and publication bias was completed. Quality was assessed using the Physiotherapy Evidence Database quality scale for clinical trials.

Results: Walking was the primary aerobic activity with stationary cycle and seated stepping also included. Meta-analysis on ES for improving aerobic capacity pre-post intervention was 0.374 (p<0.0001) indicating a small positive effect (0.2 to 0.5). When comparing the post-intervention to follow-up ES, less data were available with no statistically significant change; the ES was -0.149 (p=0.116). The 6MWT meta-analysis results demonstrated a mean gain of 38.87m (8.34) for initial 6MWT of <300m and a mean gain of 83.48m (20.25) for initial 6MWT > 300m.

Conclusions: Stroke survivors improved their aerobic and walking capacity with identified aerobic programs. The 6MWT improves greater than minimal clinical important distance of 34.4m regardless of aerobic intervention type or time since stroke. Results suggest larger gains for those with better initial 6MWT. Follow-up data were inconclusive; more research is required to determine maintenance of gains.

Clinical Relevance: Despite heterogenous sample and type of aerobic activity, all stroke survivors improved their aerobic capacity suggesting a positive influence of aerobic programs for all stroke survivors. Applying aerobic exercise for those with better initial 6MWT performance may lead to more impact on capacity. Stroke survivors with lower initial capacity, however, have potential to increase walking capacity in clinically meaningful ways, advancing from household/limited community ambulators to unlimited community ambulators. Physical therapists should consider referral to multi-disciplinary aerobic programs such as CR as part of post-rehabilitation or wellness plans for stroke survivors.
Purpose/Hypothesis: Stroke is one of the leading causes of morbidity & mortality in the USA. Many survivors are left with deficits in mobility, ADL & are vulnerable to falls & readmissions. Early identification of next level of rehabilitative care & use of standardized outcome measures are key aspects of national stroke guidelines. The AM-PAC ‘6 clicks’ Mobility & ADL short forms are valid & reliable for predicting discharge destinations (DD) to home vs. further inpatient rehab in a mixed acute hospital population. The purpose of our study was to retrospectively evaluate the utility of the 6 Clicks in an acute stroke population to determine next level of rehabilitative care.

Number of Subjects: We conducted a retrospective EMR analysis of 811 adults admitted to New York-Presbyterian Hospital's Stroke Service for 2015 and 2016.

Materials/Methods: Included patients (pts) were seen at least once by PT or OT & discharged (d/c) to either home, acute inpatient rehab (IRF) or subacute rehab (SNF). Demographic data, type of stroke, length of hospital stay (LOS), initial scaled 6 Clicks Mobility & ADL scores, & actual DD were extracted. Data for 2015 & 2016 were merged as no significant differences for age/LOS were found. Means & standard deviations (X(sd)) were calculated based on DD. Statistics included One-way ANOVAs on age, LOS & 6 clicks data with post-hoc analyses (Tukey) to determine DD differences; Receiver Operating Curves (ROCs) were run on 6 Clicks data for d/c home vs. further inpatient rehab and IRF vs. SNF to determine area under the curve (AUC) and cutoff scores.

Results: Pts d/c to home (65.51(16.83)) or IRF (65.60(13.86)) were younger than those d/c to SNF (76.34(12.47);p<.001). LOS was different between all 3 DD; with home (5.13 (6.67)) greater than IRF (11.30(9.63);p<.001) which was greater than SNF (14.49(20.08);p<.007). Both 6 Clicks Mobility & ADL scores were different between all three DDs (p<.0001). 6 Clicks Mobility scores for those pts d/c home (46.09(9.52)) were greater than pts d/c IRF (36.36 (6.00);p<.001) which were greater than those pts d/c SNF (33.21(7.43);p<.001); ADL scores followed the same pattern (p<.001). Cutoff values for Mobility (44.5) & ADL (35.4) were good indicators for d/c home vs. further inpatient rehab and IRF vs. SNF to determine area under the curve (AUC) and cutoff scores.

Conclusions: Initial 6 Clicks Mobility & ADL scores distinguish discharge destination for pts with acute stroke. There were differences between all three discharge destinations for both Mobility & ADL scores. Cutoffs scores were identified for d/c home & appear higher than those published in a mixed population. Initial 6 Clicks Mobility & ADL scores are useful in discharge destination planning to determine next level of rehab care for pts after acute stroke. These scores should be used in conjunction with other factors to help guide decision making.
The Effect of Transcranial Direct Current Stimulation on Lower Extremity Motor Tasks When Delivered with Two Different Electrode Montages.

Purpose/Hypothesis: Transcranial direct current stimulation (tDCS) is a non-invasive neuromodulatory technique that can alter resting membrane potentials within the cerebral cortex. The majority of studies regarding tDCS, focus on its effect on upper extremity (UE) function. As the lower extremity (LE) motor cortex is located in midline and deeper, more research is needed to investigate the best methods for delivering tDCS to this area of the brain. This study examined the effect of tDCS delivered with two different electrode montages (M1-SO and C1-C2) on the performance of LE motor tasks. The purpose of this study was to test the hypotheses that 1) ankle torque production will increase after tDCS compared to sham, 2) performance on an ankle-tracking task will improve after tDCS compared to sham, and 3) investigate if one electrode montage is superior.

Number of Subjects: 20; 13 female and 7 male, 19 - 31 years old

Materials/Methods: Using a repeated measure within subject design where the order of the trials was randomized and separated by at least one week, subjects received tDCS at C1-C2, M1-SO, and sham stimulation. TDCS was delivered using a Life Tech®, Ionotophor PM Delux constant current stimulator with carbon rubber electrodes and EEG paste as the conductive medium. For the active conditions, stimulation lasted 15 minutes at 2.0mA, and sham tDCS was performed for 15 minutes with a 2.0 mA ramp up for the first 30 seconds, and then dropped to 0.0 mA. For the C1-C2 montage the anode was placed over C2 (based on the international 10-20 EEG system) and the cathode was placed at C1. For the M1-SO montage and sham conditions the anode was placed over C2 and the cathode was placed supraorbitally over the left eye. Ankle dorsiflexion/plantarflexion isometric and isokinetic strength testing was completed before and after tDCS using a Biodex model 840-140. Performance on an ankle-tracking task was assessed before and after tDCS using custom written LabView program, which provided biofeedback as the subject dorsiflexed or plantarflexed their foot attempting to match the joint angle with a computer generated sinusoidal wave.

Results: Repeated measure ANOVA analyses revealed no significant difference (p>0.05) between pre and post testing nor between active tDCS conditions and sham stimulation for all dependent variables.

Conclusions: Modeling of current flow has predicted both C1-C2 and M1-SO montages yield current penetration at the LE motor cortex, and data from UE research has shown tDCS to result in changes in cortical excitability and enhanced motor function. However, in this study, there was no evidence of an impact of tDCS on lower extremity motor tasks. Based on these results, it is recommended that other stimulation parameters for tDCS of the lower extremity be explored. Additionally, it may be that practice of the motor task during stimulation is required to demonstrate measurable changes in motor outcomes.

Clinical Relevance: Additional research is recommended prior to clinical use of tDCS for influencing LE motor function.
Purpose/Hypothesis: In individuals with chronic severe hemiparetic stroke, reaching function is impaired due, in part, to loss of independent joint control. Additional impairments may include weakness, flexor spasticity, and passive elbow extension range. The predictive capacity of these impairments has not been examined in the same cohort. Describing independent contributions to reaching function will inform clinical practice and support the prescription of targeted restorative interventions. The objective of this interim analysis is to determine the continuation status of a methodologically complex multiple regression study evaluating the predictive capacity of several quantitatively measured impairments on reaching function.

Number of Subjects: 20

Materials/Methods: All participants (13 males; 58.0 ± 10.6 years old; 11.5 ± 6.7 years post-stroke; 28.4 ± 8.0 Fugl-Meyer score) provided consent and completed the study that was approved by the IRB. Reaching function was measured using a robotic device and defined as maximum planar reaching distance to an outward target against gravity. The target was at shoulder height, near end range, and standardized by joint configuration. Five impairments were quantified using kinematic/kinetic analysis and electromyography including: flexion synergy (emergence and takeover thresholds), normalized strength (elbow extension and shoulder abduction), and spasticity (change in normalized biceps EMG after reaching onset). The sixth impairment, passive elbow extension limitation, was measured using goniometry following stretching and is reported as the degrees short of full extension with overpressure to participant tolerance. Multiple linear regression was utilized to predict reaching function from impairment data.

Results: A non-significant regression equation was found (F(6,5) = 1.54, p = 0.33) with an R^2 of 0.65. Reaching distance (Mean ± SD; 0.73 ± 0.30) was significantly correlated with synergy emergence threshold (0.32 ± 0.25, r = 0.75, p < 0.01), shoulder abduction strength (0.60 ± 0.20, r = 0.38, p = 0.05), and passive elbow extension limitation (7.23° ± 9.71°, r = -0.48, p = 0.02). A subsequent model dropping non-correlated regressors found a significant regression equation (F(3,11) = 5.49, p = 0.02) with an R^2 of 0.60.

Conclusions: The findings of this interim analysis indicate that impairments such as flexor spasticity, synergy takeover threshold, and elbow extension weakness may not contribute to reaching function to the same extent as the synergy emergence threshold, passive elbow extension limitation, and abduction weakness. Expanded investigation is necessary to increase the generalizability of the predictive model and to meet the recommended criteria for multiple regression sampling of 10 participants per regressor.

Clinical Relevance: Identifying the most predictive impairments affecting reaching function will inform stroke rehabilitation by identifying the impairments that should be targeted when attempting to restore reaching function.
Purpose/Hypothesis: Patients with chronic stroke require a timely, properly programmed rehabilitation plan in order to regain motor function. These rehabilitation plans are typically carried out in hospitals and clinics across the country, yet chronic stroke patients located in rural areas have limited access to these rehabilitation plans. Therefore, home-based robotic interventions may be helpful to increase access to rehabilitation for this population. The purpose of this literature search is to determine if home-based robotic therapy can lead to improvements in upper extremity function in patients with chronic stroke.

Number of Subjects: 5 studies were included. In total, 143 subjects (88 M/55F) were included across studies. The average age of the subjects ranged from 52 to 63 years old. All five studies included both genders. Subject characteristics included chronic stroke and a baseline severity determined by the Fugl-Meyer or NIHSS/FIM (Housley et al.). Chronicity ranged from 4 months to 84 months post-stroke. Fugl-Meyer scores ranged from 22-37.

Materials/Methods: The databases PEDro, PubMed, and CINAHL were searched using a combination of the following key terms: stroke, home-based, home-based therapy, and upper limb. Five studies met the following inclusion criteria: chronic stroke, upper extremity function, and home-based interventions; and exclusion criteria: case studies, studies with interventions not meeting our definition of a robot, and studies lacking home-based interventions.

Results: Each of the five studies demonstrated small statistically significant improvements at the impairment level. Although the cohort studies indicated statistically significant improvements in motor function from pre-test to post-test, Wolf et al. found no significant differences between the home-based robotic therapy and home exercise program.

Conclusions: There is a small body of evidence supporting feasibility of home-based robotic therapy targeting upper extremity function in adults with chronic stroke. Future studies need to perform controlled experiments to determine how home-based robotics compare to traditional stroke rehabilitation performed on site in clinic.

Clinical Relevance: The findings of this literature suggest that home-based robotic therapy may be a viable and feasible option for clinicians as a means of providing physical rehabilitation to persons with chronic stroke and upper extremity motor dysfunction.
Aerobic Exercise to Assess Cerebrovascular Regulation in Stroke: A Potential “Brain Exercise Stress Test”

Purpose/Hypothesis: Current exercise recommendations emphasize the need for people post-stroke to regularly engage in aerobic exercise. Moderate intensity exercise has been shown to improve walking performance and aerobic fitness. However, little is known about cerebrovascular regulation during exercise after stroke. The purpose of this study was to examine whether cerebrovascular regulation is impaired when comparing the stroke affected and the non-stroke affected middle cerebral artery (MCA). We compared the stroke affected MCA to adults without history of stroke or neurologic disease.

Number of Subjects: Twenty-one participants completed the experimental protocol. Seven participants (age: 59.0 ± 9.1 years) were 3 months post MCA stroke and 14 age- and sex-matched adults (age: 59 ± 9.4 years, p=1.0) without history of stroke or neurologic disease were used as control participants.

Materials/Methods: Participants were instrumented with the following equipment: transcranial Doppler ultrasound and beat-to-beat mean arterial blood pressure cuff placed on the middle finger and ECG. Data was acquired through an analog-to-digital data acquisition unit and custom written software. After a 20-minute rest period, recording began with 90 seconds of rest followed by 6 minutes of moderate intensity exercise (45-55% of heart rate range). The exercise bout was performed on a recumbent stepper (legs only). Outcome measures: Baseline (BL) MCA velocity (MCAv), Amplitude (Amp) of the exercise stimulus on MCAv and MCAv during steady state exercise (cerebrovascular response, CVR).

Results: We found that BL MCAv was significantly lower for the stroke affected side (p = 0.03) while Amp (p = 0.31) and CVR (p=0.19) were not significantly different. When comparing the stroke affected MCA to the control participants, we found BL values were not significantly different (MCA stroke: 46.0 ± 11.7 cm/sec vs control: 48.4 ± 8.4 cm/sec, p = 0.61). However, significant differences were revealed during the response from rest to moderate intensity exercise for Amp (MCA stroke: 5.4 ± 3.7 cm/sec vs control: 10.6 ± 4.7 cm/sec, p=0.02), and CVR (MCA stroke: 51.6 ± 4.1 cm/sec vs control: 58.9 ± 4.6 cm/sec, p=0.03).

Conclusions: Our preliminary results suggest that the exercise response is similar between bilateral MCAv at 3 months post-stroke. However, when compared to control participants matched for age and sex, the stroke participants have a lower cerebrovascular response to moderate intensity exercise. Our ongoing study will examine a follow up at 6 months post-stroke.

Clinical Relevance: As physical therapists, we recommend exercise and physical activity to our patients following stroke. There is increased interest in using high intensity interval training to facilitate stroke recovery. We believe that assessing the cerebrovascular response to an acute bout of exercise and pre/post intervention has merit in the overall assessment of brain health for stroke patients.
Purpose/Hypothesis: To investigate whether individuals with significant errors in motor perception of torque production would also exhibit deficits in neuronal connectivity within the corpus callosum.

