ABSTRACTS

Academy of Neurologic Physical Therapy
Poster Presentations
TITLE: The Immediate Effects of Low Frequency Whole Body Vibration on Balance in Parkinson’s Disease

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Balance & Falls SIG

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ABSTRACT BODY:

Purpose/Hypothesis: The purpose of this study was to examine the immediate effects of low frequency whole body vibration (WBV) on dynamic balance in individuals with Parkinson’s disease (PD).

Number of Subjects: Eight subjects, aged 61-81 years (Mean age 71.75), with idiopathic Parkinson’s disease (Modified Hoehn & Yahr Stages 1-3) participated.

Materials and Methods: A quasi-experimental, one group design with repeated measures of limits of stability (LOS) was performed to examine the effects of low frequency WBV on dynamic balance in individuals with PD. WBV was administered using the Galileo® Med L Chip Research at 6 Hz for 5 minutes with 1 minute rest after each minute of intervention. LOS testing was performed on the NeuroCom SMART Balance Master® pre- and post- delivery of WBV. LOS testing measured reaction time, movement velocity (MVL), endpoint excursion (EPE), maximum excursion (MXE), and directional control (DCL) in eight directions. One movement trial lasting approximately 30-45 seconds was performed in each of the eight directions for a total of 4-6 minutes. Data was analyzed using the Wilcoxon Signed-Ranks test for nonparametric data.

Results: There was a statistical significant median increase in EPE in the backward right direction (median difference = -17.00; z = 2.38; p = .017) from pre-WBV (43.00%) compared to post-WBV (55.50%). Additionally, a statistical significant median increase in MVL was noted in the left direction (median difference = -0.70; z = -2.38; p = .017) from pre-WBV (1.70 deg/sec) to post-WBV (2.45 deg/sec). MXE increased significantly in the forward (median difference = -16.50; z = -2.24; p = .025) and backward (median difference = -18.50; z = -2.38; p = .017) directions. DCL increased significantly in the backward direction (median difference = -5.00; z = 1.99; p = .046). Non-significant differences were found between pre-post testing in the remaining conditions of the LOS test (p > .092).

Conclusions: Low frequency WBV had an immediate effect of improving some aspects of dynamic balance. Specifically, effectiveness was shown in the backward and backward right directions for EPE, MXE, and DCL. Additionally, the individuals were able to move quicker in the left direction while maintaining stability as MVL increased in that direction. Finally, individuals were able to move farther forward while maintaining balance as MXE improved in that direction.

Clinical Relevance: A short bout of low frequency WBV may have an immediate effect of improving some aspects of dynamic balance, especially in the backward direction, for individuals with idiopathic PD.
Impact of Mental Tiredness on Balance Control in Older Adults with and without Stroke

Purpose/Hypothesis:
The purpose of this study was to examine the effect of mental tiredness on balance control under different sensory conditions in healthy older adults and stroke population. We hypothesized that mental fatigue impairs balance control increasing the sway excursion of the center of mass (COM) during standardized balance tests healthy older adults and those with a chronic stroke. In addition, we hypothesized that the impairment in balance control attributed to the mental tiredness will be higher while these older adults perform a concurrent attention demanding cognitive interference task (dual-task paradigm).

Number of Subjects: Two groups of 15 healthy older adults (>65yrs), and one group of 15 older participants with chronic stroke participated in the study.

Materials and Methods:
15 healthy older adults and 15 older adults with chronic stroke were asked to stand on a force platform while performing 2 cognitive condition (no cognitive task and serial subtractions (SS) task) across the 6 sensory conditions of the Sensory Organization Test of the Balance Master before and after a cognitive fatigue task (stop-signal task for 60 min). In addition, 15 healthy older adults (control group) performed the same protocol before and after watching a documentary movie for 60 minutes. The conditions were: eyes open, fixed surface (EO/FS); eyes closed, fixed surface (EC/FS), eyes open, sway referenced vision (EO/SRV); eyes open, sway referenced surface (EO/SRS); eyes close, sway referenced surface (EC/SRS); eyes open, sway referenced surface and vision (EO/SRSV)). Center of mass (COM) acceleration changes were recorded using an inertial sensor (Xsens Inc.). Jerk, as an indicator of the smoothness of postural sway and the root mean square (RMS) of the COM acceleration signal were analyzed for all the experimental conditions.

Results:
Jerk and RMS were higher in the stroke group compared to the older adults group for all the 6 sensory conditions (p<0.05). Both groups showed a significant increase of Jerk and RMS after the cognitive fatigue task for all the sensory conditions (p<0.05). Differences in balance, assessed by jerk, between single and dual-task conditions was observed only during EO/SRSV after the cognitive fatigue task for older adults group, and during EO/SRS, EC/SRS, and EO/SRSV after the cognitive fatigue task for stroke group. In addition, a loss of balance incidence of 10% in EC/SRS and 30% in EO/SRSV, and 25% in EC/SRS and 17.8% in EO/SRSV was observed in older adults and stroke respectively, which increased post cognitive task to 46.6% in EC/SRS and 63.3% in EO/SRSV for older adults, and to 71.4% in EC/SRS and to 67.8% in EO/SRSV in stroke.

Conclusions: Our results indicate that mental tiredness, induced by sustained cognitive activity, can impair balance control during single and dual-task in older adults and stroke population.

Clinical Relevance: Mental tiredness could be considered as an intrinsic risk factor for falls in older adults and stroke population, and should be taken into account for preventive and therapeutic strategies.
Maintaining equilibrium while standing requires weighting and reweighting of sensory input from the visual, vestibular, and somatosensory systems under different cognitive demands. Typically, increased cognitive load is associated with reduced balance performance, however some studies suggest that a cognitive task during a challenging balance task may lead to a shift in focus of attention that allows for automaticity of the postural control process and thereby improves balance performance. This may be of importance in the presence of a moving visual environment, as someone might encounter while walking along a busy sidewalk. Our purpose was to test the effect of cognitive load on postural control given varying visual loads in healthy young adults. We hypothesized that increased cognitive load will increase the challenge of the overall balance task (i.e., increased sway), but will reduce utilization of visual cues to remain upright.

Number of Subjects:
Twenty-five healthy subjects (mean age 26.56±4.86, range 19-41, 13 females) participated.

Materials and Methods:
Participants stood in a tandem position on a force plate, wearing the HTC Vive headset. Three virtual 60-second scenes included either stationary stars, or stars moving in the anterior-posterior (AP) direction at a frequency of 0.2 Hz and an amplitude of 5 mm (low) or 32 mm (high). Each scene was repeated twice with and without an additional counting task: “serial threes” subtraction from a random 3-digit number. Postural sway was quantified via mediolateral (ML) and AP directional path (path). Weighting of visual input was reflected in AP gains (the magnitude of the postural response divided by the magnitude of the visual stimulus) and AP power spectral density at low frequencies (0 to 0.25 Hz) [PSD1].

Results:
A significant visual by cognitive load interaction was observed in ML path (p=0.018) but not in AP (p=0.41). The counting task increased participants’ sway in the ML path to a similar extent in both moving visual scenes but not in the stationary scene. AP gains were significantly lower with the high vs. low amplitude moving scene (p<0.001) with a non-significant trend of reduced gains with the counting task. We observed a significant reduction in PSD1 with the counting task (p=0.003), suggesting that participants moved less at the visual frequency (0.2Hz) when dual-tasking.

Conclusions:
The addition of a cognitive task increased the overall balance challenge in a dynamic visual environment, but appears to have reduced utilization of the visual cues when participants’ attention was allocated to counting (participants reported not even noticing that the stars were moving during the counting task).

Clinical Relevance:
If cognitive load reduces attention to visual load, when a patient experiences dizziness, imbalance or anxiety in a busy visual environment, it is possible that providing them with a secondary cognitive task may help via reducing the attention to the visual load. Added cognitive load may also cause an older adult to miss out on an important visual cue associated with stability. These hypotheses should be examined in future research.
The purpose of this study was to evaluate the test-retest reliability of the Modified Clinical Test of Sensory Interaction on Balance (mCTSIB) using a virtual balance device in a healthy young adult population.

Number of Subjects: Fifty-four healthy subjects, aged 20-27 years (Mean age 23.07, SD ± 1.6), participated in the study.

Materials and Methods: This study utilized a methodological, one-group design with participants performing the mCTSIB protocol using the VirtuSense (VS) VirtuBalance system™. Three trials of the mCTSIB were performed on two separate days to measure the mean center of gravity sway velocity under four conditions: eyes open (EO) on floor, eyes closed (EC) on floor, EO on foam, and EC on foam. Within-day reliability of trials 1-3 was estimated with intraclass correlation coefficients (ICC$^{2,1}$) and between-day reliability was estimated using the averages of trials 1-3 on day 1 and day 2 (ICC$^{2,3}$).

Results: Within-day reliability was moderate on day 1 (ICC = 0.498-0.702) and day 2 (ICC = 0.555-0.703). Between-day reliability was moderate to excellent (ICC = 0.735-0.833). The lower bounds of the confidence intervals of within-day reliability estimates were 0.241-0.580 while the lower bounds of the confidence interval for the between-day reliability estimates were 0.543-0.712.

Conclusions: Reliability of the VS for balance assessment using the mCTSIB test is moderate to excellent. Within-day reliability is higher on day 2 as compared to day 1 while between-day reliability is higher than within-day reliability.

Clinical Relevance: When using the VS to assess balance with the mCTSIB, clinicians should provide practice of each condition contained in the test. The higher between-day reliability as compared to within-day reliability suggests that clinicians should use the averages of multiple trials for each condition of the mCTSIB test when assessing balance using the VS.
Purpose/Hypothesis: Individuals with Parkinson’s disease (PD) are more prone to falling, resulting in decreased quality of life and loss of independence. Although decrements in dual-task balance have shown promise to predict falls, little attention has been given to the underlying physiological mechanisms of falls. The purpose of this study was to investigate neurophysiological changes, indexed by pupillary response, during dual task balance between three groups: PD fallers; PD non-fallers; and healthy controls.

Number of Subjects: Fourteen PD fallers (age: 69.9±6.8, sex: 7 male, Hoehn and Yahr stage II-III while ON medication), 19 PD non-fallers (age: 68.84±6.9, sex: 12 male, Hoehn and Yahr stage II-III while ON medication), and 35 age- and sex-matched healthy controls (age: 68.5±6.2, sex: 14 male).

Materials and Methods: Participants with PD were categorized into fallers (number of falls>0) or non-fallers (number of falls=0) based on their self-reported fall history in the past 12 months. The four balance conditions lasted 60 seconds and involved (1) single balance task with eyes open; (2) single balance task with eyes occluded; (3) dual-task with eyes open; (4) dual-task with eyes occluded. The dual-task comprised the auditory Stroop test. Pupillary response was recorded using a head-mounted eye tracker (Tobii Technology AB, Sweden). Balance was administered using a force platform (Advanced Mechanical Technology, USA). Two-way Factorial ANOVA and LSD post-hoc test were employed to compare pupillary response and CoP displacement across the four conditions and between the three groups.

Results: Pupillary response significantly increased with increased difficulty of the conditions (p=0.04). Pupillary response was significantly different between the groups (p<0.001). Post-hoc analysis demonstrated PD non-fallers (mean±s.d.) (0.43±0.2) exhibited greater pupillary response compared to the PD fallers (0.38±0.2) and healthy controls (0.34±0.1). CoP displacement in the anterior-posterior direction showed significant condition (p=0.04) and group (p<0.001) effect. Post-hoc analysis showed greater CoP displacement in PD fallers (51.4±2.1) compared to the PD non-fallers (49.6±2) and healthy controls (39.7±1.3). However, no interaction effect was observed in any outcomes.

Conclusions: Overall, the PD group had increased neurophysiological response, measured by pupillary response, and increased CoP during dual-task balance compared to the healthy controls. Interestingly, PD non-fallers had higher neurophysiological response compared to the PD fallers. This might suggest that PD fallers have limited cognitive capacity to perform similarly on dual-task balance compared to the PD non-fallers and healthy controls which leads to a higher risk for falls. Future studies are needed to investigate whether pupillary response can be used to predict future falls.

Clinical Relevance: Pupillary response is non-intrusive, objective, and cost-effective neurophysiological measure that reflects cognitive workload. In the future, pupillary response can be a potential tool to predict falls through understanding the neurophysiological underpinnings of dual-task balance deficiency in the PD population.
ABSTRACT BODY:
Purpose/Hypothesis: Falls and their consequences are known to be a major contributor to decreased health and well-being in older adults.\(^1,2\) Several studies suggest that fall rates are higher among individuals with long-term, physically and potentially cognitively disabling conditions such as people following stroke (CVA)\(^3,4,3\), with Parkinson’s Disease (PD)\(^5\), and Multiple Sclerosis (MS).\(^6-8\) However there is a lack of person-centered development to understand how older adults and people with a disability interpret falls and their consequences. The purpose of this study was to gain community-dwelling older adults (55 and older) with MS perspective on falls, conditions and circumstances surrounding falls, and what they feel would be important to include in fall prevention programs.

Number of Subjects: Twenty people with MS.