Number of Subjects: Stroke (6): age 60 ± 7.6 years, 8.8 ± 3.3 years since stroke, five males one female, Fugl-Meyer score 25.5 ± 12.2, lesions in the internal capsule, basal ganglia and thalamus. Controls (4): age 64.0 ± 3.6 years, three males one female.

Materials/Methods: The participants were scanned on a 3 Tesla Siemens Prisma MRI system to acquire high resolution (1.5 x 1.5 x 1.5 mm³) diffusion-weighted data. Four team members were trained to draw seed points in areas 1-5 of the corpus callosum associated with the following functional cortical areas: I (prefrontal), II (premotor and supplementary motor), III (primary motor), IV (primary sensory), V (parietal, temporal, visual). White matter tractography was performed using Bayesian estimations of the diffusion properties with the BEDPOSTX and PROBTRACTX³. The FMRIB software toolkit was used to generate average estimates of white matter tract volume⁴. The FMRIB software toolkit was used to generate average estimates of white matter tract volume.

Results: The white matter tract volume was calculated for each of the five different areas of the corpus callosum. There is a significant negative correlation between white matter tract volume through areas 3, 4, and 5 and absolute torque error in the non-paretic arm when matching the paretic arm (r = - 0.730, p= 0.017).

Conclusions: The posterior region of the corpus callosum has individual functions in areas 3 (somatosensory), area 4 (auditory) and 5 (visual perception). As the white matter tract volume decreased in areas 3-5 of the posterior region of the corpus callosum, there was a higher absolute torque error in the non-paretic arm.

Clinical Relevance: This biomarker of white matter tract volume has the potential to assess both neural deficits and neuroplasticity in future physical therapy interventions for individuals with stroke. Other regions of interest within the brain for future research could include the thalamus, basal ganglia and internal capsule.
Purpose/Hypothesis: Mirror therapy (MT) is a form of motor imagery that has been recommended as a simple and inexpensive approach to treat individuals with motor dysfunctions including functional impairments of the upper extremity (UE) following stroke. Although most research has shown some improvements in gross motor functions after MT in the acute and subacute phases of stroke, the effects of MT on motor function in the chronic phase of stroke remains unclear. The purpose of this study was to determine the effects of MT on grip strength and functional fine motor movements of the upper extremity (UE) in individuals with chronic stroke. It was hypothesized that visual feedback from the moving non-paretic hand through MT would improve grip strength and fine motor movements of the hemiparetic hand, which in turn would improve hand functions in individuals with chronic stroke.

Number of Subjects: Seven participants with chronic stroke (4 males and 3 females; ages 25-68; 26-66 months post stroke) were recruited from local St. Louis stroke support groups.

Materials/Methods: This study was a time series design A1-B-A2 spanning 12 weeks with each phase lasting 4 weeks. Participants were asked to perform functional exercises for two 30 min sessions/day, 5 x/wk incorporating the mirror box for phases A1 and A2 and without mirror box for phase B. Outcome measures used include grip strength, Motor Activity Log (MAL), Action Research Arm Test (ARAT), and the Nine Hole Peg Test (9HP) to assess hand functions. Data was collected at the two initial visits, at 4 weeks, 8 weeks and 12 weeks. The data from ARAT and MAL were analyzed using the minimal clinical important difference (MCID). The mean and standard deviation (SD) of grip strength and 9HP were calculated by using the six measurements gathered at baseline. The statistical significance was defined as two SD of change from baseline measurements.

Results: At the end of phase A1, significant improvements were noted in grip strength and 9HP while changes in ARAT scores were beyond the MCID from baseline. At the end of phase B, grip strength continued improving significantly for 3 of the 6 participants and for only 1 participant on the 9HP. ARAT scores were either maintained or declined at the end of phase B. At the end of phase A2, all participants demonstrated significant improvements in ARAT, 9HP, and grip strength. Changes in MAL scores showed some improvements at the end of phase A1 and A2.

Conclusions: The results of our study suggested that utilization of MT on the involved UE improved hand functions, especially fine motor functions in individuals with chronic stroke. However, further research with a larger sample size along with a B1-A-B2 comparison group, should be implemented in order to gain further understanding of the effects of MT in terms of improving hemiplegic arm functions.

Clinical Relevance: The results of this study may add some information to the current literature by providing another potential means of intervention to improve hemiplegic arm function in individuals with chronic stroke.
Title: The effects of motor impairment on altered kinematics and muscle synergies during reaching in stroke survivors: Preliminary Report

Current Section: Neurology

Current Sub-Category: Stroke SIG

Authors (First Name, Last Name): Lei Ma1, Christopher Taylor1, Jin-Sook Roh1

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Abstract Body:

Purpose/Hypothesis: Stroke is a major cause of long-term disabilities affecting activities of daily living (ADL). The purpose of this study is to investigate the relationship between motor impairment measured by clinical assessment and movement parameters (MP), and to examine whether motor impairments are associated with the emergence of altered muscle synergies (patterns of muscle activity that flexibly combine to produce functional motor behaviors). We hypothesized that altered muscle synergies are associated with decreased functioning as measured by MP and the Upper Extremity Fugl-Meyer Assessment (FMA-UE) in affected arms post-stroke.

Number of Subjects: Six stroke survivors (SS) with UE deficits with mean age of 56.1 (std 9.2) years; Hand (L=3); Sex (F=3); Stroke onset 8.3 (5.1) years ago. Seventeen young healthy (YH) adults 25.2 (4.3) years; Hand (L=3); Sex (F=8).

Materials/Methods: Participants perform visually guided reaching in horizontal plane, with 16 targets equally spaced on a circumference whose radius is 10 cm. Participants are required to reach to each target (random onset) within 200ms to 350ms of movement initiation to limit feedback control during reaching and maximize surface electromyographic (EMG) activity. FMA-UE is assessed on all SS. Ten EMGs are recorded in the dominant arm of YH and the affected arm of SS. A non-negative matrix factorization is applied to the EMG data to identify motor modules (synergies) during reaching. MP identified are: reaction time, movement distance, peak velocity, and initial movement angle from target. Regression analysis is performed to test the relationship among MP, FMA-UE, and motor modules. Group differences are compared using Mann-Whitney U test, with significance set at 0.05.

Results: Currently, all reaching movements result in one velocity peak in both groups. Initial movement angle from target is significant between groups (p = 0.005), with a R^2 of .89 when the angle deviation acts as a function of FMA-UL in linear model. Synergy analysis demonstrates that six motor modules accounted for over 90% of the variance of the EMG activity recorded during reaching. The similarity of motor modules to control muscle activation tends to be negatively related to FMA-UE in SS group.

Conclusions: Current data differs from previous findings in that processing time and movement distance are not sensitive to detect severity of reaching deficit as expected, and they do not differ between groups. In contrast, SS exhibits increase in initial angular deviation during reaching, and positively correlates with FMA-UE. In addition, SS's initial movement angle tends to deviate the most when reaching towards posterior-lateral directions.

Clinical Relevance: Ongoing results suggest that impaired reaching is more prevailing at the motor execution level for SS. Understanding of how post-stroke motor execution is affected by alterations in muscle activation patterns, in relation to clinical assessments, can better the design of clinical interventions to improve functional arm movements in stroke survivors.
Effects of real-time gait biofeedback regarding limb position versus push-off force generation on post-stroke gait biomechanics

Purpose/Hypothesis: Gait dysfunctions such as reduced paretic push-off and step length asymmetry contribute to reduced speed and increased energy cost of walking in individuals post-stroke. Paretic propulsion, shown to be correlated with gait speed and gait asymmetry, is an important target for post-stroke gait training. Previous studies from our laboratory investigated the short-term effects of real-time biofeedback gait training targeting paretic peak anterior ground reaction force (AGRF). AGRF gait biofeedback training induced increases in both AGRF and trailing limb angle (TLA) of the targeted leg, without modifying the non-targeted limb in able-bodied and post-stroke individuals. TLA measures the antero-posterior orientation of the limb with respect to the body's center of mass at terminal stance, and is an important biomechanical parameter influencing AGRF. The objective of this study was to compare the effects of TLA biofeedback versus AGRF biofeedback on gait biomechanics.

Number of Subjects: 9 able-bodied individuals (Age 25 ± 3.02, 7 females); 6 stroke survivors (3 females, 5 left-sided hemiparesis, Age 64 ± 8.97)

Materials/Methods: Participants completed 1-minute gait trials at their self-selected speed under the following conditions: (1) AGRF biofeedback, (2) TLA biofeedback, and (3) no-biofeedback. Biofeedback trials comprised auditory and visual feedback. Marker position and GRF data were recorded using a 7-camera motion capture system. Dependent variables were peak AGRF and TLA for the paretic (stroke) or targeted leg (able-bodied).

Results: In both able-bodied and stroke participants, paired t-test comparisons revealed that compared to no-biofeedback, each biofeedback condition (TLA and AGRF biofeedback) induced significant increases in targeted/paretic peak AGRF and TLA. No significant differences in peak AGRF and TLA were observed between AGRF and TLA biofeedback. Compared to TLA biofeedback, AGRF biofeedback showed greater specificity in impacting the target limb only without changes in the non-targeted limb.

Conclusions: Both AGRF and TLA biofeedback induced improvements in propulsive force generation in able-bodied and stroke participants. Our results support the use of real-time gait biofeedback as a safe and feasible intervention for independently ambulating stroke survivors. Our future studies on gait biofeedback will investigate long-term training effects and carryover to over ground gait.

Clinical Relevance: Reduced paretic AGRF is an important post-stroke gait deficit shown to be correlated with walking speed, but may not be directly observable in clinical settings. Compared to AGRF, TLA may be an easier gait parameter to observe and measure using wearable sensors, making TLA gait biofeedback more clinically feasible.
Background & Purpose: Patients suffering from basal ganglia stroke are known to display aggressive behavior. Post-stroke anger proneness, including behaviors of hitting, kicking, pushing, and throwing, has been shown in 15-35% of acute stage & 32% subacute stage patients. Research shows that emotional disturbances have negative impacts on patients’ clinical outcomes, however, there is a gap in the literature of how to address such behavior in patients post stroke. Patients with traumatic brain injuries (TBI) presenting with confused-agitated behavior have suggested Ranchos Scale level IV interventions including attention redirection, calm distraction, patient choice, and constant re-orientation that may have carry-over application. The purpose of this case report is to describe the application of Ranchos Scale Level IV interventions for TBI on a 53 y.o. male with behavioral complications post basal ganglia hemorrhagic stroke and the outcomes observed during the course of physical therapy (PT) treatment.

Case Description: A 53-year-old male status post a basal ganglia hemorrhagic stroke was recruited in an inpatient hospital ICU in Fremont, CA. The patient was seen for 15 PT sessions over the course of a 19-day stay.

Outcomes: Aggressive behavior was recorded through subjective reporting and number of defined aggressive displays per PT session. Levels of assist for transfers and gait were measured using the categories outlined by O’Sullivan & Schmitz. Static and dynamic balance was assessed based on the Stanbridge College Grading for Balance Scale, while progression/regression of stroke symptoms were assessed using the National Institutes of Health Stroke Scale (NIHSS). Over the course of 15 PT sessions, NIHSS scores decreased from 17 to 6. Aggressive behavior displays decreased from 6 to 0 during PT sessions, while the patient continued to exhibit aggressive behaviors with other providers. Supine to sit transfers decreased from Moderate Assist (Mod A) to Stand-By Assist (SBA) and sit to stand transfers decreased from a Mod A with front wheel walker (FWW) use to SBA, indicating increased functional mobility. Balance was improved and gait enhanced from 5 feet using Mod A and a FWW, to 500 feet using Contact Guard Assist, showing a significant increase towards patient independence.

Discussion: The application of Ranchos Scale level IV behavioral interventions decreased the number of aggressive outbursts and displays. Functional mobility, balance, and gait distance all improved with adjunct physical therapy treatment. The outcomes of this case series suggests that TBI Ranchos Scale level IV behavioral interventions may be applicable to reduce aggressive behavior is patient who suffer from hemorrhagic strokes. Since emotional disturbances are shown to have negative impact on clinical outcomes, this is a possible important adjunct to physical therapy as a method of establishing safe, positive treatment sessions to achieve the best clinical outcomes.
ABSTRACT BODY:

Purpose/Hypothesis: The stroke-lesioned motor cortex has been reported to have a relatively lower excitability compared to the contralateral motor cortex. Efforts for modulation of cortical excitability to restore the balance in motor cortices has been associated with improved function. Non-invasive brain stimulation has been reported in the recent literature to successfully modulate corticomotor excitability and improve motor function. Transcranial direct current stimulation (tDCS) is a low cost form of non-invasive brain stimulation that has been shown to be able to up-regulate or downregulate cortical excitability. While successful application of tDCS to upper extremity function, neural mechanisms remain unclear and limited studies have examined the effects of tDCS on lower limb motor corticospinal excitability and function. The purpose of this study is to examine the effects of cathodal tDCS over the contralesional motor cortex combined with isometric ankle dorsiflexion on motor cortical excitability of paretic tibialis anterior muscle and walking function.

Number of Subjects: Four individuals with chronic post-stroke hemiparesis (age: 63.5 ± 9.04 years; time post stroke: 2.375±0.75 years) participated in this study.

Materials/Methods: Each participant attended 2 data collection sessions with at least 14 days inbetween. Each session consisted of 20 minutes of isometric dorsiflexions combined with either a cathodal or sham tDCS. Corticomotor excitability was assessed prior to and following tDCS application by eliciting motor evoked potentials (MEP) using transcranial magnetic stimulation and frameless stereotaxy neuronavigation system. Gait function was assessed prior to and following tDCS application.

Results: Following 20 minutes of cathodal tDCS application combined with isometric dorsiflexions, we observed increased corticomotor excitability as measured by the MEP (p=0.03) but not with sham stimulations (p>0.05). For the resting motor threshold, although it did not reach statistical significance, there was a trend towards lower resting motor threshold following cathodal but not sham tDCS. We did not observe a statistically significant change with timed up and go test performance, step legth, stride length, gait velocity and cadence following both cathodal and sham tDCS.