Materials and Methods:
Participants with MS were recruited from a hospital MS Center, a university MS research list serve, and posting on the National MS Society (NMSS) research website. Focus group or one-on-one interviews were conducted either in person, via phone, or Zoom (https://zoom.us), a secure HIPAA video program. Focus groups and individual interviews lasted 60-90 minutes. Transcripts and notes were reviewed and compared with recordings for accuracy. Responses were then coded.

Results: Twenty people with MS (men=8 [34.7%], mean age 63.2 years (SD 5.3, range 55-75)) participated in this study. Average time since diagnosis was 20.6 years (SD 9.6, range 9-44). Only 4 people reported the ability to walk without restriction/assistive device. Common themes emerged in the data analysis. All participants agreed that the definition of a fall required ending up on the floor. However, the starting point may differ depending on mobility ability. The number of falls based on their own fall definition versus the one most commonly used in research, (i.e., “landing on the ground or at some other level, such as a chair or bed”\(^9\)) differed, with an increase in the number of falls reported when using the research definition. Participants shared that many health care providers do not ask about falls when seeing a patient with MS. Most people with MS felt that fear of falling and concern about falling do not mean the same thing although in research, these terms are often used interchangeably. Participants wanted to learn how to fall and would not join a program with the word “fall” in the title. They also would like to be in a program with other people who have mobility issues (e.g., people living with stroke, PD, post-polio syndrome, spinal cord injury, etc.).

Conclusions: People with MS agree that the definition of a fall requires ending up on the floor but the starting point changes with disease progression and as their mobility ability changes. They have definite ideas on what they would like to have included in an fall prevention intervention.

Clinical Relevance: Results from this study highlight how patients define a fall and has implications for 1) improving accuracy in the actual number of falls that people with MS report, 2) how health care providers ask about falls and fear of falling, and 3) what patient-centered elements should be considered for inclusion in future fall prevention efforts and programs for people with MS, including the program name and potential facilitators and barriers to participation.
Purpose:
Our team has developed a new, exciting, and innovative independent community balance program, which is designed to decrease elderly fall risk and reduce long-term health care costs/complications of fall-related injuries.

Description:
Approximately $50 billion healthcare dollars are spent on fall-related injuries every year, and roughly $35-37 billion of those dollars are spent on individuals over the age of 65. Falls are the leading cause of traumatic brain injury (TBI) and account for the primary mechanism of injury in 95% of hip fractures. Falls occur in one out of every four individuals over the age of 65 and are a growing concern due to the poor quality of life after a significant fall and the financial burden to the individual and the healthcare system. It is estimated that by the year 2030, the population of individuals 65 years old and older will grow by 50%, which indicates direct costs associated with falls are expected to rise substantially if the current fall rate continues.

Fall prevention programs, especially those that incorporate dynamic balance, dynamic gait, and strengthening, have been shown to effectively reduce fall risk by up to 40%. Often times, patients are not referred for fall prevention programs or balance training in physical therapy (or in some cases referred back to physical therapy) until after falls have already occurred. The Brooks Rehabilitation BASE Program is designed to satisfy the aforementioned criteria and is in line with the CDC’s current recommendation of at least 2 hours and 30 minutes of physical activity per week. This program is specifically tailored to the participants involved and is created to challenge a participant’s balance beyond what he or she could do safely at home or in a gym.

The BASE Program (Balance, Agility, Stability, and Equilibrium) is a 12-week independent community balance program offered to both Brooks patients and other adults in the surrounding community for only $15 per month. This program is specifically designed for individuals who are interested in decreasing their risk of falling and/or maintaining balance gains they achieved during traditional physical therapy. Member-specific balance circuits are designed by a physical therapist for participants in the program; these circuits are comprised of ten 4-minute exercise stations with a 1-minute rest break between each station. By utilizing a passive harness system, members of the Brooks BASE Program will challenge their balance safely and independently for up to 3 days per week. Program inclusion and circuit-specificity is determined by completing a formal physical therapy evaluation prior to enrollment in the BASE Program as well as 3 subsequent re-assessments during the 12-week program. The evaluation and re-assessments enable the physical therapist to determine inclusion criteria satisfaction and tier placement for each individual within the BASE Program; these assessments also allow the therapist to design circuits that will specifically address the balance impairments of each individual by encompassing all facets of balance including vestibular, somatosensory, proprioceptive, visual, and musculoskeletal systems. After the 12th week of participation in the BASE program, participants will be eligible to continue the BASE Program without monthly re-assessments for $15 per month.

The BASE program has already demonstrated positive and clinically significant outcomes as well as high participant and managerial satisfaction during the first 6 BASE cohorts. To date, 35 participants have been enrolled in the BASE program and the results have been more than supportive of the mission to maintain balance gains achieved in traditional physical therapy; during the 12-week programs, clinically significant improvements in objective tests/measurements have been achieved even after skilled physical therapy has ended. Across all participants enrolled during the last year and a half, the average improvement in Activities of Balance Confidence Scale increased from 66.23% to 81.25%; this is an average improvement of 15.02%. The average BERG Balance Score improved from 46.21 to 51.91; this is an average improvement of 5.69 points. The average Functional Gait Assessment score improved from 16.59 to 23.68; this is an improvement of 7.09 points. The cancellation and drop-out rates have also been lower than traditional physical therapy. The first 2 cohorts of the BASE program had an average cancellation rate of 12.03% during the 12-week program, which indicates a high level of participant engagement and commitment. An additional 10 participants plan to be enrolled before the end of 2019, and our team is looking forward to providing an even more comprehensive and system-wide Brooks BASE program across multiple clinical sites and multiple stages of care in future phases.

Summary of Use:
For this platform, examples of tiered balance circuits will be displayed along with the combined data of initial evaluations and re-assessments of all 35 enrolled participants to date; this data will include participant ABC Scale scores, gait speeds, 5x Sit to Stand times, Timed Up and Go times, BERG Balance scores, and Functional Gait Assessment scores. The data regarding participant cancellation rate and program drop-out rate will also be included. BASE program strengths and opportunities for improvement will be discussed.

Importance to Members:
This platform is designed to introduce therapists to a program that serves to maintain dynamic balance gains achieved in traditional physical therapy such that the patient does not continue to return to physical therapy every 6-12 months due to inevitable functional balance decline associated with aging. As the medical field moves toward more cost-effective strategies and an increasingly preventative nature, independent balance program development/involvement will become a crucial aspect of geriatric care.
TITLE: walk2Wellness Update: Sustained Effects of Sensory Neuromodulation on Gait Function in Persons with Peripheral Neuropathy

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Balance & Falls SIG

AUTHORS: Lars Oddsson, Teresa Ann Bisson, Helen S Cohen, Sara R Koehler-McNicholas, Doris Kung, Patricia McCracken, Diane M. Wrisley

ABSTRACT BODY:

Purpose/Hypothesis:
Individuals with peripheral neuropathy (PN) commonly experience gait and balance problems (Vinik et al. 2017). We recently demonstrated immediate improvements in gait speed and balance function in PN patients wearing a sensory neuroprosthesis (Koehler-McNicholas et al. 2019, Wall et al. 2012), Walkasins® (RxFunction Inc., MN, USA), a lower limb sensory neuroprosthesis designed to replace lost foot pressure sensation in PN patients. Patients who improved their Functional Gait Assessment (FGA) score by at least 4 (Beninato et al. 2014) were considered Responders (Koehler-McNicholas et al. 2019) a group dominated by individuals with a history of falls (Oddsson & Koehler-McNicholas, 2019). The multi-site clinical trial, walk2Wellness, (NCT #03538756, www.clinicaltrials.gov) investigates long-term use of Walkasins (1 year). We hypothesize that improvements in gait and balance function are sustained long-term, here reported after six weeks of use.

Number of Subjects:
The walk2Wellness trial enrolls up to 150 patients at multiple sites 2018-2020. Here we report results for 20 subjects after six weeks of daily device use.

Materials and Methods:
Inclusion criteria include; PN diagnosis, loss of plantar sensation, presence of ankle vibratory sense, gait and balance problems (FGA score below 23, Wrisley & Kumar 2010). Clinical outcomes include FGA, Gait Speed (Normal & Fast), Timed Up&Go and Four-Stage Balance Test, Activities-Specific Balance Confidence score (ABC), Vestibular Activities of Daily Living (VADL) and Pain rating (0-10 scale). Participants are evaluated at an initial visit and at two, six, 10, 26 and 52 weeks. Statistical analysis of the data is not conducted at this stage. Mean values of outcomes are reported here.

Results:
Participants showed these baseline characteristics and outcomes (all means): age 75.7; 16 male; 4 female; 14 used assistive device; FGA score 14.0, normal and fast gait speed 0.79 m/s and 1.16 m/s, respectively; Timed Up&Go 14.1s; 4-Stage Balance Test 26.1 s; ABC Balance Confidence score 60.0 (0-100 scale); VADL score 3.8; pain score of 3.3. At six weeks the following outcomes were noted: FGA 17.3, normal gait speed 0.86 m/s, fast gait speed 1.23 m/s, Timed Up&Go 14.5s; 4-Stage Balance Test 26.3 s; ABC Balance Confidence score 62.3; VADL score 3.6; pain score 3.3.

Fourteen participants increased initial FGA score by 3 or more points (mean 4.3) with the device turned on. After six weeks their FGA change was 4.6, normal gait speed increased by 0.09 m/s and fast gait speed by 0.10 m/s. ABC scores were initially 62.5 and 61.0 at six weeks. The remaining six participants showed an initial increase in FGA by 1.5 and 0.7 at six weeks. Normal and fast gait speed at six weeks changed by 0.05 m/s and -0.03 m/s, respectively. ABC scores were 54.2 and 65.0 at baseline and six weeks, respectively.

Conclusions:
Individuals who initially responded to balance cues from the device appear to sustain changes up to at least six weeks of use.

Clinical Relevance:
The Walkasins device may provide a new way to improve gait speed and balance in patients with PN.
Purpose/Hypothesis: Individuals with Multiple Sclerosis (MS) are at higher risk for falls and will sustain one fall on average every 6-months\(^1\). The Nijmegen Falls Prevention Program (NFPP) was created to focus on falls prevention and fall technique training to reduce the risk of injuries associated with falls. The purpose of this study was to examine the effects of the NFPP on balance, gait speed, confidence levels and risk for falls of individuals with MS. Since physical exercise and dynamic balance training are effective in decreasing risk for falls in individuals with MS\(^2\), it was hypothesized that the NFPP would improve balance, gait speed and confidence as well as reduce the risk for falls in individuals with MS.

Number of Subjects: Ambulatory individuals with MS (n=4) (age=62±5.6 years, 100% female, 100% Relapsing-Remitting). Incidence in past year (100%≥1 fall, 75% fall with injury, 25% fall with fracture, 25% fall resulting in hospitalization).

Materials and Methods: NFPP consisted of 1 session of obstacle course training and 1 session of fall technique training, every week for 5 weeks. The obstacle course included 19 stations with varying degrees of difficulty that changed with each session. Balance, gait speed, confidence level and fall risk were assessed at the baseline session and on completion of the program (final session) using the following outcome measures: Activity-specific Balance Confidence Scale (ABC)\(^3\), Falls Efficacy Scale (FES)\(^4\), BERG balance test (BBT)\(^5\), Functional Reach (FR), Tandem Stance (TS) and the Timed Up and Go Test (TUG). Gait speed was calculated using the 10-Meter Walk Test (10MW) and completion time and error rate on the obstacle course were also collected at both sessions. Paired t-test was performed to determine the effect of NFPP on these outcome measures and significance level was set at p<0.1 due to a small sample size.

Results: The following outcomes were significantly different (p<0.1) between the baseline and final sessions: ABC (15.6% improvement in balance confidence); FES (22.6% reduction in concerns about falling); BBT (9% improvement in balance); gait speed (22.6% faster speed) and obstacle course (31.6% faster completion time and 50% lower error rate). The FR test (6.7%); TS (65%) and TUG time (24%) showed improvements but were not significantly different between sessions.

Conclusions: NFPP was successful in improving perceived self-confidence, standing balance, gait speed and performance on obstacle course and in reducing fall risk in subjects with MS. The common risk factors associated with falls and fear of falling could be targeted in the treatment of patients with MS. However, additional research with a bigger sample is needed before the findings can be generalized.

Clinical Relevance: This study demonstrated the ability of the NFPP to positively influence perception and risk for falls in individuals with MS. Training programs that specifically target the common risk factors associated with falls and fear of falling could improve outcomes in this population.
ABSTRACT BODY:

Purpose/Hypothesis: Individuals with vision loss due to macular changes are at greater risk for falls and decreased mobility. Workers with vision loss have reported 'obstacles in path' as a significant barrier in pursuing occupational advancement. Although participation in work and daily life is heavily influenced by ability to see, research on accommodations, such as lighting, has been limited to individuals without visual impairments. The purpose of this preliminary study was to identify the impact of lighting and visual acuity on functional mobility in individuals with macular dystrophy. It is hypothesized that individuals will improve obstacle navigation in well-lit conditions, especially for those with lower visual acuities.

Number of Subjects: Five individuals (3 female) with macular dystrophy, aged 35-69 years (mean: 55.6 years, std. dev: 14.7 years).

Materials and Methods: Participants walked down a 40 foot walkway free of obstacles in a well-lit environment to establish baseline gait speed. Each participant then navigated through an obstacle course standardized to assess visual function and mobility in individuals with low vision. The navigation task was performed in dim and well-lit conditions. The primary outcome measure was speed of obstacle navigation normalized to participant’s baseline speed (percent of patient preferred walking speed—pPPWS). Visual acuity—in better and worse eyes—was compared to pPPWS in both lighting conditions. The Fullerton Advanced Balance Assessment (FAB) and Functional Gait Assessment (FGA) were also performed. Outcomes were assessed for each participant individually due to the small preliminary sample.

Results: For obstacle course navigation, all participants had slower gait speeds compared to their baseline assessment as indicated by a pPPWS less than 100% (range: 15.7%-82.3% of baseline). Four of the five participants had higher pPPWS in the well-lit condition compared to the dim condition (range: +2.9% to +15.5%). One participant had a lower pPPWS in the well-lit condition compared to dim (-2.6%). Overall, participants will lower visual acuity had lower pPPWS in both light conditions; however, this trend was more consistent when evaluating visual acuity in the worse eye. There was no consistent relationship between the FGA or FAB and visual acuity. Scores ranged from 17-27 for the FGA and 18-28 for the FAB. One participant had scores indicative of increased fall risk (FGA: <18, FAB<25).

Conclusions: Improved lighting may promote improved navigation in those with macular dystrophy. Lower visual acuity, especially in the worse eye, is associated with poorer performance on an obstacle assessment for visual function. In this preliminary sample, degree of visual acuity was not indicative of FAB or FGA performance.

Clinical Relevance: Physical therapists should consider lighting when working with individuals with macular dystrophy, who may be at greater risk for falls. Functional assessments commonly used to assess fall risk (ie. FAB, FGA) should be further investigated for this population.
Title: Yoga As an Intervention for Individuals with Parkinson’s Disease (PD) on Balance and Dual-Task Performance

Current Section: Neurology

Current Sub-Category: Balance & Falls SIG

Authors: Zachary Levin, Melissa Patrick, Jason Trinh, Derek Matthew Liuzzo

Abstract Body:

Purpose/Hypothesis: The purpose of this preliminary study is to examine the effect of yoga on balance, with and without dual-task (DT) performance, in individuals with Parkinson’s disease (PD). Balance was measured by postural sway on a force plate and the DT was a cognitive task. The hypothesis is that participants with PD will demonstrate immediate improvements in balance and DT performance after completion of a yoga intervention.

Number of Subjects: 5 participants diagnosed with PD in Hoehn & Yahr stages 1-3 completed the study, 4 of which reported use of medication for PD.

Materials and Methods: Demographics, medical history, and fall history were collected prior to testing. The following measures were performed before and after the yoga session. Participants’ perception of fall expectancy and fatigue were rated 1-10 using the Visual Analog Scale (VAS). Participants were asked to reach as far forward with 1 arm in standing for the functional reach (FR) test. For the single task (ST) of static balance, participants were asked to stand quietly on a force platform for 10 seconds. For the dual task (DT) of static balance and a cognitive task, participants were asked to stand on a force platform for 10 seconds while saying as many words that start with a random letter. For the intervention, participants were led through a single, 30 minute yoga session with an emphasis on postural awareness, proprioception, balance, weight transfer, guided gait training, and coordination of breathing with movement.

Results: Overall, participants experienced decreased postural sway during both ST and DT after yoga. ST median postural sway velocity decreased 6.13% from 8.73 [8.05, 10.91] cm/s to 8.18 [7.94, 11.13] cm/s. DT median postural sway velocity decreased 7.17% from 8.95 [8.73, 11.50] cm/s to 8.308 [8.10, 11.16] cm/s. Median dual task cost (DTC) decreased from 8.37 [-1.94, 12.65]% to 2.04 [-4.17, 6.29]%.

Conclusions: The participants in the study improved overall with decreased postural sway velocity and perceived fall expectancy scores and increased FR. Not all participants improved in each category and some regressed. This can be attributed to many factors such as feeling in the “off” phase of the Carbidopa-Levodopa medication. However, firm conclusions cannot be made based on the size of our study.

Clinical Relevance: This preliminary study demonstrates how individuals with PD can exhibit immediate improvements in postural sway and DT, thus increased balance after yoga. This is relevant for potentially increasing safety and independence by decreasing falls in the PD population for future research.
Purpose/Hypothesis:
The aims for this study were: 1) to determine if persons with multiple sclerosis (pwMS), reporting at least one fall in the past six months (faller) have different peak torques for bilateral knee extension (KE), ankle plantarflexion (APF), and ankle dorsiflexion (ADF) compared to non-fallers; and 2) to determine if the peak torque of the different strength measures can detect those at a greater risk of falling, by identifying cutoff scores for each muscle group. It was hypothesized that weakness in APF and KE would be associated with an increased incidence of falls.

Number of Subjects: 79

Materials and Methods:
A convenience sample of 24 males and 55 females with MS (mean age: 50.6 ± 11.2 years) participated in the study. Individuals who had a relapse in the past 60 days, a recent injury or relevant surgery, any absolute contraindications to exercise, or an abnormal response to physical activity were excluded. Self-reported number of falls were collected and used to categorize fallers (at least one fall in the past six months) and non-fallers. Isometric lower extremity (LE) ADF, APF, and KE strength (peak torque [ft-lbs]) was assessed via a Biodex System 4 Pro dynamometer for the dominant (D) and non-dominant (ND) LE. Independent t-tests were performed to assess for differences strength between fallers (n=51) and non-fallers (n=28). Receiver-operating-characteristic (ROC) curves were performed only for LE muscle groups that were significantly different to estimate the classification accuracy. Optimal cut-off scores were calculated using the Youden Index. The sensitivity, specificity, and area under the curve (AUC) were compared to determine the best predictor for falls.

Results:
When comparing fallers to non-fallers, differences were observed in ND APF (p=0.004), D APF (p=0.021), and ND KE (p=0.025) strength. No differences were found for D KE (p=0.086), D ADF (p=0.072), and ND ADF (p=0.082). The following strength cut-off scores were identified: ND KE, 49.5 ft-lbs; ND APF, 19.9 ft-lbs; and D APF, 22.5 ft-lbs. Only ND APF demonstrated an area under the curve consistent with being a true predictor of falls, with a classification accuracy of 70.1%, sensitivity of 62.8%, and specificity of 78.6% in detecting fallers.

Conclusions:
Although fallers produce significantly less peak torque during isometric APF and ND KE compared to non-fallers with MS, D KE and D APF strength were not predictors of falls. Adequate APF strength is crucial for maintaining balance via the ankle strategy. Though strength is only one factor contributing to falls, ND APF may be a target muscle group for pwMS.

Clinical Relevance:
Injuries from falls are a significant health concern for pwMS. Improving our understanding of the relationship of LE strength and falls provides targeted areas to screen for persons at risk for falls in MS.
TITLE: Perturbation-Based Balance Training Post-Stroke MAY Reduce Fall Risk By 50%: Systematic Review and Meta-Analysis

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Balance & Falls SIG

AUTHORS: Katherine Francina Marie Kempkey, Adrianna Castilla, Jonathan Sanching Tsay, Marsha E. Melnick, Diane Dameron Allen

ABSTRACT BODY:

Purpose/Hypothesis: Patients post-stroke often have slowed balance reactions and mobility deficits that lead to falls. Falls post-stroke are highly prevalent and can have severe consequences such as injuries, hospital admissions, immobility, and caregiver dependence. While Perturbation-based Balance Training (PBT) has improved rapid balance reactions and decreased falls in older adults and patients with Parkinson’s Disease, results are mixed for patients post-stroke. We analyzed existing literature on PBT post-stroke and hypothesized that PBT would improve balance/mobility or reduce falls for patients post-stroke.

Number of Subjects: Studies were included if participants were post-stroke, interventions used external perturbations, and outcomes recorded balance, mobility, or falls. Six studies met the inclusion criteria with a total of 244 participants. Participants varied in etiologies and presentations, but most were at least 3 months post-stroke.

Materials and Methods: PubMed, CINAHL, and Web of Science were searched. Two independent reviewers screened titles and abstracts and eliminated duplicates. Full texts of eligible studies were evaluated for quality and level of evidence using the PEDro and Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklists. Balance and mobility outcomes included the Berg Balance Scale (BBS), Timed Up and Go (TUG), and Activities-specific Balance Confidence questionnaire (ABC). Means and standard deviations were used to calculate within- and between-group effect sizes (ES) with 95% confidence intervals (CI). To compare fall frequency data between groups, a combined rate ratio (RR) with a 95% CI was calculated.

Results: Two studies were evaluated as level 1b on Jewell’s hierarchy of evidence, one study was level 2b, and the remaining three studies were level 4 evidence. Within-group analyses revealed statistically significant differences for the BBS (ES=0.71, CI=0.44,0.98) and ABC (ES=0.47, CI=0.18,0.75). Between-group analyses revealed significantly fewer falls in the PBT group (RR=0.56, CI=0.35, 0.89). No other findings were statistically significant.

Conclusions: Patients post-stroke receiving PBT performed equally well in standard balance/mobility measures compared to those receiving other balance-focused interventions. Notably, fall frequency was 50% less in the PBT groups compared to controls. PBT therefore shows promise as a critical balance intervention in patients post-stroke. Because protocols used different delivery methods, intervention duration, and outcome measures, future research is required to determine the most efficacious protocols for PBT and the most reliable assessments of balance/mobility.

Clinical Relevance: Compared to other balance interventions, PBT post-stroke reduced falls more and improved balance/mobility just as effectively. Reactive balance training during PBT may specifically enhance reaction time during obstacle negotiation that can reduce falls. Physical therapists should consider PBT as an important multi-modal adjunct to reduce falls in patients post-stroke.
Purpose/Hypothesis: Traditional static balance tasks have limited ecological validity to sport; sport often requires recovering balance during times of high cognitive demands. Reactive balance tasks are commonly used in mobility-impaired populations, but the value of a clinically-feasible reactive balance task in a highly athletic population is unclear. To address this gap, we examined the effects of a cognitive dual-task on reactive postural control task in collegiate athletes. As cognitive tasks have also been shown to impact cortical activity and alter postural responses after a given perturbation, we hypothesized that a clinically-feasible reactive balance task would identify slower reactive balance during concurrent cognitive tasks, even in a highly athletic population.

Number of Subjects: 11 male college athletes were recruited through the University of Utah Athletic Department (mean (SD) age = 20 (1) years; height = 200 (11) cm; mass = 90 (9) kg).

Materials and Methods: Postural responses were assessed using the Push-and-Release (P&R) test in four directions (forward, backward, left, right) during both single- and dual-task conditions. Participants were instructed to keep their eyes closed prior to the release to eliminate preparatory visual feedback. The dual-task was a variable verbal cognitive dual-task. Inertial sensors on the sternum, lumbar spine, right tibia, left foot, and right foot were used to assess the latency of stepping and the time of first heel strike. These metrics provide objective, valid measures comparable to laboratory-based measures. A sensor was also placed on the tester’s hand to identify the moment of release. Linear mixed models assessed the difference between single- and dual-task while adjusting for test direction and repeated measures.

Results: A main effect of task was found for step latency, with longer step latencies occurring during the dual task (b = 49.63 ms; p < 0.001; 95% CI = [27.012, 72.24]). There was no difference between single and dual tasks for the time until first heel strike (b = -1.50 ms; p = 0.95; 95% CI = [-45.27, 42.28]).

Conclusions: A significant dual task cost was observed for step latency, but not for time of first heel strike. While the addition of a cognitive task impacted the latency of step initiation, these highly functioning, neurologically healthy athletes were able to compensate for their late initiation by increasing the movement velocity of their stepping limb. This compensation allowed them to eliminate any dual-task deficit by the time they completed their first step.

Clinical Relevance: The P&R test is often used with more balance impaired populations. By adding a cognitive task and eliminating visual input, it appears sensitive to dual task cost in a highly athletic sample, especially when used in combination with inertial sensors. The ability to assess how a dual task impacts balance recovery may be useful when examining the effects of concussion on postural control and the recovery of postural control following a concussion for return to play decisions.
Purpose/Hypothesis: Parkinson’s disease (PD) is associated with both postural instability and gait disturbance. Gait changes with PD occur with both forward and backwards walking, but are more pronounced when moving backwards. While slower speed, reduced cadence and smaller steps in the forward direction have all been associated with falls in PD, similar studies investigating the relationship between backwards gait characteristics and falls are lacking. The purpose of this study was to examine the association between backwards gait performance and clinical measures of postural stability for individuals with PD.

Number of Subjects: 19 individuals with Parkinson’s disease (11 males; 8 females) ranging in age from 45-87 years (mean=66.7) participated in this study. Participants Hoehn and Yahr stages ranged from 1-4 (mean 2.37) and they were a mean of 6.77 years post diagnosis.

Materials and Methods: Demographic data and self-reported history of falls within the previous year were recorded for each participant. All participants were tested during the on-phase of medication. Time and number of steps to complete a standardized, 5m backwards gait assessment were recorded. Postural stability was assessed using the MiniBESTest and self-reported balance confidence was measured with the Activities-Specific Balance Confidence (ABC) Scale. Descriptive statistics, Spearman’s Rho and Pearson’s correlations were calculated using SPSS version 23.