Conclusions: Single session of cathodal tDCS over the contralesional motor cortex paired with isometric ankle dorsiflexion resulted in increased ipsilesional corticospinal excitability as measured by MEP of the paretic TA muscle.

Clinical Relevance: Findings from the study provide a scientific basis for examining whether non-invasive brain stimulation paired with a simple single joint task improves walking function in individuals with post-stroke hemiparesis. This potentially benefits chronic stroke patients with limited ambulatory capabilities.
Background & Purpose: Following a cerebral vascular accident (CVA), people often have significant functional disability associated with impaired motor function. Decreased joint proprioceptor activity and overall detection of position sense may also contribute to a reduction in motor function and balance status post CVA. Joint compression is known to increase proprioceptor input and position sense. Thus, plyometric training may help improve proprioception and motor function in people status post CVA via utilization of a person's body weight to self-impose joint compression. However, the safety, feasibility, and potential benefit of plyometric training for people status post CVA is not well understood. The purpose of this case series is to describe the administration of plyometric training and outcomes in 4 patients status post CVA.

Case Description: All persons upon initial evaluation presented with a national institute of health stroke scale (NIHSS) of 7 or less. Participating patients were as follows: a 60 year old male 1.5 years following ischemic CVA, a 29 year old male 1.5 years following a hemorrhagic CVA, a 34 year old female 2 weeks following a hemorrhagic CVA, a 46 y/o male 2 weeks following an ischemic CVA. All patients expressed that they were highly active prior to injury. Patients were selected to participate based on prior experience with plyometric training, rapid improvement in force production deficits while sensory detection deficits persisted, sufficient cardiopulmonary endurance, as well as the absence of any contraindicative factors to standard plyometric training. The mini Balance System Evaluation Test (BEST) and single leg stance time (SLS) of the affected limb were scored at evaluation, 10th, and 20th PT visit.

Outcomes: All patients achieved clinically important improvements in balance and functional mobility. SLS time improved from a mean of 2 seconds at evaluation to a mean of 30 seconds at the 20th visit. Mini BEST scores improved from a mean of 17.5 to 26 by 20th visit. Within the 20 visits of treatment all patients had at least one lower extremity that was in age matched healthy normative data for SLS.

Discussion: All patients experienced improvement with plyometric training intervention, but the 2 most acute patients demonstrated the greatest improvement. Given that these patients received early intervention, it is possible that early introduction of plyometric training enhanced neuroplasticity and recovery. Once force production deficits are resolved, this type of treatment program may aid to improve joint proprioception, motor function, and balance. While these results suggest that plyometric training is safe and beneficial in high functioning individuals status post CVA, further research is warranted on the safety and potential health benefits of this type of training.
Title: Improving and maintaining therapist compliance of using standardized outcome measures in patients post-stroke: a multidisciplinary quality improvement project

Current Section: Neurology

Current Sub-CATEGORY: Stroke SIG

Authors (First Name, Last Name): Nicole K. Biltz¹, Jonathan Wood¹, Jessica Wilchinski¹

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Abstract Body:

Purpose/Hypothesis: The purpose of this project was to implement a standardized battery of outcome measure assessments in patients post-stroke across allied health disciplines and to improve then maintain compliance documenting selected outcome measures.

Number of Subjects: Eleven physical therapists (PTs), three occupational therapists (OTs), and three speech-language pathologists (SLPs) working in a hospital-based outpatient clinic were educated on the chosen standardized measures. A total of 406 patient encounters were audited over 13 months among all disciplines (PT 37.7%, OT 33.7%, SLP 28.6%) including initial evaluations (43.1%) and monthly progress notes (56.9%).

Materials/Methods: Prior to implementation, representatives from PT, OT, and SLP selected valid and reliable outcome measures based on the documents from the StrokEDGE taskforce² and feasibility. All therapists were trained and checked off by a clinician in their respective fields through in-services and competencies. The outcomes for PT included Two-Minute Walk Test, 10-Meter Walk Test, Five Times Sit-to-Stand, Timed Up and Go, Stroke Impact Scale-16 (SIS-16), and Activity Measures for Post Acute Care (AM-PAC) Basic Mobility. Outcomes for OT included Action Research Arm Test, Modified Ashworth Scale, SIS-16, and AM-PAC Daily Activity. SLP outcomes included the Eating Assessment Tool-10 and AM-PAC Applied Cognitive. A compliance goal of 90% was established after five months. At month seven, all clinicians were provided with a refresher regarding expectations and tips to improve compliance, and support staff was retrained on providing patient-report outcome measures at evaluation. Additionally, monthly email reminders and data updates were utilized each month to maintain compliance.¹,⁶

Results: There was an upward trend of compliance across all disciplines from month one to month 13 for evaluations (+32.48%) and progress notes (+32.86%). At month 10, the 90% compliance goal was met and exceeded by each discipline: PT 90.63%, OT 94.87%, and SLP 100.0%. During the maintenance phase from month 10 to month 13, compliance was on average >90% for PT and OT, and approximately 85% for SLP.

Conclusions: Over the course of thirteen months, a multidisciplinary quality improvement project targeting therapist compliance performing specific outcome measures was established. Improvement and maintenance of compliance was accomplished by intermittent education to all clinicians and support staff, monthly reminders, and methods to increase ease of collecting outcomes.

Clinical Relevance: The use of valid and reliable outcome measures in clinical settings is an important part of evidence-based practice.³-⁵ Standardizing these outcomes in a specific patient population may be helpful for guiding treatment plans and tracking patient progress. This can demonstrate the effectiveness of treatment to ultimately guide discharge planning and reduce the number of unnecessary therapy visits.⁴,⁵
Purpose/Hypothesis: A long-duration, comprehensive stroke neurorehabilitation program is beneficial, feasible, and safe for chronic stroke survivors.

Number of Subjects: 5

Materials/Methods: Five chronic stroke participants (>6 months post-stroke) received the outpatient neurorehabilitation program, “Safety, Functional Outcomes, and Recovery after Stroke (SOARS)”, in two phases: months 1-6 were 5 days/wk; months 7-12 were 3 days/wk. Sessions were 1-2.5 hours in duration. Treatment included balance and strength training 3 days/wk, gait coordination training daily, and moderate intensity aerobic cycling 2 days/wk for 45 min/day. Outcome measures included 6 Minute Walk Test (6MWT), gait speed, Berg Balance Scale (BBS), Fugl-Meyer-Lower Extremity (FM-LE), Timed Up and Go (TUG), Functional Independence Measure (FIM), the Craig Handicap Assessment and Reporting Technique (CHART), and attendance. Pre-/post-treatment comparisons were made using the nonparametric permutation test (i.e. randomization test). Effect sizes (ES) were computed by mean(d)/sd(d), where d is the change from baseline to 12 months and sd is the standard deviation. Descriptive statistics compared outcomes to established minimal clinically important difference (MCID) and minimal detectable change (MDC) scores.

Results: There was statistically significant improvement in all measures: 6MWT, 223 ft (p=0.018, ES=0.75); BBS, 9.0 points (p=0.001, ES=1.29); FM-LE, 6.0 points (p=0.002, ES=2.45); Gait Speed, 0.38 m/s (p=0.001, ES=1.24); TUG, 10.8 sec (p=0.043, ES=1.82); FIM, 7.4 points (p<0.001, ES=0.98); and CHART, 41.0 points (p=0.025, ES=0.86). Further, clinically significant gain was ~2x the MCID for 6MWT (113 ft) and >2x the MCID for gait speed (0.16 m/s). Both participants with baseline BBS below 45/56 (a threshold for functional independence in chronic stroke), exceeded this score by study end; 60% of participants transitioned to a higher ambulatory category. TUG improvement was >3x the MDC (3.16 sec). All participants exceeded the CHART stroke norms in the domains of Physical Independence, Cognitive Independence, Mobility, Occupation, and Social Integration. Average attendance was 75.52 +/- 6.04%, indicating feasibility of participation in the neurorehabilitation program. There were no study-related adverse events.

Conclusions: The SOARS program was safe and feasible for chronic stroke survivors. Participation produced clinically and statistically significant functional and quality of life improvements, providing evidence that chronic stroke survivors are capable of significant recovery, even long after the stroke. Further research is needed to elucidate comprehensive neurorehabilitation treatment parameters in larger chronic stroke populations to optimize the efficiency of recovery.

Clinical Relevance: Chronic stroke survivors have the potential to make clinically significant functional recovery and quality of life improvements given sufficient neurorehabilitation intensity and duration. Study results support the need for insurance coverage for neurorehabilitation in the chronic phase.
Background & Purpose: A subset of patients with severe brain injury may develop paroxysmal sympathetic hyperactivity (PSH), a maladaptive hyperadrenergic syndrome presenting as tachycardia, hypertension, tachypnea, and posturing. This is especially problematic in patients with intracerebral hemorrhage as labile blood pressures (BPs) could contribute to early rebleeding. Such safety concerns often exclude these patients from standard early mobility practices thus exposing them to the risks of prolonged bedrest. We describe the use of a tilt table as a progressive mobilization intervention in a patient experiencing PSH after a large intracerebral hemorrhage with herniation.

Case Description: A 51-year-old man was admitted to the Neuroscience Critical Care Unit (NCCU) with an 8.2 x 5.3 x 3.8 cm left basal ganglia ICH with subsequent herniation requiring emergent decompressive surgery. Bed mobility and sitting activities were poorly tolerated due to episodes of PSH which occurred with tactile stimuli or sudden positional changes. This occurred despite gradual introduction of external auditory and tactile stimuli, premedication with antihypertensive medications, and administration of analgesic medications in advance of mobility sessions. We hypothesized that a tilt table to achieve incremental verticalization would be an effective strategy to overcome PSH. Thus we closely monitored the patient’s hemodynamic and neurological status during progressive position changes with increased verticalization at a rate of 15 degrees every 5 minutes.

Outcomes: Six trials of mobility were performed without the tilt table. During these sessions, supine to sit was achieved with an average supported sitting time of 4 minutes. His BP increased from a mean of 146/74 mmHg in supine to 213/116 mmHg when sitting and heart rate (HR) range from 73-110 over three sessions. He subsequently underwent three sessions using a tilt table, with an average of 22 minutes in 15-90 degrees of tilt. During tilt table verticalization, his BP was less variable (mean 149/94 mmHg in supine and 147/90 mmHg when upright) when compared to non-incremental. He also did not demonstrate posturing and was more alert (GCS range: 6-12). His HR was still variable during the verticalization sessions (86-162). During the most successful session, he tolerated weight bearing for 10 minutes at 70 degrees tilt.

Discussion: This case illustrates the challenges of mobilizing patients with PSH after ICH. BP control is a management priority in patients with ICH, and mobility is important to restoring function and improving outcomes. Incremental verticalization with a tilt table may be an effective technique in patients who require more gradual sensitization to upright posture. In this case, the therapist titrated the degree of tilt based on patient tolerance. This allowed enough time for the patient to acclimate to the new position and maximized the possible benefit of therapy. The tilt table may be a useful strategy to reduce positional sympathetic responses and therefore limit bedrest for patients with PSH.
Title: Effect of Reactive Lateral Step Treadmill Training on Reactive Paretic Limb Step Parameters in Chronic Stroke

Abstract Body:

Purpose/Hypothesis: Stroke survivors (SS) tend not to respond to perturbations using paretic limb (PL) steps. The purpose of this study was to determine the effectiveness of reactive lateral step treadmill training (RLSTT) on PL reactive stepping in SS. We hypothesized that RLSTT would increase the frequency, decrease the reaction time and increase the velocity of initial reactive PL steps in response to lateral perturbations and decrease the time on the Four Square Step Test (FSST).

Number of Subjects: Three community-dwelling chronic (>6 months) SS (59-82 y/o). (S1-S3)

Materials/Methods: Training consisted of 6 RLSTT sessions (80 trials). Subjects were instructed to stand perpendicular to the treadmill belt direction with equal weight on both legs with PL nearest the front of the treadmill. Subjects were instructed to initiate stepping with PL to maintain their position on the treadmill, while simultaneously participating in a dual task word game as the treadmill was randomly turned on for 3 seconds at a speed of 0.7 mph and acceleration of 0.25 m/s². Treadmill acceleration was increased by 0.25 m/s² after 10 consecutive successful trials. Success was defined as an initial PL lateral step without external support. Pre-post treadmill testing consisted of 40 trials with the treadmill belt accelerated (0.25m/s²) randomly in either direction. Subjects were instructed to respond such that they remained in the center of treadmill. Pre-post waist pull perturbations consisted of 7 lateral waist pulls (8% body weight) in each direction. Subjects were instructed to stand with equal weight on both legs on two separate force plates and to respond naturally to the pull. Kinematic and force plate data was collected. The FSST was administered pre-post.

Results: Training Sessions Progression: S1 progressed to 1.0 m/s² treadmill acceleration; S2 progressed to 3.0 m/s²; S3 remained at 0.25 m/s². Treadmill test: Use of PL for initial lateral reactive steps increased from 10% to 90% for S1, 50% to 100% for S2, and 0% to 20% for S3. Reactive waist pull test: S1: Use of initial PL lateral step increased from 20% to 80%, step reaction time was faster by 40 ms, and step velocity was faster by 0.97 m/s. S2: Used 100% initial PL lateral steps pre/post and demonstrated no change in step reaction time or step velocity. S3: Use of initial PL lateral steps increased from 0 to 40%. FSST: S1 improved by 12.38 s and S3 improved by 2.32 s. S2’s time did not change.

Conclusions: RLSTT was associated with an increased tendency to initiate reactive stepping with the PL in response to treadmill and waist pull perturbations in SS. An increased willingness to take a PL lateral reactive step may explain the decreased FSST times. The largest improvement in FSST for S1 may be related to the faster reaction time and step velocity post training.

Clinical Relevance: RLSTT is a clinically feasible method to appropriately challenge balance and facilitate PL reactive lateral stepping in SS. RLSTT may be best applied to SS with a decreased tendency to execute a PL lateral step to a lateral perturbation.
Purpose/Hypothesis: Robot-assisted ankle rehabilitation (RAAR) has been shown to improve ankle function and locomotor ability in stroke survivors. However, the underlying mechanisms are poorly understood, and the magnitude of recovery observed is not complete. Transcranial direct cortical stimulation (tDCS), a non-invasive neuromodulatory technique, when paired with motor training enhances corticospinal excitability and improves motor performance in healthy individuals and stroke survivors. The purpose of the study was to determine the effects of RAAR delivered alone or in combination with tDCS on corticospinal excitability in chronic stroke survivors as measured by volitional activation of the tibialis anterior muscle on the hemiparetic lower extremity. We hypothesized that a single session of RAAR in chronic stroke survivors will increase corticospinal connectivity, and this effect will be increased when performed in combination with tDCS.

Number of Subjects: 9 chronic stroke survivors participated in the study.

Materials/Methods: In this within-group pilot study, all participants completed the following 3 sessions in random order, separated by at least one week, but less than three weeks apart: Session 1: RAAR session combined with 15 minutes of tDCS (RAAR+tDCS). Session 2: 15 minute RAAR session combined with 15 minutes of sham tDCS (RAAR+sham tDCS). Session 3: 15 minutes of sitting quietly (control). Tibialis anterior (TA) motor vepked potential was assessed before and after each 15-minute session using transcranial magnetic stimulation (TMS). The amplitude of the paretic tibialis anterior MEP was plotted at different intensities of stimulation to create a recruitment curve. The slope of the recruitment curves were calculated and compared pre and post session and across conditions. Friedman’s ANOVAs with Dunn’s Post Hoc were performed. The alpha level was set at .05.

Results: Statistical analysis revealed no significant differences, however, some interesting trends were observed. In the paretic limb the RAAR+tDCS and RAAR+sham tDCS demonstrated a positive change in slope amplitude, while control showed a negative change. In addition, the average change during the RAAR+tDCS session was over 3 times greater than the change observed during the RAAR+sham tDCS session.

Conclusions: Overall the data trends suggest that a single session of robot-assisted ankle rehabilitation delivered alone or in combination with transcranial direct cortical stimulation promotes enhancement of corticospinal tract excitability. This enhancement appears to be greatest when both interventions were delivered. The duration of this enhancement is not known. The effects of multiple sessions, are also not known.

Clinical Relevance: Enhanced corticospinal tract excitability may be an underlying mechanism for RAAR and tDCS induced improvements in function in stroke survivors. Combining training with tDCS may promote greater physiological changes compared to training alone.
Purpose/Hypothesis: Physiological complexity of gait, a measure of the interaction of multiple control mechanisms for walking, is decreased in persons with chronic stroke compared to those without disability. The primary purpose of this study is to determine if physiological complexity of gait changes over the first six months post stroke within the contemporary healthcare environment. The secondary purpose was to explore the relationships of changes in complexity to changes in walking speed.

Number of Subjects: Fifty individuals within one month of ischemic stroke (19 males; 27 with left hemiparesis; mean age 57.2 SD 14.1; median days post stroke 15.0 IQR 13.0; lower extremity Fugl-Meyer score 25.0 IQR 5.0) participated in this prospective longitudinal study.

Materials/Methods: Testing was completed within one month (baseline) and at three and six months post stroke. During each testing session participants completed a comfortable 10-meter walk test and a 2-minute continuous walking task at their preferred pace on a level, indoor surface while wearing wireless inertial measurement units (IMUs) on each lower extremity segment (foot, shank and thigh) and pelvis. Walking tests were completed with their preferred assistive device (no device, cane or walker). If the preferred device changed at follow-up sessions, then walking tests were conducted with the original baseline device, as well as the current preferred device. Multivariate multiscale entropy was calculated from the tri-axial accelerometer signals from the IMUs and converted to a complexity index for each leg segment and pelvis for analysis.

Results: Thirty-seven participants returned for follow-up testing and were included in the analysis. Significant increases in median complexity indices were found across time in all paretic and non-paretic segments and the pelvis (p<.001). Post hoc analysis indicated significant increases in median complexity indices between each time period (base to 3 and 6 months and 3 months to 6 months) across all segments and pelvis (p<.001), except for the non-paretic thigh and pelvis from base to 3 months (p>.017). Results did not differ whether using the preferred device or baseline device overtime. Walking speed only increased significantly from baseline to 3 and 6 months using a preferred device (p<.001). Changes in walking speed were not related to changes in complexity across most time periods and segments.

Conclusions: This group with stroke demonstrated significant increases in physiological complexity of gait that continued for six months after stroke. As higher complexity is associated with lack of disease, the improvements shown by this group with stroke over time signify a change towards more normal movement and an improved ability to adapt to everyday environmental stresses. The improvements in complexity of gait indicate a positive change in function, not distinctly related to changes in gait speed.

Clinical Relevance: Adaptation of gait function continued for 6 months, despite few participants receiving physical therapy beyond 3 months post stroke.
Assessing Dual-Task Performance and Characterizing Task Prioritization Strategy in Individuals Post-Stroke.

Purpose/Hypothesis: Functional walking requires individuals to perform concurrent tasks, such as walking while talking or planning another action. The act of performing two concurrent tasks with distinct objectives is referred to as dual-tasking, and unsuccessful dual-task behavior has been linked to fall risk, both in healthy older adults (Beauchet et al., 2009) and individuals with neurologic conditions (Baetens et al., 2013). The characterization of dual-task behavior has not been fully examined in individuals post-stroke, therefore, we carried out this study to: 1) compare performance between walking (single-task 1), serial 7 subtractions (single-task 2), and walking while performing a cognitive task (dual-task); and 2) characterize task prioritization in individuals post-stroke.

Number of Subjects: 14

Materials/Methods: Fourteen subjects fulfilled the following criteria: diagnosis of ischemic or hemorrhagic stroke, Modified Rankin Score of <4, sedentary prior to stroke, ability to walk ≥10 meters with or without assistance. Participants were fitted with a sensor based analysis system (Mobility Lab APDM, Inc) and performed the following tasks: a 90-second walk test (single task 1), serial 7 subtractions (single task 2) and walking while performing serial 7 subtractions (dual-task). Accuracy was computed for the serial subtraction task and dual-task cost (i.e., performance decrements resulting from performing two tasks concurrently) was calculated using the following formula: (Dual Task - Single Task)/Single Task X100. Paired t-tests were utilized to make comparisons between the single-task conditions and dual-task conditions. Statistical significance was set at p<0.05.

Results: There was no statistically significant difference between serial 7 subtraction accuracy between single and dual-task conditions (percentage of correct responses [p=0.251], correct responses rate [p=0.075], or the overall response rate [p=0.134]). There was a statistically significant difference on walking performance between single and dual-task conditions (stride velocity [p=0.020], mean stride length [p=0.032], and mean cadence [p=0.009]), with performance showing decrements in the dual-task condition.

Conclusions: Our results suggest that in the comparison between the single and dual-tasks employed in the present study, individuals post-stroke show greater deterioration of walking performance compared to cognitive performance, perhaps suggesting a prioritization of cognitive tasks over walking. Specifically, decrements were noted in stride velocity, stride length and cadence.

Clinical Relevance: The study results highlights specific deficits in dual-task performance that are relevant for fall risk and prevention in individuals post-stroke. This information can be meaningful for the design of strategies for the retraining of walking and fall risk prevention in individuals post-stroke.
Purpose/Hypothesis: Rhythmic auditory stimulation (RAS) is used to facilitate a more symmetric gait pattern using an audible cue created by a metronome or a musical beat. The literature indicates that RAS improves walking ability after stroke. However, the effect of RAS on gait symmetry has not been thoroughly investigated. Thus, the purpose of this systematic review was to identify if RAS could improve temporospatial gait symmetry in individuals with stroke.

Number of Subjects: This systematic review included 202 individuals with stroke.

Materials/Methods: Four researchers independently searched relevant studies from inception through July 2017 using keywords of auditory stimulation, stroke, and gait via the electronic databases including PubMed, CINAHL, Embase and PEDro. Inclusion criteria for the studies were: 1) randomized controlled trials, 2) including subjects with sub-acute or chronic stroke, 3) having subjects with no other neurological or musculoskeletal conditions that limit gait, 4) reporting gait symmetry or bilateral gait parameters, and 5) published in English. The studies that allowed subjects to use an assistive device during the testing session were excluded. The PEDro scale was used to assess the methodological quality of the studies. Gait symmetry ratios (less-affected side/affected side) of temporospatial variables in the studies were calculated for further analysis. Descriptive analyses were conducted to evaluate the effect of RAS on gait symmetry.

Results: A total of 273 studies were initially identified from the electronic databases and after applying the inclusion and exclusion criteria, six studies were remained for the systematic review. The PEDro scale revealed that three out of six studies were high quality randomized controlled trials (≥ 6). The RAS group demonstrated noticeably greater improvements in gait symmetry ratios of temporal variables, i.e., swing time and double limb support time, changing from 0.73±0.28 to 0.86±0.16 after training, compared to the control group changing from 0.72±0.29 to 0.75±0.20. However, changes in gait symmetry ratios of a spatial variable, i.e., stride length, were minimal in both the RAS (from 0.97±0.03 to 0.98±0.03) and control group (from 1.00±0.02 to 1.00±0.04).

Conclusions: This systematic review shows that RAS could be an effective intervention to improve the temporal gait symmetry but not the spatial gait symmetry following stroke. Nonetheless, further studies including other spatial gait variables, such as step length, may provide a better understanding of the benefits of using RAS for gait symmetry.

Clinical Relevance: People with stroke who experience asymmetrical gait, especially in temporal variables, would greatly benefit from RAS intervention.
Purpose/Hypothesis: The driver’s steering is an essential part of driving. Unilateral impairments of the upper extremity following stroke interfere with the efficiency of using both hands for steering. This interference often leads the driver to develop a compensatory strategy of avoiding the use of the affected arm, which may cause serious consequences to the driver’s safety. However, steering errors in people with stroke have not been clearly understood. The purpose of this study was to identify the effects of unimanual and bimanual steering on driving ability in people with chronic stroke by measuring steering errors in a simulated driving environment.

Number of Subjects: Twenty-four individuals with chronic stroke (13 right hemiplegic and 11 left hemiplegic) and 21 healthy adults participated in the study.

Materials/Methods: This is a cross-sectional study of mechanism. All subjects were right-handed and at least 1 year post stroke. They had also held a valid driver’s license prior to the study. A simulated driving system (UC-win/Road Ver. 5.0) used in this study consisted of a main computer, three monitors, an automatic gear, and three wheel pedals (Logitech, G27). The subjects underwent 5 minutes of practice driving to get used to the simulated driving environment. Then, they were instructed to drive on a 5km straight road three times with paretic, non-paretic, and both hands, maintaining a speed of 60km/h. The steering error was assessed by calculating the deviation (i.e., root mean square error) of the distance from the center of the road while driving. A two-way repeated measures ANOVA using IBM SPSS Statistics 22 was conducted to examine the effects of group and hand used on steering errors, followed by a post hoc analysis using an independent samples t test.

Results: The steering errors were significantly different between groups (p < .01) as well as between hands used (p < .05), but no interaction was found between the hand used and the group. The steering errors in the stroke group appeared to be 2.5 times greater than those in the control group. The post hoc analysis revealed that the steering error while driving with the paretic hand in the stroke group was significantly greater than with the non-paretic hand (p < 0.05) and with both hands (p < 0.05). However, no difference in the steering error was found between the non-paretic hand and both hands.

Conclusions: Individuals with chronic stroke demonstrated significant increased steering errors in a simulated driving environment compared to the healthy controls. Moreover, the steering errors were significantly greater while driving with the paretic hand compared to with non-paretic hand and with both hands.

Clinical Relevance: The results of this study show markedly decreased driving abilities in people with chronic stroke. This suggests that people with stroke who want to regain their driving skills should focus on minimizing steering errors.
TITLE: Characterization of interhemispheric inhibition in neurologically intact older adults

AUTHORS (FIRST NAME, LAST NAME): Deborah Korzun, Steven L. Wolf, Nathalie Angel, Nina Kansagra, Camille Silverman, Michael R. Borich

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ABSTRACT BODY:

Purpose/Hypothesis: Coordinated uni- and bimanual movements are mediated by interhemispheric inhibition (IHI) between primary motor cortices (M1). IHI is hypothesized to be abnormal after stroke and may contribute to persistent motor impairment. IHI can be characterized non-invasively using transcranial magnetic stimulation (TMS). Younger, healthy populations demonstrate maximal IHI under specific TMS conditions. Despite evidence of changes in brain structure and function with aging, IHI has not been comprehensively characterized in neurologically intact older adults to distinguish effects of normal physiologic aging versus neurological insult. The purpose of this study was to characterize IHI and evaluate relationships with manual dexterity in healthy older adults. We hypothesized that (1) older adults would exhibit IHI at rest and (2) IHI would be correlated with manual dexterity.

Number of Subjects: 15

Materials/Methods: Fifteen neurologically intact right-handed individuals (mean age 68.7y, 9 male) completed a single TMS evaluation of IHI. Standard TMS hotspot and resting motor threshold (RMT) procedures were performed targeting the first dorsal interosseous (FDI) muscle. Surface electromyography (EMG) data were collected from bilateral FDI to measure TMS motor evoked potentials (MEP). To elicit IHI, a single suprathreshold (120% RMT) conditioning stimulus (CS) was applied over the contralateral M1 at various interstimulus intervals (ISI) (range: 1-25 ms) prior to a single suprathreshold (120% RMT) test stimulus (TS). MEP peak-to-peak amplitudes were normalized to unconditioned TS responses and used to calculate the IHI ratio (conditioned/unconditioned). The protocol was performed bilaterally to characterize bidirectional IHI. A laterality index (LI) was calculated to determine the asymmetry of IHI. Timed performance on the 9 Hole Peg Test (9HPT) was administered at baseline to evaluate manual dexterity. The TMS protocol was repeated with 10 of the individuals on a separate day to evaluate inter-session variability.

Results: Older individuals exhibit significant IHI at ISIs 8-12ms. The ISI eliciting maximum IHI varied between individuals and between sessions. Greater maximal IHI and more negative LI (greater IHI from dominant to non-dominant hemisphere) were significantly associated with faster 9HPT performance bilaterally.

Conclusions: These findings demonstrate that IHI is present in similar magnitudes and at similar ISIs compared to previous reports in young adults and could provide a biomarker of hand motor dysfunction in clinical populations. However, the substantial variability of IHI may make inter-individual and longitudinal assessments a challenge.