Results: Backwards gait assessment was completed in a mean of 12.1 seconds (±5.7) and 19.4 steps (±8.3). Both time and number of steps on backwards gait assessment demonstrated a strong negative correlation with the total MiniBESTest score (r=-0.878, p=0.000 and r=-0.707, p=0.001 respectively). A moderate negative correlation was found between backwards gait (time and steps) and the ABC Scale (r=-0.551, p=0.015 and r=-0.552, p=0.014 respectively). Only the ABC Scale demonstrated a significant negative correlation with self-reported falls history (r=-0.522, p=0.022).

Conclusions: The miniBESTest and the ABC Scale, both of which have established falls risk cut-off scores, are correlated with backwards gait speed and performance. While the miniBESTest and backwards gait did not show a correlation with history of falls in this study, this may be due to the retrospective, rather than prospective data that was analyzed. In conclusion, individuals with PD who move slower and take shorter steps when walking backwards are more likely to demonstrate balance impairment and a fear of falling.

Clinical Relevance: Backwards gait assessment measuring time and number of steps over a 5m distance is a feasible test to perform in a clinic setting with minimal equipment. Further research should examine the reliability and validity of this assessment to screen for postural instability and predict falls risk in individuals with Parkinson’s disease.
What Is behind Dual-Tasking and Mild Cognitive Impairment in Parkinson’s Disease and Freezing of Gait?

**CURRENT SECTION:** Neurology  
**CURRENT SUB-CATEGORY:** Balance & Falls SIG  
**AUTHORS:** Alessandra Swarowsky, Ana Sofia Kauling de Souza, Marcelo Pinto Pereira, Talita Kuhn, Rafaela Simon Myra, Suhaila Mahmoud Smaili

**ABSTRACT BODY:**

**Purpose/Hypothesis:** Studies have indicated that freezing of gait (FOG) is related to the impairment of cognitive domains such as attention and executive function in people with Parkinson’s disease (PD). Such as FOG, mild cognitive impairment (MCI) contribute to a major risk of falls in this population influencing the gait parameters as well. One of the ways of sensitizing the relation between cognition and gait is performing a dual-task (DT). When gait was analyzed while performing a DT, evidence showed a worsening in almost all spatiotemporal parameters in PD persons who presented MCI except the step length variability. When included PD persons presenting MCI and FOG, the results showed differences in swing time, time of single and double-support and as well as gait speed. However, all of these findings were attributed only to MCI, excluding any influence of FOG. For this reason, this study aims to analyze the spatiotemporal parameters of gait (stride length, speed and width, pace time, time of single, swing and double support and its variability) as well as the number of errors while performing a single and DT while walking in PD with and without MCI considering FOG as a co-variable.

**Number of Subjects:** 24

**Materials and Methods:** 24 PD persons with mean age 68 (±7.5), Hoehn & Yahr mean 2.3 (±0.5) were divided into two groups: PD with MCI (n = 11) and PD without MCI (n = 13), according to MOCA scores (< 26/30: with MCI and ≥ 26/30: without MCI). For FOG screening was used the FOGQ question 3: ≥1 (i.e., rarely, about once a month) was classified as showing freezing; <1 (i.e., never) were classified as not showing freezing. Both groups performing 3 different tasks: 1 (habitual gait at comfortable speed), 2 (functional cognitive dual-task: gait at comfortable speed associated with answering questions while walking) and 3: (non-functional cognitive dual-task: gait at comfortable speed associated with counting even/odd numbers), in an 8-meter track, randomized and repeated 5-times each. The gait variables were analyzed through Vicon Motion and processed by Matrix Laboratory (MATLAB) program. An analysis of covariance (Ancova) was performed to evaluate the effect of the group (DP with MCI and DP without MCI) and task (1, 2 and 3) including FOG as covariate. This research was approved by the University Research Ethical Review Board of the Santa Catarina State University, Brazil (nº 2.274) and all participants gave their informed consent to join this study.

**Results:** When FOG was considered as a covariate, there was no difference between groups or group and task. However, there was an effect of the task (1x2x3) with significant difference in stride length (p < 0.01; F = 17.15; η² partial = 0.44; Power = 0.99), stride speed (p < 0.01; F = 23.66; η² partial = 0.52; Power = 0.99) and swing time (P = 0.02; F = 3.93; η² partial = 0.15; Power = 0.67). When the variability was analyzed, a task effect (1x2x3) was found only at the pace time (P = 0.01; F = 4.36; η² partial = 0.17; Power = 0.72). Regarding the mean of errors in the non-functional cognitive dual-task (3), there was no significant difference (P = 0.13), although the PD/MCI group presented a higher number of errors.

**Conclusions:** Our results showed that there were no significant differences in spatiotemporal parameters of gait between groups, suggesting that MCI alone is not determinant in gait parameters.

**Clinical Relevance:** Our findings suggest that FOG has a crucial role and it might be more relevant than the cognitive impairments per se in gait performance in Parkinson’s disease. For these reasons, both MCI and FOG should be considered and should not be assessed in isolation. This study has provided a step forward towards the understanding of the approach of the physical therapist in this patient profile as well as providing a foundation for future studies.
Background and Purpose: An estimated 20 million people in the United States have some form of peripheral neuropathy (PN) according to National Institute of Health. Diabetic neuropathy (DN) is the most common complication of diabetes. Pathophysiological changes in peripheral and central vestibular structures due to diabetes have been noted, and vestibular screen and exercises are warranted. Chemotherapy induced peripheral neuropathy (CIPN) is a frequent complication of chemotherapy. Idiopathic peripheral neuropathy (IPN) typically occurs in people > 60 years without a clear etiology. The authors hypothesized that patients (pts) with PN will have increased presence of vestibular dysfunction despite different etiology. Screening pts with PN for deficits with vestibulo-ocular reflex (VOR) and adding gaze stability exercises may improve the use of all systems for balance reactions and decrease fall risk. The purpose of this case series was to evaluate the presence of vestibular dysfunction in pt’s with CIPN and IPN, as well as benefits of incorporating gaze stability exercises into their physical therapy (PT) program.

Case Description: We present 2 pts with PN: CIPN and IPN. Both pts were referred to PT for balance and gait training due to PN with complaints of imbalance and feet paresthesias. Neither of the pts reported dizziness. Clinical examination for PN included: deep tendon reflexes, proprioception, vibration sensation, light touch, and muscle strength. Function of the vestibular system was evaluated with manual and computerized Dynamic Visual Acuity Test (DVA), to assess pt’s gaze stability during head movements (0.2 LogMAR and 0.33 LogMAR difference or less being normal respectively; and normal angular velocity of 120 deg/sec or more). Pt 1 was an 80 year old female with IPN. Pt 2 was a 63 year old female with CIPN. In addition to static/dynamic balance exercises and aerobic conditioning, pts were prescribed gaze stability exercises.

Outcomes: Pts completed 8 sessions of PT. Pt 1 improved her FGA from 11/30 to 17/30, gait speed from 0.95 m/s to 1.15 m/s, manual DVA from 0.4 LogMAR to 0.2 LogMAR, and computerized DVA from 0.51 LogMAR to 0.24 LogMAR. Pt 2 improved her FGA from 20/30 to 26/30, gait speed from 1.04 m/s to 1.19 m/s, manual DVA from 0.3 LogMAR to 0.1 LogMAR, and velocity of head turning from 116 deg/sec to between 121 and 144 deg/sec. Both pts reported subjective improvements in balance.

Discussion: There may be a correlation between PN and vestibular dysfunction based on the presence of VOR abnormality in these cases. Significant improvement occurred on all fall risk outcome measures and VOR function returned to normal. Previous publications reported PT lasting from 18 sessions to 12 months for pts with DN and CIPN as compared to the 8 sessions in this case series. These studies did not include vestibular exercises. Further investigation is warranted to screen pts with additional types of PN and implement VOR training if needed. In the future, it may be reasonable to promote incorporating vestibular screening into the initial assessment of Pts with PN referred to PT for balance dysfunction and fall prevention.
Individuals after stroke often have physical impairments including balance deficits that increase falls risk. Patients post stroke are more likely to fall than those in other diagnostic groups in the inpatient rehabilitation setting (IRF). Consequences of falls may include the need for additional medical procedures, increased lengths of stay, and increased utilization of resources. Identifying those patients at risk for falling and minimizing that risk is imperative in all healthcare settings. The Berg Balance Scale (BBS) has been found to predict falls in multiple diagnostic groups. However, the literature on the use of the BBS to predict falls for patients after stroke while in IRFs is inconclusive. In those studies that do identify the BBS as fall predictor tool, there is variability in the cut off scores. The purpose of this study was to examine the ability of the BBS to identify potential fallers in patients on a stroke unit within an IRF. We hypothesized that the BBS can identify those patients who are at risk for falling while in an IRF. Two cutoff scores (40 and 31) that were identified in the literature as falls risk indicators were examined for predictive accuracy.

**Number of Subjects:**
362 stroke patients in an urban IRF; 174 males, 188 females.

**Materials and Methods:**
Falls were recorded using an internal reporting system. Characteristics and BBS scores of fallers, repeat fallers, and non-fallers were examined and compared at the time of admission. Cut off scores of 40 and 31 were examined for fall prediction accuracy.

**Results:**
Fallers (p<0.05) and repeat fallers (p<0.001) scored lower on the BBS than non-fallers. Fallers (p<0.01) and repeat fallers (p<0.05) stayed in the inpatient rehabilitation setting longer than non-fallers. Repeat fallers were younger than non-fallers (p<0.0015). The cut off scores of 40 and 31 were both found to be sensitive (95% and 90% respectively) but not specific (16.46% and 30% respectively) with poor positive predictive values.

**Conclusions:**
Although the majority of fallers were accurately identified, a large number of individuals were also identified as likely fallers who did not actually fall. Therefore, these cut off scores were sensitive but not specific, indicating type I error. Previously identified falls risk scores for the BBS indicated in the literature did not accurately identify fallers in this population.

**Clinical Relevance:**
The utilization of a sensitive and specific falls predictor assessment tool should be an essential part of the admissions process into an IRF to increase safety and reduce harm. The BBS may not accurately identify falls risk in this setting for patients after stroke. Further investigation is required to identify if there is a falls risk assessment tool that is predictive of falls for patients with stroke in the inpatient rehabilitation setting. This tool should have a strong positive predictive value to prevent over utilization of resources to prevent falls.
Title: Effectiveness of Whole Body Vibration on Mobility in an Individual with CMT: A Case Report

Current Section: Neurology

Current Sub-category: Balance & Falls SIG

Authors: Christina M Kelly, Jennifer A Bogulski, Stacie Dailey, Bethany Sivak

Abstract Body:

Background and Purpose: Charcot Marie Tooth (CMT) is an inherited neurologic disorder resulting in neuropathy. Individuals with CMT present with skeletal deformities, extremity weakness and peripheral sensory deficits, impacting balance and functional tasks. Focal vibration has been effective in improving balance in individuals with CMT. Recent evidence suggests whole body vibration (WBV) improves balance for individuals with peripheral neuropathy due to diabetes and chemotherapy. The implications of WBV has not been investigated in individuals with CMT.

Case Description: The patient is a 42 year old female with CMT Type 1A. Initial examination testing revealed joint position sense and kinesthesia was absent below the ankles and sensation below the knee was diminished (50%). Functionally, she noted balance declines, difficulty with ambulation and sit to stand transfers. Examination testing included Five time Sit to Stand (5xSTS), 10 meter gait speed, postural sway assessment and Functional Gait Assessment (FGA). The patient participated in a therapeutic exercise program using a WBV (60 Hz) platform twice a week for eight weeks.

Outcomes:

Immediate Results: Following the first intervention session, the patient was re-assessed on the FGA and 5xSTS to examine any immediate effect in functional performance. FGA score improved from 20/30 to 21/30, 5xSTS decreased from 14.53 seconds to 12.72 seconds and 10m gait speed increased from 1.19m/s to 1.26m/s. The improvements noted were in tasks relying on sensory input.

Eight Week Outcome: Post-testing was completed after eight weeks of treatment using WBV. The patient improved her FGA to 24/30, 5xSTS to 9.66 seconds and 10m gait speed improved to 1.14m/s. Postural sway, measured using the BTrackS force plate, showed improved limits of stability and mCSTIB for measures of somatosensory cues improving from a sway path length of 161 cm at baseline to 78 cm at post-assessment.

Two Week Post Intervention: Functional testing declined to a score of 22/30 on the FGA, 5xSTS increased to 11.06 seconds and gait speed remained unchanged. Postural sway gains were maintained in the two weeks after intervention without the use of WBV intervention.

Four Week Post Intervention: The patient scored a 21/30 on the FGA indicating an elevated fall risk classification. Her 5xSTS score increased to 12.33 and gait speed remained at 1.14m/s. Postural sway path length increased to 90cm.