Clinical Relevance: Inherent variability of IHI characteristics in neurologically intact adults may inform how cortical connectivity changes following stroke. This study provides new insight for future studies evaluating neural biomarkers that can predict responses to rehabilitation to develop effective treatments for motor dysfunction in clinical populations.
ABSTRACT BODY:

**Background & Purpose**: Impaired walking ability and increased falls incidence resulting in limited community mobility are major complications for individuals post-stroke. Locomotor training with virtual reality (VR) allows clinicians to expose patients to more complex and challenging environments, in a safe and permissive environment, while incorporating principles of motor learning critical for recovery of walking function. VR based interventions have demonstrated significant improvements on walking adaptability and dynamic balance, however, current treatments often consist of costly equipment not readily available in most physical therapy clinics. The purpose of this case study was to examine the effect of VR based locomotor training, utilizing low-cost smart phone enabled VR goggles, on walking recovery and fall risk in an individual post stroke.

**Case Description**: The patient was a 68-year-old male that suffered a right middle cerebral artery stroke 3 weeks prior. He participated in a VR-based locomotor training program on a treadmill and over ground, 2x a week for 8 weeks. Each session consisted of 45 minutes of VR training, in addition to 3 hours per week of standard physical therapy care. The patient’s primary goal was to return to unlimited community ambulation without the use of an assistive device. Smart phone enabled VR goggles were utilized secondary to its accessibility and affordability in a clinical setting. VR goggles were used with various smart phone applications that promoted environmental demands similar to those encountered in the community. Smart phone applications were selected based on their inclusion of certain domains of walking adaptability, such as obstacle negotiation, cognitive dual tasking, and ambient demands. Balance was assessed using the Berg Balance Scale (BBS) and walking adaptability was measured using the Dynamic Gait Index (DGI).

**Outcomes**: After 16 sessions of VR-based locomotor training combined with outpatient standard physical therapy, the patient demonstrated improved balance and walking ability. His BBS score improved from 35/56 to 48/56, while the DGI improved from 9/24 to 19/24. Both outcomes surpassed the accepted minimal clinically important difference, with improvements noting a reduction in fall risk.

**Discussion**: This case study is one of the first to report on the use of smart-phone enabled VR goggles for locomotor training in an individual post-stroke. The use of this VR alternative strategy, in addition to standard physical therapy care, proved feasible and demonstrated clinically important improvement in walking adaptability and fall risk reduction with this individual. Future research should investigate the effect of smart-phone enabled VR goggles for locomotor training in individuals with neurologic injuries.
TITLE: Targeted reaching guided by kinesthetic memory may be impaired ipsilesionally following stroke

ABSTRACT BODY:

Purpose/Hypothesis: Kinesthetic matching tasks for upper extremities have been used to measure post-stroke kinesthetic impairment. However, while research measures having excellent precision, available clinical measures are course. Kinesthetic matching tasks are conducted within limb or between limbs. The latter is thought to have greater requirements for interhemispheric communication, and thus, may be confounded by cognitive impairment. Using a clinically practical method of quantifying within limb kinesthesia, the purposes of this study were to: 1) to determine whether kinesthetic sense is impaired in the ipsilesional upper limb following stroke and 2) to investigate whether absolute error (AE), variable error (VE) or % of the distance reached (%) is best method of error quantification to identify differences between control and post-stroke participants. Data on reliability and validity are also reported.

Number of Subjects: 20 healthy adults, 8 adults with chronic stroke

Materials/Methods: In this descriptive study 20 adults with no history of conditions affecting neuromuscular function of the upper extremities (UE), (age ranging from 23-58 years) and 8 persons with chronic stroke (ages 55-85 years) participated. Participants completed the Edinburgh Handedness Questionnaire and underwent 2 days of testing, 1 week apart. Testing included; quantifying error in target reaching using the Brief Kinesthesia Test (BKT) and threshold to detection of passive movement (TDPM) of the elbow. Pseudorandomization was used to determine the order of UE testing. Results from the control participants right UE were compared to the ipsilesional limb of the post-stroke participants. The level of significance was set at p < 0.05. All participants provided written informed consent for participation in this IRB approved study. Data were analyzed using JMP 13.2.0.

Results: Post-stroke participants ipsilesional UE had statistically greater error in targeted reaching guided by kinesthetic memory than control participants (t = 4.1, p = 0.004, two tailed). Each method of error quantification yielded statistically significant between group differences (AE p = 0.004, VE p = 0.03, % error p<0.001). Error in targeted reaching was correlated between testing time points (r = 0.92, p < 0.001) and the intraclass correlation coefficient (ICC = 0.95, p <0.001) suggests excellent test-retest reliability. TDPM of the elbow was statistically greater among those with stroke (t = 4.3, p = 0.003).

Conclusions: Targeted reaching guided by kinesthetic memory was impaired ipsilesionally in this sample of people with stroke as quantified by a reliable and clinically practical measure.

Clinical Relevance: In tasks where there is limited or no visual information available for planning upper limb reaching movements, people with stroke may perform more poorly, even with the less affected limb. Visual information may enable feedforward control and better accuracy in reaching tasks.
TITLE: Clinical utility of an attention-demanding task at hospital discharge to estimate fall risk in subacute stroke

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Stroke SIG

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ABSTRACT BODY:

Purpose/Hypothesis: Falls post stroke are a serious public health concern. The attentional demands of gait are increased in the community by obstacles and variable terrain, which can be challenging for even well-recovered stroke survivors. Failure to clear the obstacle may lead to a trip, loss of balance and, subsequently, a fall. Our aim was to examine the clinical utility of an attention-demanding and community-relevant mobility task, obstacle negotiation, at hospital discharge to estimate fall risk 3-months after hospital discharge post stroke. We hypothesized that people who fail the obstacle task on at least one trial would be more likely to experience a fall within the 3-month follow-up period than those who pass the obstacle task. We also expected that fallers would demonstrate greater pre-obstacle step length variability, slower average obstacle-crossing gait speed, and longer obstacle-crossing paretic swing duration at hospital discharge than non-fallers.

Number of Subjects: Fourteen individuals post stroke, with mean age of 59.5 years (SD 13.3) and 8.9 days post stroke (SD 7.2). These are preliminary results from an ongoing study.

Materials/Methods: Immediately prior to hospital discharge, subjects completed 4 obstacle-crossing trials (height: 10% of leg length) at their self-selected walking speed on an instrumented walkway. Each trial was scored as either a "pass" or a "fail". Subjects also underwent a series of clinical assessments and completed a prospective falls diary over the next 3 months. Participants were dichotomized into 2 groups, faller or non-faller, based on whether they experienced at least one fall or no falls, respectively, over the 3-month post-discharge period. An odds ratio and confidence interval were determined along with group differences using independent t-tests.

Results: Subjects who failed the obstacle task at hospital discharge were 5.3 (95% CI: 0.5, 56.8) times more likely to fall in the first 3 months after discharge. As we hypothesized, the 5 fallers in comparison to the 9 non-fallers had significantly greater pre-obstacle step length variability (MD: -2.52, 95% CI: -4.9, -.14), and tended to have slower obstacle-crossing speed (MD: .35, 95% CI: -.10, .79), and longer obstacle-crossing paretic swing duration (MD: -.16, 95% CI: -.35, .03). In addition, fallers had significantly lower balance self-confidence, greater perceived impact of their stroke on walking, slower usual gait speed, and dynamic balance deficits.

Conclusions: Obstacle crossing may be a useful discharge risk-assessment tool for identifying future fallers based on the preliminary odds ratio and the clinically meaningful differences in obstacle-crossing gait performance measures. Statistically significant changes on all obstacle-crossing parameter were likely not met due to a small sample size in this preliminary analysis.

Clinical Relevance: The use of obstacle-crossing success as an indicator of fall risk has the potential to immediately impact clinical practice based on the simplicity of classifying obstacle crossing as pass or fail in a clinical setting.
**Background & Purpose:** Previous data suggests that attempts to maximize stepping training at high intensities early post-stroke may improve walking independence, speed and distance, and facilitate discharge to home. While this intervention may be feasible and tolerated in a research setting, implementation of these strategies early post-stroke can be difficult, as many patients demonstrate cognitive deficits, medical complications, lethargy, and limited or no ability to stand or ambulate. The purpose of this abstract is to outline decision-making processes related to delivery of high intensity stepping in patients < 3 months post-stroke, and facilitators used to overcome potential barriers encountered.

**Case Description:** Five participants in inpatient rehabilitation < 3 months post-stroke with at least moderate assistance to walk were chosen for this series. Attempts to maximize stepping at high intensity (< 85% age-predicted maximum heart rate [HR]) were performed during scheduled physical therapy (PT) sessions, with HRs and steps/day recorded daily. Weekly outcomes included 10 m and 6 min walk tests with level of assistance, Berg Balance Scale (BBS), and FIM scores. Specific facilitators for and barriers to implementing high intensity locomotor training were encountered and strategies altered accordingly.

**Outcomes:** Four of five patients presented with BBS < 5, with one presenting with “pusher” syndrome” and total to moderate assistance to ambulate, but were able to achieve 1579±979 steps/day with 40% of PT sessions directed towards stepping practice. Specific facilitators included weight-supported systems over treadmills and overground, with clinical aides trained to provide assistance as needed. Vital signs were monitored continuously, although barriers included difficulty achieving higher HRs in more impaired patients. Average changes in BBS (16±14), 10 m walk (0.24±0.24 m/s), and 6 min walk (106±129 m) were above minimal detectable changes for most all patients. Three patients required minimum assistance or less to ambulate, including resolution of “pusher” signs in one patient with minimal attention towards those behaviors. Four of the five patients were able to discharge home with family.

**Discussion:** High intensity stepping training was possible and tolerated by subjects within the first 3 months post-stroke in inpatient rehabilitation with gains in walking and non-walking outcomes achieved. Use of this intervention may be limited in patients with greater impairments, although facilitators enhance delivery of such training.
ABSTRACT BODY:

**Purpose/Hypothesis**: The body weight support approach has been used extensively in ambulation training in patients with stroke. The high upfront cost of a computerized body weight support system (CBWSS) and paucity of evidence on its added benefit comparing to the standard mechanical body weight support system may prevent institutions from committing the financial investment to such a system. It is also unclear how therapists adopt to the use of technology and subsequently change their practice routine. The purpose of this retrospective study was to explore the initial usage and outcomes of using a CBWSS on patients with stroke during the first 4 months of installation.

**Number of Subjects**: 149 patients with stroke

**Materials/Methods**: This is a retrospective study with medical record review. All patients who were diagnosed with stroke and were admitted to a local rehabilitation hospital for inpatient service during the first 4 months (September 2015 to December 2015) of the initial installation of a new computerized body weight support system (Vector, Bioness Inc.) were included. Demographic and clinical data including age, gender, diagnoses, comorbidities, number of visits, length of stay, admission and discharge Functional Independence Measure scores (FIM), discharge destination, and number of sessions gait or balance training using unweighted system were abstracted. Patients who underwent treatment using the system were also compared to demographically and clinically matched patients. Descriptive analyses were used to describe demographic and clinical data. Chi Square and Mann-Whitney test were utilized to compare the difference in baseline and discharge outcomes between groups.

**Results**: A total of 149 patients with stroke were admitted and treated in this facility during the time period. Only fifteen of those patients received treatment using the computerized body weight support system by 6 out of 23 therapists with an average of 1.5 sessions. Patients who were treated with the system had statistically significant lower admission FIM motor score (46.8 vs. 53.8) and required more PT visits (17.7 vs. 11.6). There was no difference in the clinical outcomes at discharge with or without underdone CBWSS training.

**Conclusions**: The early adoption of a computerized body weight support in a rehabilitation facility was limited, both in therapists involvement and in the usage. Patients who were treated with the CBWSS were more involved and required more PT visits. Ten patients were treated with CBWSS only once, which indicates the usage might be just a result of therapists’ exploration rather than a clear clinical decision. It is hard to draw a clear conclusion on the clinical effectiveness.

**Clinical Relevance**: The cost of a CBWSS is significant to any clinical settings. This retrospective study showed a slow adoption process for therapists to change their clinical approaches to include a new technology. The clinical effectiveness of a CBWSS was inconclusive because of limited usage and warrants further investigation.
Purpose/Hypothesis: Robotic-resisted treadmill walking is a form of task-specific training that has been used to improve gait function in individuals with neurological injury. Traditionally, these devices use motors to provide resistance during walking, making them bulky, expensive, and less suitable for overground or in-home rehabilitation. We recently developed a low-cost, wearable robotic brace that generates resistive torques across the knee joint using a simple magnetic brake. However, the possible effects of training with this device on gait function in a clinical population are currently unknown. The purpose of this study was to test the acute effects of resisted walking with this device on kinematics, muscle activation patterns, and gait velocity in chronic stroke survivors. We hypothesized that significant improvements in kinematics, muscle activation patterns, and gait velocity will be observed with training.

Number of Subjects: Six chronic stroke survivors.

Materials/Methods: The experiment consisted of three phases: (1) pre-test phase, (2) training phase, and (3) post-test phase. During the pre-test phase, subjects’ baseline overground walking speed, and hip and knee gait kinematics were established. During the training phase, subjects wore the resistive brace and performed four 5-minute blocks of resisted walking while simultaneously performing a foot trajectory-tracking task that minimized stiff knee gait during resisted walking. Electromyographic activity of the quadriceps and hamstring muscles were recorded during training. During the post-test phase, the subjects’ overground walking speed and hip and knee gait kinematics were recorded again.

Results: Robotic-resisted treadmill training resulted in a significant increase in quadriceps and hamstring EMG activity during walking (p<0.05). Significant aftereffects (i.e., improved joint excursions) were also observed on the hip and knee kinematics (p<0.05). More importantly, training resulted in significant improvements in overground gait velocity (p<0.05). These results were consistent in all the subjects tested. Correlation analyses indicated a significant positive correlation between increase in hamstring muscle activation and kinematic aftereffects (p<0.05) at the knee, but not at the hip (p>0.05).