Discussion: This patient case demonstrates improvement in function and balance after eight weeks of WBV. Immediate improvement in outcomes was found after one intervention session; however, these results did not have lasting effects. With prolonged WBV intervention, the patient demonstrated substantial improvement in balance and function decreasing her fall risk classification and achieving clinically important difference in scoring. Although four week reassessment indicated regression in scoring, she still remained above baseline testing scores. These results warrant further investigation to examine prolonged use of WBV for individuals with CMT compared to a typical land-based program.
The Effects of Balance-Based Torso-Weighting in Individuals with Various Neurological Conditions; A Case Series

**ABSTRACT BODY:**

**Background and Purpose:**
Gait dysfunction and falls are a major debilitating complication in many neurological conditions. Balance-Based Torso-Weighting (BBTW), an orthotic device, involves assessment of directional instability using systematic perturbations to inform strategic placement of light weights that counter imbalance. BBTW has resulted in increased gait velocity and improved postural control in select individuals with gait ataxia but has not yet been tested in a more diverse neurological population. The purpose of this case series is to evaluate the immediate effect on gait stability with the use of BBTW in three individuals with different neurological diagnoses.

**Case Description:**
Three participants, each clinically diagnosed with one of the following: multiple sclerosis (MS), Huntington’s disease (HD) and chronic inflammatory demyelinating polyneuropathy (CIDP) were recruited from a physical therapy clinic on Long Island. All individuals presented with gait instability as determined by the Functional Gait Assessment (FGA). Subject 1: 56 y/o male with dx MS with self-reported fall history of 1 fall/3mos. Subject 2: 62 y/o female with dx of HD self-reported fall history of several times/month. Subject 3: 73 y/o female with dx of CIDP with negative fall history. All subjects completed a medical questionnaire including fall history. Subject’s gait assessment was performed using the FGA. Subjects were then assessed with the BalanceWear vest utilizing standardized BBTW assessment protocol (0.25-2 pounds). Following the fitting, subjects were immediately retested with the FGA.

**Outcomes:**
All 3 subjects showed significant improvement in their postural control during gait and a Minimally Clinically Important Difference (MCID) of greater than 4 points using the FGA. Subject 1 had 57.5% improvement in FGA (12/30 pre-test, 19/30 post-test). Subject 2 had an 78.4% improvement in FGA (11/30 pre-test, 20/30 post-test). Subject 3 showed an 82.5% improvement in FGA (12/30 pre-test, 22/30 post-test).

**Discussion:**
BBTW application demonstrated immediate impact in improving gait stability in all three subjects as documented by improvements in FGA. BBTW may have potential for improving postural control and possibly reduce fall-risk in many different neurological conditions. Further research is needed to confirm these preliminary findings, identify optimal candidates, and determine the long term impact of BBTW in reducing gait dysfunction.
Purpose:
Fall prevention is a common and important goal of physical therapy. This report describes a new device, Walkasins® (RxFunction Inc., MN, USA), a lower limb sensory neuroprosthesis designed to replace plantar sensation in patients with peripheral neuropathy (PN) who have balance problems (Vinik et al. 2017). Short-term improvements in gait speed and balance function using the device were recently shown, (Oddsson & Koehler-McNicholas 2019, Koehler-McNicholas et al. 2019) confirming earlier pilot data (Wall et al. 2012). Here we report encouraging observations showing a decrease in falls in patients wearing the device long-term. Although results are preliminary, this interim report is of likely interest to the membership.

Description:
Walkasins provides gentle directional tactile cues around the lower leg reflecting changes in foot pressure distribution measured with an instrumented foot pad in the shoe. When walking, the device provides sensory cues related to the stance and swing phases of gait. Intended for daily long-term use, patient candidates have a PN diagnosis, loss of plantar sensation, presence of ankle vibratory sense, and have gait and balance problems with high fall-risk indicated by a Functional Gait Assessment score below 23 (Wrisley & Kumar 2010).

Summary of Use:
A patient participating in a case study of long-term use of the device reported falling once a week in the prior six months. Following use of the device the patient fell once after six months and a second time after 10 months. Furthermore, falls are reported and monitored in the ongoing multi-site clinical trial, walk2Wellness, (NCT #03538756, www.clinicaltrials.gov) investigating long-term device use on clinical outcomes. Subjects are assessed after 2, 6, 10, 26 and 52 weeks, respectively. The trial will enroll up to 150 patients across multiple sites 2018-2020. Currently three sites are active with two being added summer of 2019. Of 30 subjects enrolled so far, 17 reported a total of 43 falls in the six months prior to study participation (8.0 falls/1000 patient days for all 30 participants, 14.1 for the 17 pre-fallers only). To date, participants have accumulated 3499 days in the study (average 116 days), a total of 10 falls have been reported, i.e. 2.9 falls/1000 patient days (3.4 for pre-fallers only), corresponding to a relative risk reduction of 64% across all subjects (76% for pre-fallers only). None of the falls led to injuries requiring medical treatment. Four of the falls occurred while wearing the device. The six other falls occurred when subjects were either unable to wear the device (e.g. in the shower) or had chosen not to wear it.

Importance to Members:
We have shown that Walkasins use during a single brief balance training session improves clinical outcomes more than not using the device. These recent data support and extends that finding. The Walkasins device may provide a new way to improve gait speed and balance and manage fall risk in patients with PN. Future research may determine if combining device use with balance physical therapy intervention enhances outcomes.
**TITLE:** Determining Brain-Behavior Changes Secondary to an Internal Focus during Standing: A Preliminary Study  
**CURRENT SECTION:** Neurology  
**CURRENT SUB-CATEGORY:** Balance & Falls SIG  
**AUTHORS:** Alexander Jeffrey Garbin, Stephanie Nicole Yassa, Beth E. Fisher  

**ABSTRACT BODY:**  
**Purpose/Hypothesis:** Previous research has shown that adopting an internal focus of attention (IFA) results in a nonoptimal neuromuscular pattern consisting of reduced motor cortical inhibition\(^1,2\) and increased muscle co-contraction\(^3\) during simple force production tasks. However, neither of these variables of have been examined during a more ecologically valid task such as standing. IFA instructions are commonly utilized in clinical practice\(^4\) and the concomitant neural and biomechanical changes may lead to increased fall risk\(^5\). Therefore, we aim to characterize the neural (motor cortical inhibition) and biomechanical (co-contraction) changes following internal vs. external focus of attention (EFA) instructions delivered during different standing postures. Our results will support future work that aims to understand how focus of attention may impact older adults with an excessive concern of falling.  

**Number of Subjects:** 4 non-disabled adults (aged 25-31)  
**Materials and Methods:** 4 Participants stood with a narrow-base or single-limb-stance while being instructed to “stand quietly and focus on minimizing movement of your ankles” (IFA) or “stand quietly and focus on minimizing movement of the markers (EFA; markers were placed 3 inches lateral to lateral malleoli). While standing, co-contraction index was measured via electromyography placed on the Soleus and Tibialis Anterior of the dominant limb. Motor cortical inhibition was quantified via the combined use of peripheral electrical stimulation and transcranial magnetic stimulation\(^6\). Changes in these measurements secondary to instruction conditions were expressed by mean difference ± standard deviation and assessed via independent t-tests. Relationships between these measures were quantified via Pearson correlations.  

**Results:** Statistically significant differences were not seen between conditions; however, adoption of an IFA increased lower extremity muscular co-contraction relative to an EFA in 3 of 4 participants during narrow-base stance (1.06 ± 2.72) and 4 of 4 participants during single-limb stance (3.57 ± 1.68). For our neural measure, we were unable to interpret data for one subject due to excessive noise. Adoption of an IFA reduced motor cortical inhibition relative to an EFA in the remaining 3 participants during narrow-base stance (-0.147 ± 0.119) and 2 out of 3 participants during single-limb-stance (-0.133 ± 0.398). Moreover, there was a statistically significant relationship between inhibition and co-contraction during narrow-base-stance indicating an association between a reduction in inhibition and an increase in co-contraction (\(R=0.833, p-value=0.039\)).  

**Conclusions:** Our preliminary findings suggest that adoption of an internal focus of attention may increase lower extremity muscular co-contraction and reduce cortical inhibition during stance. Also, there appears to exist a relationship between motor cortical inhibition and co-contraction during narrow-base-stance.  

**Clinical Relevance:** These findings demonstrate that utilization of internal focus of attention instructions during movement training may induce maladaptive neural and biomechanical changes that increase fall risk. Additionally, the relationship observed between these neural and biomechanical measures indicates that reduced motor cortical inhibition may be a source for the observed co-contraction. This is central to our future work exploring if older adults with an excessive concern of falling adopt an internal focus of attention that reduces cortical inhibition and subsequently increases co-contraction.
Performance on complex walking tasks, such as obstacle crossing and dual-tasking, is often poor in people with neurological impairments such as after stroke, spinal cord injury, and in frail older adults. There is a need for improved mechanistic understanding of the underlying impairments that limit complex walking, including how these mechanisms differ among individual patients. This knowledge is crucial for designing precision rehabilitation approaches that may produce more successful therapeutic outcomes. Emerging evidence using mobile neuroimaging techniques, particularly functional near-infrared spectroscopy (fNIRS) of prefrontal cortex, demonstrate a strong role for cognitive/executive contributions to control of complex walking. Consistent with data from the cognitive literature, neuroimaging of complex walking points to at least two major abnormal brain recruitment findings. The first is over-recruitment of brain networks, even at low levels of task complexity. In the context of walking, over-recruitment may be elicited as a compensatory response to impairments within the brain (e.g., inefficient processing; poor specificity of network activity) and/or impairments peripheral to the brain (e.g., deficient afferent input or impaired spinal circuitry). The second abnormal brain recruitment finding is a reduced ceiling of brain resource recruitment, which limits the brain’s control of complex tasks. This problem is exacerbated by the aforementioned compensatory over-recruitment, and together these abnormal brain recruitment findings can lead to substantial performance decrements as task complexity increases. In a recent study we reported that both prefrontal over-recruitment and recruitment ceiling issues are present during complex walking in people post-stroke, but to different degrees in different individuals. An important target for future intervention studies is to reduce brain over-recruitment and to restore a higher ceiling of brain resource recruitment. There are several major intervention approaches that are promising. Some of these approaches have already been studied to some extent, but often not comprehensively and/or not in the context of brain recruitment during walking. It will be important to understand how best to match a particular intervention to a particular individual based on their specific impairment(s), as well as what combination of interventions might produce the most potent stimulus for eliciting beneficial plasticity. In this presentation we specifically focus on three strategies being testing in our ongoing research studies: prefrontal transcranial direct current stimulation, transcutaneous spinal (lumbosacral) direct current stimulation, and somatosensory augmentation with tactile feedback on the soles of the feet. Each of these strategies is being applied in combination with rehabilitation or motor learning paradigms using complex walking tasks.
The Effects of Jaw Clenching on Dynamic Postural Control in a Patient with Multiple Sclerosis

**Background and Purpose:**
Previous studies have examined the effect of jaw musculature recruitment on balance in healthy sample populations. However, research is limited on this relationship in populations with neurological conditions, specifically Relapsing-Remitting Multiple Sclerosis (RRMS). The purpose of this case study was to investigate the effects of jaw musculature recruitment on dynamic postural control in an individual with RRMS.

**Case Description:**
The participant for this case study was a 54-year-old female diagnosed with RRMS 12 years ago who has significant balance impairments. The NeuroCom® Balance Master force platform system was used to measure various variables of dynamic postural control during 3 tests: Rhythmic Weight Shift Test (RWS), Limits of Stability Test (LOS), and Sit-to-Stand Test (STS). The participant completed the tests using 4 different jaw positions (relaxed, bilateral clenching, right clenching, and left clenching). The participant used a custom biteplate during unilateral and bilateral jaw clenching.

**Outcomes:**
Left jaw clenching produced a 32% improvement in directional control (front to back) during RWS compared to relaxed jaw position. Participant was not able to complete the LOS test with jaw relaxed due to instability and excessive stepping strategy. During the LOS, the participant's ability to move outside her base of support with left jaw clenching was 24% and 20% better compared to bilateral and right jaw clenching, respectively. The participant was very inconsistent with her weight symmetry during the STS until she utilized left jaw clenching. The consistency in weight symmetry between both lower extremities with left jaw clenching also enabled the participant to complete the sit to stand transfer without the use of a forearm crutch, which was required for all other STS trials.

**Discussion:**
Jaw musculature recruitment, particularly left jaw clenching, has a positive influence on dynamic postural control in an individual with RRMS. This improvement has the potential to improve functional mobility and overall safety of the participant. These results warrant further research on the effects of jaw musculature recruitment in the MS population and other neurological populations for generalizability.
TITLE: Prefrontal over-Recruitment during Walking Is Associated with Impaired Tactile Somatosensation in Older Adults

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Balance & Falls SIG
AUTHORS: Pallavi Sood, Sudeshna Chatterjee, Jared Skinner, Paige Lysne, Chanoan Sumonthee, Samuel Wu, Ronald Cohen, Dorian Kay Rose, Adam Woods, David Clark

ABSTRACT BODY:

Purpose/Hypothesis:: Older adults exhibit a heightened cognitive/executive demand of walking, which may predispose them to adverse mobility outcomes such as falls (1, 2, 3). Investigating the underlying mechanisms is important for designing therapeutic strategies. Prior evidence suggests that diminished sensory input to the central nervous system can impair sub-cerebral networks of walking automaticity (1,2,4). Loss of automaticity may be responsible for a compensatory increase in the cognitive demand required to control walking (1).

Tactile somatosensory impairments are common among older adults and are strongly linked to poor gait performance (5). Therefore, this study aims to determine the association between tactile somatosensory perception and the cognitive demand of walking measured by prefrontal cortical activation in older adults. We hypothesize that older adults with impaired somatosensations will exhibit greater prefrontal cortical activation during walking.