Conclusions: The results indicate that robotic-resisted treadmill walking significantly increased the EMG activity of several of the key gait muscles during walking. Most notably, the hamstring muscles, which were the primary muscles targeted during training, showed almost 5- to 7-fold increase in muscle activity. The increase in hamstring activity was also paralleled by significant improvements in hip and knee gait kinematics and overground gait velocity—a consistent finding that was observed in all the subjects tested in this study.

Clinical Relevance: This study provides preliminary evidence supporting that resisted walking with our robotic knee brace induces meaningful biomechanical aftereffects that translate to overground walking, making it a feasible approach to improving locomotor functions after stroke.
A Systematic Review and Meta-Analyses of the Diagnostic Accuracy of Head Shaking Induced Nystagmus and Vibration Induced Nystagmus in the Diagnosis of Unilateral Vestibular Hypofunction

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Purpose/Hypothesis: Head shaking induced nystagmus (HSN) and vibration induced nystagmus (VIN) are simple clinical diagnostic procedures for unilateral vestibular hypofunction (UVH) that do not require expensive instrumentation, are non-invasive, and can be performed in a clinician’s office as alternatives to the laboratory-based tests, such as the caloric and rotary chair tests. The purpose of this study is to evaluate the diagnostic accuracy of the HSN and VIN tests for UVH.

Number of Subjects: 22 studies

Materials/Methods: This study was performed by following the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) statement. A systematic search was performed in three electronic databases, MEDLINE, CINAHL, and Embase from the establishment of each database until July 18, 2017 using carefully selected search terms. Articles were screened by two authors to ensure they met the pre-specified inclusion criteria. Two authors independently assessed all included studies for bias using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool. Meta-analyses of diagnostic test accuracy were run using a hierarchical summary receiver operating characteristics curve analysis to determine the pooled estimates of test sensitivity, specificity, positive likelihood ratios, and negative likelihood ratios with their 95% confidence intervals.

Results: All studies included in the meta-analyses evaluated the sensitivity and specificity of physical tests to diagnose UVH. The meta-analyses included 9 studies each for HSN and VIN. The VIN results reported an overall sensitivity of 84.92% (95% CI: 75.78%, 91.02%) with a negative likelihood ratio (LR-) of 0.17 (95% CI: 0.10, 0.29) and an overall specificity of 86.88% (95% CI: 73.51%, 94.04%) with a positive likelihood ratio (LR+) of 6.47 (95% CI: 2.98, 14.04). Overall, the HSN test had a sensitivity of 61.62% (95% CI: 41.66%, 78.31%) with a LR- of 0.51 (95% CI: 0.35, 0.76) and a specificity of 74.80% (95% CI: 60.37%, 85.26%) with a LR+ of 2.45 (95% CI: 1.75, 3.42).

Conclusions: Overall, both tests exhibited higher specificity values than sensitivity values. The VIN test produced values of higher diagnostic accuracy than the HSN test, including LR+ and LR- with moderate pre-test to post-test probability shifts.

Clinical Relevance: Both the HSN and the VIN tests will be better used as diagnostic tests to rule in UVH as opposed to screening tests to rule out UVH. If one of these tests is to be used to diagnose UVH, the VIN test should be selected due to its higher specificity and LR+ values.
Background & Purpose: Benign paroxysmal positional vertigo (BPPV) is one of the most common causes of dizziness.1,2 BPPV is characterized by recurrent, brief episodes of vertigo triggered by head position change and caused by free-floating otoliths (canalithiasis) or otoliths that have adhered to the cupula (cupulolithiasis) within the three semicircular canals.3 This condition is typically treated with canalith repositioning maneuvers (CRM) which have a success rate of 70-95%.4 In regards to the horizontal canal, there are resources for treating canalithiasis5,6 but there is a gap in the literature for cupulolithiasis7. The purpose of this case report is to present the treatment of horizontal canal cupulolithiasis resistant to CRM.

Case Description: A 65 year old female presented to an outpatient clinic with dizziness, nausea, and room-spinning that occurred with rolling over in bed. She was seen in the Emergency Department (ED) 6 days prior for her dizziness. A Neurologist attempted to treat her with an Epley maneuver, but was unsuccessful in resolving her symptoms. She was admitted to the hospital where a Physical Therapist also attempted to treat with an Epley. Both MD and PT assessed anterior/posterior canals via Dix Halpike. The horizontal canals were not assessed. She was discharged with referral to outpatient vestibular PT. On evaluation in outpatient PT, she was found to have right-beating nystagmus in right Dix Halpike, left-beating nystagmus in left Dix Halpike, and apogeotropic nystagmus >60sec in bilateral roll test positions, with symptoms more severe on the right. She was diagnosed with left horizontal canal cupulolithiasis, and PT attempted to treat via Barbecue Roll maneuver. She did not tolerate this CRM well due to nausea and did not have improvement in symptoms afterwards. During the second visit, she was treated with 3 cycles of Gufoni Maneuver, again without resolution of symptoms. During the third visit, the PT determined the otolith was well-adhered to the cupula, and attempted to dislodge it using knowledge of vestibular anatomy. The patient's head was flexed 30 degrees to align the horizontal canal perpendicular to gravity, and was laid down rapidly and forcefully onto the left side. She experienced severe dizziness with this maneuver, which resolved within 60sec. She was then treated with a Gufoni Maneuver.

Outcomes: The patient experienced immediate resolution of dizziness after the rapid ipsilateral maneuver followed by Gufoni maneuver. Subsequent testing within the session was negative for nystagmus and symptoms. She was retested 4 days later and was again negative. She also reported no dizziness during position changes at home, indicating successful treatment.

Discussion: This case demonstrates a novel technique for treating persistent cupulolithiasis of the horizontal canal, for which there are limited resources in the literature7. This patient was successfully treated by using knowledge of vestibular anatomy, understanding implications of types of nystagmus, and problem-solving an otolith well-adhered to the cupula.
cVEMP amplitude is influenced by various motoric maneuvers.

Neurology

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ABSTRACT BODY:

Purpose/Hypothesis: Cervical Vestibular Evoked Myogenic Potentials (cVEMPs) assess the function of the saccule of inner ear. cVEMPs are short latency inhibitory reflexes recorded from the sternocleidomastoid muscle (SCM) in response to high-level, low-frequency acoustic stimuli. The cVEMP reflex pathway includes the saccule, inferior vestibular nerve, vestibular nucleus, medial vestibulospinal tract, accessory nucleus and the SCM muscle. Tonic contraction of the SCM is required to elicit the response. Clinical interpretation of cVEMPs have focused primarily on P1/N1 (P13/N23) amplitude and latency measurements (McNerney and Burkard, 2011, McNerney et al.,2014, Bogle et al., 2013).

A recent preliminary study using the concept of reflex reinforcement by the Jendrassik maneuver showed that cVEMP P1/N1 amplitude can be enhanced by the Jendrassik maneuver (as well as other maneuvers: Robert and Cacace, 2014). However, the mechanism of reflex reinforcement by the Jendrassik maneuver is unclear, although several plausible causes include alpha motor neuron facilitation, fusimotor activation and presynaptic disinhibition (e.g., Gregory et al., 2001). In the present study, we hypothesized that regulation of alphamotor neuron recruitment by background muscle activity influences the cVEMP response (which can be potentiated by various maneuvers, including the Jendrassik maneuver). The objective of the present study is to relate the cVEMP P1/N1 amplitude produced by various maneuvers with several different levels of background EMG activity.

Number of Subjects: Six healthy volunteers (5 males and 1 female) with ages ranging from 18-40 years were enrolled in this pilot study.

Materials/Methods: The TECA Evoked Potential System was used for the cVEMP stimulus presentation as well as for the data collection. To assess changes in the cVEMP amplitude, during stimulation with a 110 or 120 dB pSPL 500 Hz toneburst, we combined SCM tension with the Jendrassik maneuver, jaw clenching, and forceful closure of the eyes. The cVEMP from the SCM muscle was amplified, bandpass-filtered and averaged for 100 sweeps for each average, and two averaged responses were collected for each condition. SCM tension (i.e., EMG magnitude re: maximal contraction) was 100%, 75% and 50%.

Results: Preliminary analysis of cVEMP amplitude across condition shows that (mean) cVEMP amplitude increases with increased muscle contraction and with increased tone-burst level. In addition, cVEMP amplitude appears to be enhanced by several of the motor maneuvers performed, but these effects are dependent on both toneburst level and magnitude of SCM contraction.

Conclusions: The interpretation of these results will be discussed in terms as to whether they support the thesis that the Jendrassik (and other?) maneuvers is due to alphamotor neuron recruitment, along with co-recruitment of gamma motor neurons to alter the stretch sensitivity of muscle spindles for incoming stimuli.

Clinical Relevance: The cVEMP has recently gained diagnostic importance clinically, as cVEMP abnormalities can reflect the integrity of the otolith structures underlying vestibular pathology.
Title: Recovery of head trunk degrees of freedom following unilateral vestibular loss

Abstract Body:

Purpose/Hypothesis: To (i) characterize head and trunk kinematics from the acute post-operative period following removal of vestibular schwannoma to the sub-acute period post-surgery, and (ii) compare these behaviors to individuals without vestibular hypofunction.

Number of Subjects: 12 participants post vestibular schwannoma resection (VSR) and 20 individuals without vestibular hypofunction (NoVH).

Materials/Methods: Yaw plane head and trunk amplitude and velocity during the first turn of the timed up and go (TUG) were gathered using wearable inertial sensors (APDM Inc, Portland, OR). Differences in yaw plane outcomes between individuals with VSR at 4 days (acute) compared to 6 weeks (sub-acute) post-surgery were examined using paired t-tests, while comparisons between participants with VSR and NoVH were done using independent samples t-tests. Pitch plane head and trunk amplitude and velocity during sit-to-stand (STS) were summarized using descriptive statistics.

Results: Participants post VSR demonstrated significant increases in yaw plane rotational amplitude and velocity from the acute to sub-acute period (Head yaw plane amplitude: acute: 129.3 [47.6] deg; sub-acute: 157.5 [15.2] deg. Head yaw plane velocity: acute 87.0 [42.7] deg/sec; subacute: 154.3 [42.4] deg/sec. Body yaw plane amplitude: acute: 128.1 [47.7] deg.; sub-acute: 161.8 [9.5] deg. Body yaw plane velocity: acute: 80.4 [31.3] deg/sec; sub-acute: 141.0 [33.4] deg/sec) (p<0.05 for all comparisons). Yaw plane movements were still significantly reduced compared to participants without vestibular hypofunction (Controls: Head yaw plane amplitude 173.5 [9.5] deg; Head yaw plane velocity 268.6 [76.9] deg/sec; Body yaw plane amplitude 171.4 [14.9] deg; Body yaw plane velocity 243.5 [69.6] deg/sec) (p<0.05 for all comparisons).


Conclusions: Compared to individuals with NoVH, participants post VSR demonstrated profound pitch and yaw plane head movement degree of freedom restrictions. Despite significant improvement over 6 weeks, participants post VSR failed to achieve normal degrees of freedom of head movement.

Clinical Relevance: Acute restriction of head and trunk movements likely reflect compensatory mechanisms to limit symptom provocation, but may have the longer-term consequence of failing to stimulate physiological adaptation of gaze and postural stabilization mechanisms.
THE USE OF OPTOKINETIC TRAINING AS A TREATMENT FOR MOTION SENSITIVITY SYNDROMES: A SYSTEMATIC REVIEW

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ABSTRACT BODY:

Purpose/Hypothesis: Motion sensitivity (MS), commonly known as motion sickness is a diagnosis that affects many people. MS often results in symptoms of nausea and impaired balance which can have a marked impact on quality of life. MS is often triggered by traditional modes of transport such as cars, boats and trains. Optokinetic (OPK) exposure has been explored as a conservative treatment for people with MS as an alternative to pharmacologic management, which is the current standard of care. The purpose of this systematic review was to determine the effectiveness and safety of OPK treatment as an intervention for managing symptoms of MS.

Materials/Methods: Ovid Medline, PubMed, CINAHL and Scopus databases were searched in October of 2017 using the search terms Optokinetic AND motion sickness, and Optokinetic AND swaying. Inclusion criteria were experimental or quasi-experimental studies with human participants with motion sensitivity disorders, and the use of an optokinetic treatment protocol. Two reviewers developed consensus ratings of threats to validity for each study using the PEDro scale. Each “yes” on the PEDro scale was operationalized with 1 point, creating a range from 0-11, with higher scores indicating fewer threats to internal validity.

Results: Seven papers were identified that met the inclusion criteria. Median PEDro score was 6 (IQR 1, range 5-8). The included studies all utilized a form of optokinetic rotation as the mode of intervention and subjective ratings of MS as a dependent variable.

Conclusions: The body of evidence examined provides support that OPK training can produce a vestibular and/or central adaptation response of which can lead to a reduction in MS symptoms. OPK had immediate positive and post treatment effects on MS with no evidence of long term negative side effects. Further research is warranted to establish a specific training protocol that is efficient and effective in achieving reduced symptoms of MS. In addition, larger-scale studies comparing the effectiveness of OPK training to current pharmacological management and the combination of the two is recommended.

Clinical Relevance: At this time, pharmacologic management of symptoms is the first-line treatment for those who experience MS. The results of this review suggest that OPK training is a safe and effective intervention for reducing symptoms associated with MS. Clinicians who work with patients with MS should consider prescribing OPK training as an adjunct to current treatments to ameliorate MS symptoms.
Purpose/Hypothesis: Patients with vestibular dysfunction typically complain of dizziness and imbalance in busy and complex visual environments. We created a clinical app using Unity for the HTC Vive headset, to provide a graded method for patients to experience complex environments in a functional and non-threatening context. Our purpose was to describe the app usability from the physical therapists’ (PTs) and patients’ perspective and its implementation in a vestibular rehabilitation clinic.

Number of Subjects: Six PTs enrolled 17 patients with peripheral or central vestibular dysfunction over 4 months. Four patients dropped-out due to medical reasons, scheduling problems or increased anxiety.

Materials/Methods: Within our app, patients explore a virtual street, airport, subway or park. The clinician controls direction, amount and speed of virtual people. Starting point and progression are guided by self-reported symptoms. All patients completed the Short Feedback Questionnaire (SFQ) after a first exposure to a scene. Five PTs completed the System Usability Scale once per month and had a monthly feedback meeting with the principal investigator.

Results: Average usability scores were 70 when the PTs used the system < 5 times, dropped to 63 at 5-10 times usage and increased to 73 above 10 times (ideal is 100, 68 is acceptable). SFQ scores per scene were 16 for the subway, airport, city and 15 for park (best score is 20). Enjoyment and ‘feeling inside the task’ were rated above 4 out of 5 for all (highest on subway, scale is 1-5), and 3.75 for park. Discomfort and difficulty (scored 1-5 where lower is less discomfort) were around 1 for the airport and park, and close to 2 for the subway and city. In the majority of the patients there was no increase in symptoms from baseline to post session.

Conclusions: The new HTC Vive app was feasible and fairly easy to operate. The patients enjoyed the scenes, the PTs liked the system. Symptoms were minimal, particularly on the milder settings. Implementation challenges included guarding the patients without blocking the Vive light-houses. The PTs also asked for the user-interface to be simplified such that no ‘cheatsheet’ is required. Suggestions for improvements included adding auditory cues, and transitioning to a wireless system.

Clinical Relevance: Virtual reality programs have been used for many years in vestibular rehabilitation and overall have been shown to be effective for various vestibular disorders. Recent advances in head-mounted display technology allow for high level of immersion at low costs and minimal technical requirement. Immersive environments can mimic daily sensory load and induce related symptoms and emotions, such as fear and anxiety, that patients may experience in their daily living and are not easily reproducible in traditional rehabilitation. Our long-term goal is to provide a streamlined, individualized, user-friendly intervention platform ready to be tested in clinical trials; that will lead to improved participation and quality of life following an individualized virtual environments training.
Background & Purpose: Meniere’s disease (MD) is a vestibular disorder associated with episodic vertigo, tinnitus, aural fullness, and sensorineural hearing loss (SNHL). Its effects are initially unilateral (u/l) and result in progressive permanent SNHL. Bilateral (b/l) MD diagnosis is rare, with incidence of 9-16%. Even when diagnosed, it typically follows the initial fluctuating symptoms and then sequential worsening of symptoms found in u/l disease. Profound SNHL in the contralateral ear is not a symptom of u/l disease, nor is sudden prolonged imbalance and vertigo. Once SNHL is found b/l, however, cochlear implants (CI) are a widely used surgical technique to improve communication. Though research is limited, CI have been found to have little to no effect on the vestibular system itself and implantation of CI has been shown to improve gait quality and balance. The purpose of this case series is to describe the unusual increase of vestibular symptoms following CI on the non-MD affected side and its effects on the functioning and subsequent rehab of these individuals.

Case Description: Pt A is a 71 y/o male with PMH of episodic imbalance and lightheadedness who began use of L CI in December 2017. Then in January 2018 he began experiencing vertigo which progressed in duration and intensity leading to episodes lasting hours to days. This continued to progress to where he was dizzy and imbalanced between attacks. His vestibular testing revealed a positive R HIT, L beating nystagmus, 7 line difference on DVA, and 20/30 on the FGA.

Pt B is a 62 y/o female with PMH of R MD including fluctuating hearing loss in R ear and episodic vertigo. This was treated with steroids and she was vertigo free for 2 yrs. In 2016 she experienced progressive permanent SNHL resulting in use of R hearing aid. She then had sudden SNHL and began using L CI due to b/l signal loss in March 2017. Following CI implantation, her vertigo attacks increased, her balance worsened, and she presented to ED as symptoms were more intense and differed from prior episodes. Her vestibular eval revealed positive R HIT, 1st degree L beating nystagmus, and 22/30 on the FGA.

Outcomes: Treatment for both patients have included dynamic gait and gaze stability training, habituation exercises, and education about symptom management. After 8 sessions, pt A improved FGA from 20 to 24 and his ABC from 52% to 68% while decreasing his DHI from 50 to 38. After 7 sessions, pt B, improved FGA from 22 to 25 and her ABC from 78% to 85% while decreasing her DHI from 50 to 27.

Discussion: MD is an often frustrating disease, which can have a profound effect on the daily life of those affected. Though prevalence is rare, b/l involvement can necessitate the need for CI to improve outcomes and function. Worsening vestibular symptoms post operatively have not been demonstrated in the literature and can further complicate the prognosis of these pts. However, despite the atypical and complex presentation of these pts, vestibular rehab was demonstrated to improve functional outcomes. Further studies are needed to investigate PT protocols.
Background & Purpose: Intralabyrinthine hemorrhage (ILH) is a rare cause of acute vestibulocochlear dysfunction. Onset of ILH is associated with sudden and severe sensorineural hearing loss (SNHL), vertigo, and disequilibrium. ILH can be related to cardiovascular disease and/or use of anticoagulants. Few reports of ILH are found in the literature, with scarce reports aimed at vestibular involvement. The purpose of this case study is to describe the clinical presentation of a patient with ILH and the role of vestibular physical therapy (VPT) in aiding functional recovery and symptom management.

Case Description: Patient (pt) is a 56 year old male with past medical history significant for coronary artery disease, diabetes mellitus type 2, hyperlipidemia, and hypertension. Pt had sudden onset of left sided hearing loss, with subsequent vertigo that was not positional and lasted over 24 hours. Pt was seen in the emergency room and diagnosed with BPPV. Pt followed up with otolaryngologist who diagnosed pt with SNHL, prescribed prednisone and steroid injections, and subsequently referred to VPT. At initial evaluation (IE), pt’s chief complaints were dizziness and instability that were provoked by bed mobility and head movements, which limited his ability to safely operate his taxi. Pt had severe unsteadiness when walking and reached for external support while entering clinic. Imaging revealed left sided intralabyrinthine hemorrhage. Vestibular testing revealed third degree right beating nystagmus without fixation, positive head shaking nystagmus, and positive left head impulse test (HIT) indicating a left peripheral vestibular dysfunction. Pt also had a 7 line difference on the Dynamic Visual Acuity (DVA) scale and immediate loss of balance when performing activities with eyes closed. Pt was seen two times per week for 45 minutes with interventions focused on enhancing gaze and postural stability.

Outcomes: Pt was assessed at IE and visit 8. Pt improved on the Functional Gait Assessment from 8/30 to 15/30, indicating reduced risk for falls. Pt had a clinically significant change on the Dizziness Handicap Inventory score from 64/100 to 16/100 and Activities-Specific Balance Scale score improved from 39.38% to 65.63%. Pt improved gaze stability as evidenced by increased number of head turns per minute while performing VOR (36% to 78% of expected norm) and a 4 line difference on the DVA. Pt returned to work two months after onset.

Discussion: Pt quickly made significant gains in balance and gaze stability with VPT. This is likely due to the acute nature of the condition. At IE pt did not provide a copy of medical records and was unsure of his diagnosis. Differential diagnosis included bilateral asymmetrical loss, as per an unexpected initial finding of a positive bilateral HIT, an immediate loss of balance with eyes closed activities, and more than a 3 line difference on the DVA. Several weeks into VPT, pt presented copies of imaging that revealed ILH.
Background & Purpose: Migraines are a common cause of episodic vertigo and disequilibrium. Approximately 40% of migraine patients (pts) have an accompanying vestibular dysfunction. Symptoms (sx) of migraines include dizziness, motion sensitivity related to head/body position changes, and spontaneous vertigo attacks accompanied by nausea and vomiting. Studies have shown pts with migraines are three times more likely to develop benign paroxysmal positional vertigo (BPPV). Pts with migraines can report positional vertigo and exhibit nystagmus during BPPV testing, therefore it can be difficult to discern vestibular migraine exacerbation from BPPV. This case study aims to demonstrate the importance of considering BPPV as a differential diagnosis in a pt with a history of migraines.

Case Description: Pt is a 73 year old female with past medical history significant for anxiety, BPPV, and headaches/migraines with visual aura. Pt reports initial onset of room spinning vertigo occurred suddenly while getting out of bed, resulting in a fall due to imbalance. Pt continued to have episodic vertigo related to head/body position changes with residual dizziness and imbalance between vertigo attacks. Pt was initially diagnosed with vestibular neuritis by her primary care physician due to a recent viral infection, however her otolaryngologist was not in agreement and referred her to vestibular physical therapy for further assessment. At initial evaluation pt reported dizziness, vertigo, and imbalance. Sx were provoked by bed mobility, looking up, bending down, and head turning. Pt required assistance from her spouse for all functional mobility and activities of daily living. Upon examination, significant findings included impaired smooth pursuits and saccades, as well as convergence insufficiency; likely related to history of migraines. BPPV testing revealed signs and sx consistent with right posterior canalithiasis, left posterior canalithiasis, and right horizontal canalithiasis.

Outcomes: Pt was initially treated for left posterior canalithiasis with canalith repositioning treatment (CRT). Once cleared, pt was treated with CRT for right posterior canalithiasis, and then subsequently treated for remaining right horizontal canalithiasis with Appiani and BBQ Roll maneuvers. Pt was negative for BPPV within 6 sessions. Her Dizziness Handicap Inventory improved from 58/100 on evaluation to 0/100 at discharge, indicating no residual handicap due to dizziness.

Discussion: Pt’s history of anxiety, headaches/migraines, and recent viral infection complicated the examination. The list of differentials included migraine exacerbation, vestibular neuritis, anxiety related dizziness/vertigo, and BPPV. Subjective reports from pt throughout examination and treatment was of key importance in deciphering diagnosis of BPPV from migraines, and therefore assisted in appropriately guiding treatment and returning pt to prior level of functioning.
Purpose/Hypothesis: The purpose of this study is to investigate the impact of vestibular rehabilitation (VR) on the physical activity (PA) of individuals with vestibular disorders.

Number of Subjects: Subjects were adults with a diagnosed vestibular disorder presenting to outpatient VR. Five subjects (N=5), three females and two males, with an average age of 47.2 ± 9.2 years (34-61) completed this study thus far (actively accruing subject, anticipate 10-15 subjects by CSM).

Materials/Methods: The StepWatch Activity Monitor (SAM) was programmed and calibrated for each subject. Subjects wore the SAM for 10 days at the beginning and end of VR. Data on PA from the first seven complete days from the each measurement period was recorded, along with demographic data, compliance with home exercise program (HEP), number of VR sessions, weeks spent in VR, and initial and final scores on the Activities Specific Balance Confidence Scale (ABC), Dizziness Handicap Inventory (DHI), and Functional Gait Assessment (FGA).

Results: Subjects complete an average of 6 ± 1.8 PT sessions over 7.6 ± 5.1 weeks with an average HEP compliance of 82.6 ± 15.7%. Average changes on outcome measures were 32.8 ± 17.8 point decrease in the DHI, 6 ± 4.2 point improvement in FGA, and 24.2 ± 22.6 % improvement in ABC. On average, subjects took 4263.9 more steps (p=0.0355) and were active for 134.6 more minutes (p=0.0296) from beginning to end of VR. When breaking down the steps by intensity, on average subjects took 860.1 more steps in low intensity (p=0.7263), 2672.6 steps in medium intensity (p=0.0318), and 262.1 steps in high intensity (p=0.0098). When breaking down the time by intensity, on average subjects spent 76.7 more minutes in low intensity (p=0.5103), 50.66 minutes in medium intensity (p=0.0228), and 7.1 minutes in high intensity (p=0.0367).

Conclusions: The results of this study indicate that VRT lead to statistically significant gains in two important markers of PA: Total step count and minutes active. These gains in PA are likely attributed to improvements in balance, gaze stability, and dizziness resulting from VR. When looking more closely at intensity of PA, subjects demonstrated statistically significant gains step count and minutes in medium and high intensity activity but not step count nor minutes in low intensity activity. This results may indicate that gains in dizziness, gaze stabilization, and balance allowed these subjects to more quickly. Future research should look at a larger and more diverse sample, identify specifically what VR interventions are most effective at targeting PA, and investigate if these changes are long lasting.

Clinical Relevance: The results of this study indicate that VR can significantly increase overall PA and improve PA intensity in individuals with vestibular disorders. These improvements would allow individuals with vestibular disorders participate more fully in home, social, and employment life roles.
Implementing the APTA Clinical Practice Guidelines for Peripheral Vestibular Hypofunction: Preliminary results of a multicenter mixed-methods case series

Purpose/Hypothesis: A volunteer taskforce of the Academy of Neurologic Physical Therapy (ANPT) of the APTA developed a 3-phase plan to improve clinician adherence to target action statements from the ANPT-published clinical practice guidelines (CPGs) for peripheral vestibular hypofunction. In this report, we present preliminary results from the second phase—a multi-center mixed-methods case series implementation study—in which taskforce members at five sites implemented stakeholder-generated, evidence-informed interventions to promote CPG adherence.

Materials/Methods: Members of the taskforce at each site were responsible for leading the development of an intervention to increase therapist CPG adherence using Workgroup for Intervention Development and Evaluation Research (WIDER) guidelines. Prior to intervention initiation and at the end of the study, each site will survey participating therapists using questions informed by the Consolidated Framework for Implementation Research model and Organizational Readiness to Implement Change survey. Chart review and auditing clinician engagement will be used to assess CPG action statement adherence at baseline, each month during the intervention, and at the end of the 6-month intervention period. Site leaders will provide therapists with individualized feedback each month during the intervention period.

Results: Each site is providing 3-5 individually-tailored interventions to enhance CPG adherence: audit and feedback (5 total sites), reminders (2), educational materials (2), educational meetings (3), patient mediated interventions (4), routine patient reported outcomes (3), and monitoring healthcare delivery (1). Results presented will include detailed descriptions of implementation interventions developed at each site, and preliminary data regarding baseline and intervention-period adherence to CPG action statements. We will describe how the Consolidated Framework for Implementation Research and the Knowledge to Action Cycle played a dynamic role in shaping the implementation process throughout the intervention period.

Conclusions: Dissemination and implementation of APTA academy/section CPGs may be effective through a 3-phase, sequential process. The findings from the taskforce member-initiated effort to implement the peripheral vestibular hypofunction CPG will provide useful strategies to promote successful implementation of this and other CPGs.