Number of Subjects: Thirty-eight older adults (age 74.5 ± 7 years) participated in the study.

Materials and Methods: This study used a cross-sectional design. Participants walked at a comfortable speed for multiple alternating 30-second intervals of walking and standing rest. Functional near-infrared spectroscopy (fNIRS) was used to quantify prefrontal cortical activity based on changes in oxygenated hemoglobin concentration between the walking and resting periods (ΔO2Hb). Separately, tactile somatosensory perception was evaluated using Semmes-Weinstein monofilaments and a two-point discrimination test on the sole of the dominant foot at the head of the first metatarsal (just below the great toe). Mobility function was assessed using walking speed and the Berg Balance Scale (BBS).

Results: There was a significant association between higher activation of the prefrontal cortex during walking and worse tactile perception for both Semmes Weinstein monofilaments (r=0.30, p<0.05) and two-point discrimination (r=0.41, p<0.05) tests. Other findings including an association between higher prefrontal activation during walking and older age (r=0.44, p<0.05); an association between higher prefrontal activation and poorer balance function assessed using BBS (r=-0.48, p<0.05); lack of an association between prefrontal activation and walking speed (r=-0.11, p=0.27).

Conclusions: Older adults with tactile somatosensory impairments exhibit compensatory over-activation of the prefrontal cortex during walking. These individuals also exhibited poorer balance function. These findings elucidate a likely contributor to higher prefrontal (cognitive/executive) demand of walking in older adults. This compensatory prefrontal over-activation might help to preserve walking speed.

Clinical Relevance: Clinicians should assess tactile somatosensory function in the feet of older adult patients to gauge potential risk of high cognitive demand of walking, which may be a risk factor for falling. Future research should assess whether therapeutic strategies to augment somatosensations may improve walking and balance function in older adults.
ABSTRACT BODY:

Purpose/Hypothesis: Sport-related concussion (SRC) represents as many as 3.8 million reported nonfatal traumatic brain injuries each year with an estimated 50,000-300,000 SRCs sustained by adolescent athletes each year.\(^1\)\(^-\)\(^3\) Given that postural instability is considered a hallmark sign of acute concussion based upon the injury’s known disruption of sensorimotor processing and integration, postural control assessment is a critical component of comprehensive concussion management.\(^4\)\(^-\)\(^6\) The current approach to concussion management utilizes a static postural control test, the Balance Error Scoring System (BESS), which evaluates postural stability in 3 stances on a firm and foam surface.\(^6\)\(^,\)\(^7\) Sex and age differences have been reported to affect BESS scores among adolescents.\(^6\)\(^,\)\(^7\) However, previous studies mention issues with the test’s ability to distinguish between typical and problematic postural control.\(^6\)\(^,\)\(^7\) The Y Balance Test (YBT), a dynamic test of postural control, may more closely mimic the demands of both everyday movement and athletic play.\(^8\) Using both balance assessments may optimize return to play (RTP) protocols. Thus, the purpose of this research study was to use the BESS and YBT within a proposed algorithm to assess postural control and assist clinicians with RTP decision making during management of adolescent SRC.

Number of Subjects: 128 male high school athletes and 68 female athletes were assessed with the YBT. An additional 49 participants, 30 male and 19 female athletes, between the ages of 14 and 18-years-old, were recruited from an area adolescent sports medicine center after a clinical diagnosis of SRC. All concussed athletes were greater than one week post-injury.

Materials and Methods: Athletes performed each reach direction (anterior, posterolateral, and posteromedial) three times on each leg. The best reach of the three attempts was selected and normalized to leg length. Scores on the BESS were compared to published norms\(^6\) and YBT scores were compared to pilot data norms generated from the 196 healthy athletes.\(^9\)

Results: The median normalized distance in cm for the anterior reach was 92, posterolateral 70, and posteromedial 65 for male athletes and 93, 76, and 68 for female athletes. All positions were statistically different for female athletes (p<0.05), and the anterior reach was statistically different for male athletes (p<0.05). Seventy-one percent of male and 90 percent of female athletes with acute concussion and 47 percent of male and 50 percent of female athletes with chronic concussion scored below the median for the BESS. Ten percent of female and 13 percent of male athletes with acute concussion and 19 percent of female and 13 percent of male athletes with chronic concussion scored above the median for the BESS but scored below the median for the YBT.

Conclusions: The BESS has been shown to provide an assessment of static balance, but the literature strongly recommends a more comprehensive balance assessment. This study provides data that supports the use of both assessments during rehabilitation and RTP.

Clinical Relevance: Analysis of both assessments could add to a comprehensive profile of an athlete’s overall capabilities or deficits and guide RTP decisions, possibly reducing the risk of re-injury. The proposed algorithm would assess all athletes on the standard BESS scores and include static balance rehabilitation activities in conjunction with the RTP protocol (once athlete is symptom free) if the athlete does not meet the established criteria for the BESS. Additionally, the YBT should be assessed once the athlete scores above the median score on the BESS to evaluate the dynamic balance component. Dynamic balance rehabilitation should be included with the RTP protocol if deficiencies are present.
**Title:** Test-Retest Reliability of the King Devick Test in the Young Adult Population

**Current Section:** Neurology

**Current Sub-Category:** Brain Injury SIG

**Authors:** Rebecca Ann Bliss, Erin Nicole Yacuzzo, Hayley Seiler, Lisa Marie LePine, Mikayla Krystyna Paluzzi

**Abstract Body:**

**Purpose/Hypothesis:** The King Devick (KD) Test is a screening tool designed to assess cognitive visual impairments, namely saccadic rhythm post-concussion. Psychometrics of the computerized version have not been established. The purpose of our study was to examine within session performance on the computerized KD as well as test-retest reliability among the young adult population. Additionally, we sought to determine if there were performance differences in those with history of concussion versus no history of concussion.

**Number of Subjects:** 77 participants aged 18-35, 41 without and 36 with a history of concussion

**Materials and Methods:** Participants completed 6 trials of the computerized King Devick Test (Version 1) to establish stabilization of performance following standard instructions. 18 subjects were randomly selected to return for a second administration of the test to establish test-retest reliability at a time interval within 2-7 days. The Friedman’s test was utilized to determine if there was a difference between trials, with a post-hoc pair-wise comparison utilizing the Wilcoxon Signed Rank Test and alpha level correction. A Mann Whitney U test was utilized to investigate between group differences and Infraclass correlation Coefficient (ICC) to determine test-retest reliability. All statistical analysis were performed using SPSS, Version 25.

**Results:** There was a significant difference in single session computerized KD Test (Version 1), Chi-square value of 142.3, P<.001. Post hoc analysis revealed significant differences in trials 1-4, P=.02. No significant differences were found in KD fastest time scores in those with history of concussion versus no history (P=0.55), athlete versus non-athlete (P=.070) or those with history of migraine versus no migraine (P=0.32). Test-retest reliability was excellent, ICC = 0.99; 95% confidence interval = 0.98-0.99.

**Conclusions:** To our knowledge, psychometrics on the computerized KD Test have not been previously reported for young adults. Test-retest reliability was excellent within a 7-day timeframe. A significant learning effect was noted, and scores stabilized after 4 trials, which is more than the current recommended standard protocol of 2 trials.

**Clinical Relevance:** When utilizing the computerized version of the KD Test it may be beneficial to have the subject complete 4 trials to establish a true score secondary to large learning effect.
BACKGROUND AND PURPOSE: Overground exoskeleton gait training (OEG) is currently used for the rehabilitation of gait after Spinal Cord Injury, Traumatic Brain Injury (TBI) and Stroke. Current traditional rehabilitation for ataxia addresses motor coordination and balance impairments which impact gait. The use of OEG to treat gait disturbance due to ataxia is not well represented in current literature. The purpose of this case study is to demonstrate how one client with severe ataxia after chronic TBI improved in gait, balance and functional mobility with the use of high dose OEG.

CASE DESCRIPTION: The client in this case study was one year post severe TBI and had undergone traditional physical therapy (PT) in multiple settings. His primary impairments included whole body ataxia, lack of automatic balance reactions and significant cognitive deficits impacting his overall safety and independence. Initially he ambulated with minimal (MIN A) to moderate assist during PT with a front wheeled walker (FWW). He used a manual wheelchair to navigate his home and was unable to participate in any leisure activity due to his impairments. We provided a high dose of 31 OEG sessions at a frequency of 2 times/week for four months alongside traditional PT sessions. The swing trajectory-free feature of the exoskeleton was used to allow the client to be supported by the device while providing the freedom to choose his step trajectory with respect to length, speed and height. Gait and balance were measured with the 10 meter walk test (10MWT), Romberg and Berg Balance Scale (BBS) and functional mobility levels of assistance were determined pre and post OEG intervention. Observational improvements in motor control and balance during gait were noted.

OUTCOMES: Improvements were demonstrated with the 10MWT from 63 sec on admit to 39 sec on discharge (MCID >0.05 sec) with gait speed improving from 0.15 m/s to 0.26 m/s, classifying him as a household ambulator. Balance improved with BBS from 17/56 to 21/56 (no MDC established for TBI, MDC for chronic stroke >2.5-4.6 points) and Romberg from 12 sec to a normal score of 30 sec at discharge. Importantly overall functional mobility progressed from MIN A to Contact Guard Assist with a FWW for 150 ft allowing him to ambulate within his home.

DISCUSSION: In this case study, OEG was used to safely and efficiently provide optimal gait training at a high dose for a client with severe ataxia due to chronic TBI. This unique use of OEG in trajectory free mode contributed to improved gait speed, balance and functional mobility independence. In turn caregiver burden was minimized, the client was now regularly ambulating within his home and participation in community based leisure activities were initiated. In conclusion, this case study suggests that OEG appears to be a possible intervention to address ataxia and improve gait, balance and overall functional mobility independence in clients with chronic TBI. The use of OEG to more effectively address the impairment of ataxia is an emerging area for research and could potentially impact clients with chronic TBI not only at the impairment level but also lead to a greater overall participation in their lives.
Purpose/Hypothesis: Traditional static balance assessments utilized in concussion management have been reported to lack ability to detect subtle balance disturbances that may persist following injury. These subtle neuromotor control deficits are postulated to be responsible for increased incidence of subsequent lower extremity injuries in individuals with history of concussion. The purpose of this study is to investigate the use of the HSSOT as an objective measure to identify residual postural control deficits in post-concussive individuals.

Number of Subjects: 50 participants aged 18-35 (25 with history of concussion, 25 with no history of concussion)

Materials and Methods: 50 participants ranging in age from 18 to 35 years, 25 with history of concussion and 25 matched controls completed the ABC, DHI and PCSS. Subjects then completed Conditions 2 and 5 of the SOT portions of computerized dynamic posturography on Neurocom EquiTest™ equipment while maintaining head stationary followed by horizontal head movement at velocities of 80 degrees per second. Descriptive statistics, differences between groups utilizing the Mann Whitney U with a Bonferroni correction, and the Spearman Rho to examine relationships between the dependent variables were run utilizing SPSS, Version 25.

Results: Mean age for both groups was 25±2.6 years. No differences in baseline characteristics of age or gender were found between the two groups. Significant differences were found between those with a history of concussion versus those without in the following: HSSOT Condition 5 performance, P=.01, PCSS, P=.01 and DHI, P=.01. A low negative relationship was also found between PCSS score and HSSOT Condition 5 performance $r=-.297$, P =.04.

Conclusions: ±4.85 years. Higher level postural control measures may be useful in identifying residual postural control deficits not detected by other measures.

Clinical Relevance: Common balance assessments currently utilized in concussion assessment may not be sensitive enough to detect residual neuromotor control deficits and tests such as the HSSOT may be a useful measure to identify these impairments prior to return to play to decrease risk of subsequent injury.
TITLE: Effect of Canine Assisted Therapy on Functional Activity Level in Individuals with Brain Injury

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Brain Injury SIG

AUTHORS: Carolyn Grace Tassini, Evan T. Cohen, Jamie Jo Young

ABSTRACT BODY:

Purpose/Hypothesis: Limited mobility and engagement in activity are common sequelae after brain injury (BI). The use of animals within physical therapy has been theorized to improve engagement and participation. Our purpose was to study the feasibility and effectiveness of canine assisted therapy (CAT) during walking activity at a day program for persons with BI.

Number of Subjects: 16 men and women (age=41.1 +/-12.9 years), mean Mayo Portland Adaptability Inventory-4=17.6 +/-5.3), who attend an outpatient BI day program. Participants could ambulate with supervision or independently, with or without an assistive device.

Materials and Methods: A randomized cross-over model was used to compare the usual care daily walking intervention to the intervention with the addition of CAT. In the CAT condition, participants held a leash of a therapy dog during the intervention. If there was a safety concern, a second leash was held by a handler. Each session lasted up to 30 minutes. Both conditions occurred within the same week. Sessions took place in a perimeter hallway within the program facility—the same location of usual care. During sessions, participants were instructed to complete the walking program and were provided with standard cues. Participants were observed during walks by study staff who recorded the outcomes. These included distance walked (DW), total walking time (TWT), a visual analog scale of enjoyment (VAS-E), and the Rehabilitation Therapy Engagement Scale (RTES). Comparisons were conducted with a paired samples t-test (DW, TWT, VAS-E) or Wilcoxon signed-ranks test (RTES). The alpha level was set at p=.05.