Clinical Relevance: Our work provides a model for other APTA academies and sections for CPG dissemination and implementation.
Background & Purpose: Most individuals with a concussion recover within a 7-10 day period, however various studies suggest that somewhere between 10-20% of individuals experience persistent post-concussive symptoms (PPCS) for weeks, months, or potentially years. While expert opinion from the Zurich guidelines continues to recommend physical and cognitive rest until the individual is asymptomatic, the latest research suggests otherwise. More specifically, one study found that patients ages 5-18 years who participated in physical activity within 7 days of injury had a decreased risk of PPCS when compared to patients who rested. With a potential shift emerging in the management of post-concussion syndrome (PCS), it is imperative that patients gain access to healthcare providers with experience and knowledge of this diagnosis. Even with the development of concussion centers across the nation, there are individuals without access to these clinics who may benefit from consult via telerehabilitation.

Case Description: The patient was a 32-year-old female living in Turks and Caicos who was diagnosed with PCS. Following her injury, she was eager to seek consultation from a clinician experienced in PCS care, as her symptoms significantly limited her ability to participate in her daily activities, including regular exercise. As a result, emotional aspects of PCS presented, including depression and anxiety. Her anxiety heightened when she was unable to locate or identify a healthcare professional with experience in this diagnosis. Although this physical therapist and the patient were thousands of miles apart, treatment through telerehabilitation was initiated via FaceTime. The patient was seen for a total of 4 visits, 45-60 minutes long over the course of 4 weeks. Her program consisted of education regarding PCS care, the association between physical symptoms and psychological symptoms, as well as the importance of implementing physical activity with a managed approach. Her program specifically consisted of turning, ambulation with head turns, vestibular-ocular reflex training, and exertion training.

Outcomes: The ability to complete performance-based outcome measures via telerehabilitation was limited, however this patient demonstrated significant improvement on the SCAT-3 Symptom Evaluation, Activities Specific Balance Confidence Scale, and Dizziness Handicap Inventory (DHI). More specifically, she improved her confidence level from 64.4% to 91.9% and her symptom severity according to the DHI from 62 to 18. In addition, she improved her symptom severity on the SCAT-3 from 59 to 29.

Discussion: The favorable results of this case study suggest that telerehabilitation may play an integral and beneficial role in the treatment of post-concussive symptoms, especially for those in areas where this specialty is nonexistent. Further research is warranted to examine the safety and effectiveness of using FaceTime or other telerehabilitation technologies in the realm of PCS care.
Purpose/Hypothesis:
Skew deviation, vertical misalignment of the eyes, is associated with acute vestibular syndrome and may be measured with dissociating tests of phoria, the prism neutralized Maddox Rod Test and modified Thorington method. Differences in measurements may occur between sitting and recumbent supine in individuals with vestibular lesions due to the effects of gravity. The purpose of this study was to determine the inter-rater reliability of 2 dissociating tests of phoria in normal adults with artificially created phoria to determine if physical therapists may reliably measure phoria.

Number of Subjects: Thirty adults (mean age 24.87±4.74 years) participated in the study.

Materials/Methods:
Subjects were randomly assigned to wear trial lenses (1, 2, 4, or 6 prism diopter (D) prism left; plain glass right) to create artificially acquired phoria. In sitting and supine, distant phoria was measured using the prism neutralized Maddox Rod Test and near phoria using the prism neutralized modified Thorington Method. First neutralization of endpoint was measured. For each test, position, and trial lens, the mean, standard deviation, and range were calculated for each examiner. The percentage of trials in agreement (< 2 and 4 D); paired t-tests; and Pearson correlation coefficients between examiners were calculated.

Results:
Participants underwent 20 measurements by each examiner, total 1200. Incongruency of > 4 D between examiners occurred in 48 measurements (4%), all in the horizontal plane and 22 of the incongruent measurements (46%) when wearing 6 D lenses. The Maddox rod test in both positions had statistically significantly different means between the two examiners (p<0.05 for all t-tests) except for supine 2 D lenses. The modified Thorington test had no significant difference. The inter-rater correlation coefficient for each test was statistically significant at a level of p<.01 (ICC>.67<.94) except for the modified Thorington test in supine, horizontal plane with a p<.05 (ICC>.38).

Conclusions: Between examiners, both tests had significant correlations in each position. Although there was a statistically significant difference in means between examiners using the Maddox Rod test the difference is not clinically significant and does not affect the correlation. No difference was found in the modified Thorington test.

Clinical Relevance:
Physical therapists may reliably measure artificially created phorias using the prism neutralized Maddox Rod Test and modified Thorington Method in sitting and recumbent supine. These findings are consistent with others in the measurement of heterophoria and suggests that the tests may reliably be used in the clinic.
In fall of 2017, UC San Diego Medical Center initiated an Acoustic Neuroma Program. Patients from across the country travel to San Diego for surgical resection and routine care of cerebellar pontine angle tumors. To maximize the functional outcomes of this patient population, the surgical and rehabilitation departments worked together to create a rehabilitation protocol. This protocol includes a pre-operative outpatient physical therapy evaluation, post-operative inpatient physical therapy intervention, and outpatient physical therapy follow up approximately 10 days post operatively. To further maximize patient outcomes, inpatient and outpatient physical therapists worked closely together to create a standard evaluation and treatment guideline.

Our team’s goals included maximizing patient functional outcomes, improving the patient experience, and creating a seamless transition between the outpatient and inpatient settings. These goals were addressed by increasing communication between outpatient and inpatient therapists, establishing super-users for this patient population, and providing mentorship and education opportunities for the entire staff. Education opportunities included cross training between settings, in-services, hands-on skills labs, and a competency quiz that were led by the super users. Through implementation of this plan, patients receive consistent and evidence-based care.

As therapy becomes increasingly specialized, this program highlights the importance of communicating across settings and creating competency-based educational opportunities to maximize patient outcomes, improve the patient experience, and create a seamless transition between the inpatient and outpatient settings.

Future goals for the program include retrospectively analyzing patients’ pre- and post-operative functional outcomes and comparing this progress to current literature regarding acoustic neuroma resections. This would allow us to determine if increasing “hand off” communication has an impact on the patient’s outcome and experience.
ABSTRACT BODY:

Purpose: The head impulse test (HIT) was originally developed as a clinical method to evaluate reduced VOR function at the bedside as identified by the presence of a re-fixation saccade following a rapid small passive head rotation. Video HIT testing now allows rapid quantification of VOR gain, the ratio of eye velocity/head velocity during the impulses. Recently there has been increased interest in re-fixation saccades associated with reduced VOR function, their relevance to gaze stability, and their diagnostic utility. The suppression head impulse paradigm (SHIMP) is being promoted as a means to examine re-fixation saccades.

Description: The SHIMP test differs from the standard HIT in that the target is fixed with the head rotation (similar to the clinical VOR suppression test). This SHIMP measures the ability to suppress the VOR, which normally takes 80-90ms. Due to the long suppression latency of the VOR, the eyes cannot immediately follow the moving target in healthy VOR function, and instead a large amplitude, high velocity corrective saccade is recruited to re-acquire the target. With the SHIMP, the corrective saccade becomes the sign of normal VOR function, and absence of a corrective saccade suggests pathology as there is no need to suppress the VOR (the VOR is absent or weak). The developers propose the SHIMP involves a “cleaner” estimation of VOR gain during head impulses because there are few covert re-fixation saccades that interfere with the gain calculation.

Summary of Use: We have employed both video HIT and SHIMP testing in clinical and research settings. We will present selected examples in the context of discussing the overall utility of SHIMP testing for physical therapists. Specifically, we highlight the ideal saccade responses for individuals with healthy VOR function and individuals with bilateral vestibular hypofunction (BVH). We will show that not all individuals with BVH present with the response the developers suggest. We will show asymmetrical SHIMP responses in the case of symmetrical BVH; we will show an example of bi-directional saccades in a case of severe bilateral vestibular loss. Additionally, the SHIMP interpretation is not always clear for individuals with unilateral vestibular hypofunction (UVH); we will show SHIMP responses that appear normal with UVH. We will also highlight differences in VOR gain measured with SHIMP and video HIT, as a recent paper identified significantly lower VOR gain with SHIMP in healthy adults.

Importance to Members: More physical therapists are using video HIT as part of their vestibular evaluations; SHIMP is an appealing complementary testing protocol available on several commercial systems. However, there are some clear limitations in the diagnostic capability of the SHIMP, which physical therapists must consider when evaluating such results. It is as yet unclear whether SHIMP saccades will be a useful metric of recovery following vestibular rehabilitation. The neural mechanisms responsible for the SHIMP response have not been clearly elucidated, and changes in SHIMP responses over time should be cautiously interpreted.
ABSTRACT BODY:

Background & Purpose: Vestibular abnormalities can have a detrimental effect on an individual's ability to maintain balance and perform activities of daily living. Symptoms can present from dysfunction in either the peripheral or central vestibular systems and are often treated with evidence-based physical therapy (PT) interventions focused on habituation, substitution, and adaptation techniques. These interventions are detailed in the clinical practice guideline published by the Academy of Neurologic Physical Therapy for the treatment of peripheral vestibular dysfunction. The purpose of this case report is to outline a PT treatment plan that demonstrates successful outcomes in a patient presenting who exhibited a combination of peripheral and central vestibular dysfunction.

Case Description: The patient was a 70-year-old female who presented to an outpatient PT clinic with signs and symptoms indicative of both peripheral and central vestibular dysfunction as diagnosed by a PT student. The primary impairments, completed over a multitude of patient visits, included left posterior semicircular canal canalithiasis, unilateral vestibular hypofunction, and central vestibular dysfunction, with secondary impairments of loss of balance and dizziness. The patient presented with activity limitations of not being able to walk with head turning in busy environments. Participation restrictions included having to limit her work day at Home Depot and missing family gatherings due to an increase in her symptoms.

Outcomes: PT intervention involved the use of habituation, substitution, and adaptation techniques to challenge the patient’s vestibular system to promote recovery. Such interventions included balance and gait activities, VOR exercises, imaginary targets, optokinetic balance exercises, and the Epley maneuver. The patient met the majority of her PT goals and demonstrated improvement in the Functional Gait Assessment going from a 22/30 to a 29/30, and improving her Dizziness Handicap Inventory score from a 24 to 16.

Discussion: PT intervention was successful in treating a patient presenting with both peripheral and central vestibular dysfunction after 6 PT visits over the course of three weeks. This finding is significant because while there is a plethora of research regarding the treatment and prognosis of patients presenting with only peripheral vestibular dysfunction, the current literature is lacking regarding prognosis and treatment for a patient presenting with both peripheral and central vestibular dysfunction.
Background & Purpose: The purpose of this case report was to examine the effects of individualized vestibular rehabilitation on a patient diagnosed with left chronic unilateral vestibular hypofunction. The aim was to critically apply the clinical practice guideline (CPG) established by the Academy of Neurological Physical Therapy (ANPT). 1

Case Description: A 37-year-old female accountant who developed dizziness symptoms seven years ago with residual, fluctuating symptoms since the initial occurrence, was referred to outpatient vestibular rehabilitation by an Ear, Nose, & Throat physician. The patient had a diagnosis of chronic left vestibular hypofunction as evidenced by her positive Electronystagmography (ENG) results.2 The patient's primary impairments included vertigo and dizziness, decrease balance with uneven support surfaces, and decrease gaze stabilization contributing to limitations including impaired gait with head turns, walking on uneven surfaces, and driving without an increase in symptoms. These impairments and activity limitations made it difficult for this patient to work as an accountant and participate in family activities.

Outcomes: After 2x times a week for eight weeks on physical therapy interventions, all impairments were resolved, and the patient demonstrated successful completion of both personal and physical therapy goals which ultimately improved her quality of life further supporting previous research illustrating similar results.3 The patient initially could not complete the Dynamic Gait Index (DGI) due to exacerbation of symptoms, but at discharge she was able to complete it with a score of 22/24, indicating the patient was safe with ambulation.4 The patient demonstrated improved perceived level of handicap improving her score from 48/100 to 18/100 on the Dizziness Handicap Inventory (DHI), indicating mild perception of handicap associated with symptoms, as results were higher than the 18-point MCID recommended by research evidence.5

Discussion: Utilizing the evidence-based CPG established by the ANPT for peripheral vestibular rehabilitation is indicated for individuals with chronic unilateral vestibular hypofunction. Application and adherence to the CPG optimized the patient’s treatment efficacy and she was able to return to her professional and personal responsibilities symptom-free. Further research would suggest following this patient for a greater amount of time to gather data regarding the durability and lasting effects of her interventions.
Purpose/Hypothesis: The purpose of our study was to compare behavioral and physiological measures of gaze stability following 5 weeks of progressive gaze and postural stability exercises.

We hypothesized that ipsi and contralesional head rotation would show improved behavioral measures (Dynamic Visual Acuity, DVA) of gaze stability but not improved physiologic measures (Video Head Impulse Test, VHIT).

Number of Subjects: 12 patients: 6 Right, 6 Left unilateral de-afferentation (UVD) patients completed the exercise protocol.

Materials/Methods: The DVA Test included custom software developed by the JHU LVNA Lab integrated with a Windows 10a tablet and a single inertia measurement unit (XSENS Technologies, Enschede, Netherlands) mounted on a headband. We also collected DVA data in aged-matched healthy control subjects. All DVA (static, right, left) testing was completed at 200 cm. A minimum of > 120°/second active head rotation was required to generate the random optotype presentation. We used the Otometrics ICS System (Natus Medical Incorporated, Denmark) to measure the vestibular ocular reflex (VOR) gains (eye/head velocity). Subjective measures of balance confidence and dizziness handicap were also collected.

Results: The average time between UVD surgery and initial DVA/VHIT testing was 51 (± 54) days. Baseline yaw DVA scores were significantly impaired for both ipsi and contralesional head rotation. VOR gains were reduced only for ipsilesional head rotations; contra-lesional VOR yaw gains were normal. After a 5 week intervention, 50% showed improvement in DVA; 11/12 and 12/12 subjects reported positive change in their Activities Balance Confidence (ABC) and Dizziness Handicap Inventory (DHI) respectively; 6 subjects reported MCID (> 18 point change) in DHI scores, including subjects who did not show change in DVA or VOR gain measures.

Conclusions: Our data suggest patients with UVD have bilaterally impaired DVA even though contralesional VOR gains are preserved.

Clinical Relevance: Patients are reporting improved functional outcomes, despite not always showing improvements in DVA or VOR gains after a 5 week vestibular rehabilitation program.