Results: 13 participants completed both conditions and were included in the analysis. The intervention is feasible. Aside from costs of maintaining a therapy dog, there was little additional cost. Participants were enthusiastic to attend CAT sessions. There seemed to be a refractory impact on attendance as the 3 dropouts were first assigned to the CAT condition and refused to complete the control condition. There were no safety problems. Analyses revealed that participants spent more TWT in the CAT condition compared to the control (p=.004), and rated higher levels of enjoyment on the VAS-E (p=.038) and engagement on the RTES (p=.003) in the CAT condition compared to the control. There was no difference in the DW between conditions.

Conclusions: CAT is a safe and feasible addition to a walking program in a therapeutic BI day program. CAT resulted in greater TWT, enjoyment, and engagement than usual care. There were some limitations in this pilot. The small sample was somewhat heterogeneous in their function. Also, the therapy dog was close to retirement age and thus walked more slowly than a younger dog might. Future studies should investigate CAT with people of different functional levels, and whether using a different animal alters intervention effectiveness.

Clinical Relevance: Increasing activity and mobility is often a challenge for people with BI. Using CAT may be a safe and effective tool to increase activity and engagement in this population.
Purpose/Hypothesis: Concussion management guidelines often include neurocognitive and balance assessment, and less traditionally, neck pain outcome measures. Return to play decisions are multifactorial and include some consideration of baseline to post-concussion score changes in addition to physical examination findings and symptom report. In addition to intra-individual comparison on specific measures, it can also be valuable to consider norm-referenced data at baseline. The purpose of this study is to examine issues affecting return to play decision-making when several baseline scores are examined via intra-individual comparison and versus normative cut scores.

Number of Subjects: N = 126. College athletes examined at baseline.

Materials and Methods: Data were examined retrospectively. Outcome measures included the Post Concussion Symptom Scale (PCSS), Balance Error Scoring System (BESS), Neck Disability Index (NDI), and Computerized Balance Assessment (COBALT). Total scores were examined on the PCSS, BESS, and NDI. On the COBALT, two variables were examined from the foam surface condition: head shake sway score (HS-COB) and visual motion sensitivity sway score (VMS-COB). An impairment variable combining HS and VMS (IMP-COB) was also analyzed. Cutoffs on the BESS and COBALT measures were defined using normative data corresponding to the 10th percentile. A PCSS cutoff was defined at the 90th percentile due to the nature of the measure (i.e., elevated scores indicating greater symptoms). The NDI cutoff was a raw score of 4 based on previous research.

Results: Considering all four measures, only 40.5% of athletes scored within normal limits at baseline. Considering the measures individually, baseline scores outside of expectation were observed at the following rates: 12.7% (PCSS), 18.5% (NDI), 22.2% (BESS), 15.9% (HS-COB), 30.2% (VMS-COB), and 38.9% (IMP-COB).

Conclusions: On a concussion assessment battery comprised of symptom report and balance instruments, less than half the athletes performed within normal limits at baseline with rates of impaired scores on individual tests ranging from 12.7 to 38.9%. These findings highlight some of the inherent complexity in baseline concussion evaluation. If the measures are used without reference to normative data, then below-expectation post-concussion results might be interpreted incorrectly as reflecting symptom persistence rather than scores consistent with a low baseline performance, which might increase return to play time unnecessarily.

Clinical Relevance: Below-expectation norm-referenced scores are common in baseline evaluations of college athletes. A multi-domain evaluation based on intra-individual and normative comparison may improve return to play decisions by more accurately differentiating baseline weakness from concussion sequelae.
TITLE: Using the Long-Form ADL Score to Classify SNF Discharge Disposition Among Older Adults with TBI

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Brain Injury SIG

AUTHORS: Emily Alyce Evans, Linda J. Resnik, Kali S. Thomas, PhD, MA

ABSTRACT BODY:

Purpose/Hypothesis: Most older adults who are unable to return home after hospitalization for traumatic brain injury (TBI) are discharged to a skilled nursing facility (SNF).\(^1\,^2\) SNFs address on-going medical needs, functional limitations, and ideally help patients discharge to, and then remain in their home environments.\(^3\)

Independence with self-care and mobility is important in planning for discharge. The long-form activities of daily living scale (ADL score), reported for all patients treated in Centers for Medicare & Medicaid Services-certified nursing homes, assesses self-care and mobility and may be useful in discharge planning.\(^4\) The objective of this study is to 1) evaluate the ability of the admission ADL score to discriminate between patients who do and do not discharge home 2) evaluate the ability of the discharge ADL score to discriminate between those who do and do not remain at home for 30 days after a discharge home and 3) identify cut-off points in the ADL score that maximize correct and incorrect classification of discharge category.

Number of Subjects: Medicare beneficiaries (n=97586) aged 65 and older who were discharged to a SNF following hospitalization for TBI, excluding those with history of SNF, inpatient rehabilitation or hospice use in the past year.

Materials and Methods: This study is a retrospective secondary data analysis using Medicare Administrative Data (2011-2015) including linked Medicare enrollment files, Part A claims and Minimum Data Set 3.0.\(^5\) In a derivation cohort (80%), receiver operating characteristic (ROC) curves were used to examine the discriminative ability of the ADL score and determine a cut-off score using Youden’s Index.\(^6\,^7\) Positive predictive value (PPV) and negative predictive value (NPV) of identifying negative outcomes, and percent of correct classification were determined in a validation cohort (20%) using the derived cut-off scores.

Results: In the sample, 67% of patients were discharged home and 58% remained at home for 30 days. Admission ADL scores demonstrated a significant but limited ability to classify patients who did versus did not discharge home (AUC= 0.68, CI: 0.67-0.68). A cut-off score of 20 maximized the discriminative ability resulting in a PPV of 0.50, a NPV of 0.76, and 67% correct classification. Discharge ADL scores demonstrated a significant but limited ability to classify those who did and did not remain at home for 30 days post discharge home (AUC= 0.63, CI: 0.62-0.63). A cut off score of 17 maximized the discriminative ability, resulting in a PPV of 0.21, a NPV of 0.91 and 56% correct classification.

Conclusions: Among older adults with TBI in SNFs the long-form ADL scale demonstrates a significant but limited ability to discriminate between discharge categories as a stand-alone measure.

Clinical Relevance: The ADL score and should be considered only in conjunction with medical, personal and environmental factors. Alternative cut points may be derived depending on the clinical risks associated with false positives and false negatives.
TITLE: Effect of Body Weight Supported Treadmill Training in Traumatic Brain Injury: A Systematic Review

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Brain Injury SIG

AUTHORS: Neeti Pathare, Nick Kossor, Alaina Possumato, Christopher William Riley

ABSTRACT BODY:

Purpose/Hypothesis: Given the long-term impairments linked with traumatic brain injury (TBI), research that addresses effective interventions in this population is critical. Due to its repetitive and task-specific nature, body weight supported treadmill training (BWSTT) is proposed to facilitate improvements in TBI. A synthesis of literature on the effect of BWSTT in TBI is lacking. The aim of this study was to conduct a systematic review on the effects of BWSTT on measures of postural control/balance, gait and aerobic capacity in individuals with TBI. Our hypothesis was that BWSTT will improve postural control, gait parameters and aerobic capacity in TBI.

Number of Subjects: The sample size ranged from 1-27 participants/study with total data extraction from 114 participants (17-70 y), with a diagnosis of chronic TBI.

Materials and Methods: Database search included Medline, CINAHL and PTnow.org using PRISMA guidelines in June - July 2018. Articles written in English using BWSTT for individuals with TBI (> 17 y) were included. The key words were: (traumatic brain injur* or TBI or head injur*) AND (treadmill* or locomot*). Eligibility was determined by 4 independent reviewers and further quality appraisal was performed using the Physiotherapy Evidence Database (PEDro) score.

Results: Out of 530 studies, 12 articles met eligibility criteria. The review included varied study designs (randomized controlled trials: 3, repeated measures: 1, single group: 2, single subject: 1, case series: 2 and case study: 3) and treatment characteristics (session duration: 100-180 minutes/week, treatment duration: 6 to 52 weeks, frequency: 2x -3x/week). The eligible articles ranged from poor to fair quality (PEDro: 2/10 to 5/10). Three studies reported none or not significant adverse effects. BWSTT was reported to significantly improve static balance (n = 2), dynamic balance (n = 4), gait speed (n = 6), spatiotemporal measures of gait (n = 5), functional outcomes (n = 2) and aerobic capacity (n = 3) in individuals with TBI.

Conclusions: Our review suggests that BWSTT may improve dynamic balance, gait parameters and aerobic capacity in individuals with TBI (17 to 70 y). Intense protocols lasting greater than 6 weeks of BWSTT combined with over ground training may result in larger improvements following BWSTT in the TBI population. Further studies evaluating long term effects of BWSTT with a larger sample size and robust research designs are warranted. Limitations of the review included small sample size, inconsistent treatment parameters, lack of control group and heterogeneous outcome measures.

Clinical Relevance: This review provides valuable data to clinicians to make educated decisions regarding the use of BWSTT in the TBI population.
TITLE: A Retrospective Investigation of Symptoms Triggered during Sustained Neck Rotation Post-Concussion in Military Service Members

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Brain Injury SIG

AUTHORS: Miriam Helen Hammerle, Carrie W. Hoppes, Jeremy Nelson, PhD, Alicia Swan, PhD, Lisa Lu, PhD, Lucy Thomas, PhD, BPhty, Julia Treleaven, PhD, BPhty

ABSTRACT BODY:

Purpose/Hypothesis:
To identify prevalence and type of symptoms that occur within one minute of sustained neck rotation (SNR) in those with headache post-mild traumatic brain injury (mTBI).

Number of Subjects:
Military service members (n=125) presenting for treatment of headache after mTBI.

Materials and Methods:
A retrospective review of medical records of 125 patients. Demographics, baseline symptoms, and symptoms that occurred during a one-minute period of sustained neck rotation (SNR) to the right and left were recorded. Patients were divided into symptomatic (Symp-SNR) and asymptomatic groups (Asymp-SNR). The Symp-SNR were further divided into those with symptoms that occurred in either right or left rotation (Uni-SNR) or those with symptoms in both positions (Bi-SNR).

Results:
Of 125 participants, 81.6% had an abnormal SNR test. Of the 125 in Symp-SNR, 55 were in Uni-SNR and 47 Bi-SNR. The most common symptoms elicited in Symp-SNR were tear disruption (40%), ocular incoordination (25.4%), and blepharospasm (16.6%).

Symptoms were then grouped (with overlap) into potential vascular (VBI) (presyncope, diplopia, facial paresthesias, confusion, nausea, ptosis, nystagmus, vertigo, disequilibrium, tinnitus, dysphagia, glove pattern numbness) and autonomic dysregulation (AD) (tear disruption, nausea, visual shifts, blurry vision, depth perception changes, non-syncopal tunneling, diplopia, or hot flash). The most common symptoms among Symp-SNR were potential VBI at 42.2 % followed by AD at 27.5%. Individuals in Bi-SNR were significantly more likely to report tear disruption, ocular incoordination, and symptoms of AD than Uni-SNR, (p<.01).

Those in the Symp-SNR group were also more likely to report baseline photophobia (Uni-SNR 93%, Bi-SNR 85%, Asymp-SNR 61%), altered facial sensation (Uni-SNR 43.6%, Bi-SNR 34%, Asymp-SNR 8.7%), and average number of reported VBI symptoms (Asymp-SNR 3.5, Uni-SNR5.5, and Bi-SNR 4.7), compared to the Asymp-SNR, (p<0.01). Syncopal history, while relatively rare, was significantly more likely to occur in Uni-SNR at 25.5% (Bi-SNR 4.3%, Asymp-SNR 8.7%), but there were no differences with respect to number of mTBI, age, service, or rank (p>0.27). Those in the Bi-SNR group were more likely to be female (p=0.02).

Conclusions:
A high percentage of patients with headache post-mTBI demonstrated symptoms during SNR testing. Symptoms reported suggest that SNR testing may be eliciting symptoms suggestive of AD or VBI but further study is needed.

Clinical Relevance:
Symptom origin in mTBI is considered multifactorial. Evidence is building supporting a contribution from the cervical spine as treatment of the neck has been shown to improve dizziness outcomes.

It is possible that sustained neck rotation can affect vertebral artery flow and/or autonomic regulation through the superior cervical ganglia due to the close approximation of these structures to the upper cervical spine and any relative change with sustained positioning.

Further study is needed to better understand the mechanisms of action of SNR testing and subsequent symptom production.
TITLE: Utilizing Intrinsic Motivation and External Focus of Attention in a Patient with Cerebellar Ataxia
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Brain Injury SIG
AUTHORS: Lydia Marie Maloney, Jennifer C. Fay, JJ Mowder-Tinney
ABSTRACT BODY:

Background and Purpose:
Ataxia is commonly seen in people with cerebellar injuries. This impairment is challenging to treat and there is a lack of evidence of the best therapeutic approach. The OPTIMAL (Optimizing Performance through Intrinsic Motivation and Attention for Learning) Theory of motor learning has been linked to improved self-efficacy and autonomy, leading to enhanced performance and functional skills. However, there has been limited study of its application in people with cerebellar ataxia. The aim of this case report was to examine the impact of intrinsic motivation and external focus of attention on task specific function in a patient with cerebellar ataxia.

Case Description:
The patient was a 36-year-old expectant father, eight years post a medulloblastoma removal, resulting in cerebellar ataxia. He came to physical therapy with the goal of improving gait and balance to enhance his ability to safely care for an infant. He attended 10 weekly treatment sessions to address decreased core strength, lower extremity strength, poor motor planning and ataxia. Interventions emphasized improving obstacle avoidance, dynamic stability, management of even/uneven surfaces and transitions while performing tasks such as picking up an infant, managing a carrier or wearing a harness. Each intervention required the client to focus on a “baby” while managing auditory distractions, conversational demands and performing complex motor tasks.

Outcomes:
Standardized outcome measures included the Mini Best Test, Scale for the Assessment and Rating of Ataxia (SARA), and the Five Times Sit to Stand. Measures were taken following the ten weeks of treatment and then at a one-month follow up. The Mini Best score increased from 18/28 to 24/28 points, surpassing the minimal detectable change. The five times sit to stand score decreased from 16.5 to 14 seconds. However, the SARA score remained the same, indicating no change in ataxia. The patient’s safety, independence, and quality of movement while negotiating stairs and getting on and off the floor with a “baby” improved over the course of treatment.

Discussion:
Functional mobility and balance improved after treatment involving motivation and external focus of attention in an individual with cerebellar ataxia. The outcomes of this case report suggest that the OPTIMAL theory is a viable framework for improving motor learning and functional performance in patients with cerebellar ataxia. In this case, providing treatment in the context of goals that the patient was highly motivated to achieve correlated with positive outcomes. The patient had increased control over his treatment, and ultimately, improved his mobility and skill performance. His study has clinical relevance because its results demonstrate a potentially effective treatment foundation for patients with cerebellar ataxia. More study with a larger sample size is required.
TITLE: Reliability and Validity of a Recumbent Stepper Submaximal Exercise Test after Traumatic Brain Injury
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Brain Injury SIG
AUTHORS: Connie Lee Fiems, Megan Renae Bales, Stephanie Rose Ganley, Dylan Michel, Kallee Rice, Kayla Silverman

ABSTRACT BODY:

Purpose/Hypothesis: To determine the test-retest reliability of a submaximal exercise test using a total body recumbent stepper (TBRS) and the concurrent validity with the 6-minute walk test (6MWT) in individuals with a chronic (>6 months post diagnosis), severe traumatic brain injury (TBI). Associations between the TBRS submaximal exercise test and 6MWT with other measures throughout the International Classification of Functioning that are indicative of overall health and fitness were also examined.

Number of Subjects: A convenience sample of 25 ambulatory community dwelling participants with chronic, severe, TBI were included in the analysis (median age 36, range of 19-64 years; male 72%). Severity of TBI was characterized by self-reported length of loss of consciousness (> 24hrs), acute hospital admission, and inpatient rehabilitation stay.

Materials and Methods: Participants completed a TBRS submaximal exercise test, 6MWT, and Mayo Portland Adaptability Index (MPAI-4) at initial testing, and a TBRS submaximal exercise retest 4-7 days later. Estimated peak oxygen consumption (VO₂) was calculated from results of the TBRS submaximal exercise tests. Distance walked, rate of perceived exertion and heart rate were recorded for the 6MWT. Participants wore a StepWatch™ Activity Monitor (SAM) for the 4-7-day period between tests to record average daily steps.

Results: Data analysis was completed on 25 participants, with 23 completing both TBRS submaximal exercise tests. The test-retest of the TBRS submaximal exercise test demonstrated good reliability (ICC = 0.784, p <.001) with mean estimated peak VO₂ of 34.5±7.0 ml · kg⁻¹ · min⁻¹ and 33.8±8.2 ml · kg⁻¹ · min⁻¹ respectively. The TBRS submaximal exercise tests did not correlate with distance walked on the 6MWT (r=.059, p=.783). None of the participants achieved a target heart rate of 85% during the 6MWT, while 74% and 78% achieved it during trial one and two respectively during the TBRS test. A statistically significant relationship was found between the 6MWT and total daily steps (r = .498, p = .011).

Conclusions: This data suggests that TBRS submaximal exercise testing may be used to reliably estimate peak VO₂ in ambulatory adults with chronic severe TBI, however more research is needed to identify patient characteristics that would be most responsive to this method of testing.

Clinical Relevance: Submaximal exercise testing using the TBRS is a safe and practical alternative to other submaximal walking tests for those with chronic severe TBI. While the 6MWT distance is a helpful functional measure, factors other than exercise capacity may have greater impact on performance in this population.
Yoked Prism Lenses Acutely Improve Spatio-Temporal Gait Parameters in Individuals with Acquired Brain Injuries

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Brain Injury SIG
AUTHORS: Nathan Riley Bedel, Susan Durham, Alma Privette, Srikant Vallabhajosula

ABSTRACT BODY:
Purpose/Hypothesis: Those who sustain an acquired brain injury (ABI) with resultant symptoms like that of concussions can present with deviations from their typical gait pattern. Along with headaches, dizziness, and photophobia, individuals with ABI report difficulty with balance and postural alignment. It has been suggested that symptoms associated with ABIs are due in part to poor integration of the sensory motor system thereby altering visual midline. This deficit has been described as Visual Midline Shift Syndrome. Recent research has shown that yoked prisms can alter spatial perception in a healthy population leading to believe it can correct a disrupted visual midline. By addressing the visual deficits associated with an ABI, yoked prism lenses have the potential to alter visual midline to improve visuo-spatial processing and gait. The purpose of this study was to examine acute changes in spatio-temporal gait parameters and plantar pressure distribution in those with ABIs with the use of yoked prisms.

Number of Subjects: Participants with ABI (n=24; age, 44±18 years).

Materials and Methods: Participants completed two to four trials of barefoot, forward walking at a comfortable pace across a 14’ GAITRite walkway under two conditions with current vision correcting prescription: first without yoked prisms (WOP) and secondly with yoked prism lenses (WP). Each trial consisted of an acceleration phase, ambulating on the walkway, and a deceleration phase to capture steady state gait. Gait speed, stride length, stride width, single support percentage, and plantar pressure were extracted and averaged across the trials within each condition. Plantar pressure was divided into forefoot, midfoot, hindfoot, medial, and lateral regions. A paired samples t-test was used to compare the spatiotemporal gait parameters between both conditions and a 3-way ANOVA was used to compare plantar pressure among the regions bilaterally for both the conditions.

Results: Wearing yoked prism lenses resulted in significantly increased gait speed (WOP: 92.3±25.9 cm/s; WP: 99.1±28.9 cm/s; p=0.007) and stride length (WOP: 102.1±17.7 cm; WP: 108.3±20.0 cm; p=0.035). Stride width (WOP: 10.8±3.8 cm; WP: 10.8±3.0 cm) and single support percentage (WOP: 37.0±2.8 %; WP: 37.3±2.9 %) did not show significant changes. Shifts in plantar pressure showed no significant changes (p>0.05).

Conclusions: Participants with ABIs who wore yoked prism lenses may experience improved sensory motor system integration which includes a corrective shift in visual midline. This corrective shift facilitates increases in gait speed and stride length but does not account for reweighting of plantar pressure.

Clinical Relevance: Individuals with ABIs can suffer from visuospatial deficits along with a multitude of persistent, adverse symptoms. Application of yoked prism lenses has been clinically observed to improve gait and reduce some of these symptoms. Current results show that the yoked prism lenses have the potential to provide therapists another mechanism to improve gait in those with visuospatial deficits associated with ABIs.
Purpose/Hypothesis: Sleep disturbances and fatigue are very prevalent in patients post stroke and traumatic brain injury (TBI), contributing to deficits in attention and cognition. Increased fatigue in patients post-stroke is associated with poorer functional outcomes. The purpose of this study was to determine whether daytime fatigue measures predict cognitive performance in patients attending inpatient rehabilitation for stroke or TBI.

Number of Subjects: Thirty-three subjects (64.8±17.4 years, n=19 male) admitted to an inpatient rehabilitation facility post-stroke or TBI were included in the study.

Materials and Methods: On a single test day, subjects reported their fatigue levels on three subjective scales: Karolinska Sleepiness Scale (KSS), Wits Pictorial Sleepiness Scale (WITS), and Fatigue Visual Analogue Scale (VAS). Subjects also completed three cognitive performance measures: Trail Making Test Version A (TMTA) and Version B (TMTB), and Rey Auditory Verbal Learning Test (RAVLT). Descriptive statistics and simple linear regression analysis were conducted using SPSS version 24.

Results: Regression analyses indicated that the KSS, WITS, and VAS each independently predicted performance on both the TMTA and more cognitively challenging TMTB (all p<0.05), with lower fatigue ratings predictive of better performance. None of the fatigue measures predicted RAVLT scores (p>0.05).

Conclusions: Findings from this study suggest that lower ratings of fatigue are predictive of better performance on the TMT in a sample of patients post-acute stroke or TBI. Conversely, fatigue ratings were not predictive of performance on the RAVLT, a measure of verbal and auditory learning and memory. The TMT assesses cognition by evaluating attention, the ability to execute and modify a plan of action, and the capacity to maintain two simultaneous trains of thought. The ability of the fatigue measures' ability to predict TMT scores but not RAVLT scores may be due to impairments related to brain-injury in this patient population, compromising verbal or auditory learning pathways more than pathways required for sequencing and speed.

Clinical Relevance: Patient fatigue is an important consideration given its ability to predict cognitive performance. In turn, cognitive performance is positively correlated with improved functional outcomes. Physical therapists should consider that, while fatigue may play a role in some specific aspects of cognition, it may not be associated with others. Congruently, while patient-reported fatigue did not correlate with auditory and verbal learning, it did influence performance on tasks requiring cognitive abilities such as speed and sequencing in a sample of patients post stroke or TBI. Further research is warranted to determine whether fatigue-reducing interventions can effectively alleviate fatigue and improve functional outcomes in patients post stroke or TBI.
ABSTRACT BODY:

Purpose/Hypothesis: Ipsilesional deviation of the head, trunk, and eyes when resting but awake is a sensitive indicator of spatial neglect (SN). During a recent case study, one individual with acquired brain injury (ABI) who was unable to participate in conventional SN intervention demonstrated immediate correction of postural asymmetry and orientation towards the neglected side when blindfolded, resulting in improved participation in therapy. The purpose of this retrospective study was to examine the effects of binocular occlusion in a larger cohort of patients with ABI.

Number of Subjects: 7

Materials and Methods: This project was approved by our local IRB for a retrospective chart review study with data collected from individuals meeting the following criteria: Inpatients with ABI and SN confirmed by clinical observations or standardized measures, who underwent blindfolding during physical, occupational or speech therapy sessions. Variables collected from the chart review include: demographics, ABI characteristics, Functional Independence Measure (FIM) scores at admission and discharge, and response to blindfolding (evaluated before, during and after blindfolding). Positive responses were defined as active or passive maintenance of the head/trunk towards the contralesional side or improved ability to point towards body parts of the contralesional side.

Results: The chart review revealed that 7 patients (3 male, 4 female; mean age = 71.1 years, SD = 10.79) were blindfolded during their therapy sessions. Type of ABI included stroke (n=4), traumatic brain injury (n=1), and nontraumatic brain injury (n=2). Patients underwent between 1 and 7 sessions of blindfolding for a duration of between 2 and 15 minutes. 6 of the 7 patients demonstrated head rotation towards contralesional side or ability to sustain position when positioned by a therapist, and 2 were noted with immediate head rotation in response to blindfolding. 5 of the 6 patients who were instructed to point toward body parts on contralesional side of body showed improved ability to do so when blindfolded. 2 of the 3 patients who verbally expressed their thoughts of blindfolding had positive reports.

Conclusions: Consistent with the previous case study, the current study showed that benefits were not maintained once blindfold was removed. However, while blindfolded, patients demonstrated improved postural symmetry, orientation and engagement towards the contralesional side.

Clinical Relevance: Binocular occlusion can be performed to enhance participation in therapy and potentially improve rehabilitation outcomes among low functioning patients with difficulty participating in conventional interventions to address neglect.
TITLE: Influence of Prism Lenses on Post Concussive Postural Control Rehabilitation: A Case Study

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Brain Injury SIG
AUTHORS: Alex M. Habegger, Rebecca Ann Bliss

ABSTRACT BODY:

Background and Purpose: Evidence of physical therapy intervention specific to clinical trajectory improvement following concussion is well documented. Trajectory areas include; oculomotor, vestibular and balance, cervical, as well as exertional rehabilitation. The purpose of this case study is to demonstrate the importance of integration between the magnocellular and parvocellular visual systems as part of the oculomotor clinical trajectory in post-concussion rehabilitation. This case study also highlights the importance of follow up after prism prescription due to the brain's innate ability to continue to adapt via neuroplasticity and the effect on postural control.

Case Description: Patient was referred to physical therapy after incomplete resolution of symptoms following head trauma that occurred one year prior. Patient was originally prescribed corrective prism lenses one year following injury and continued to comply with wearing for a total of 13 months. Following comprehensive evaluation findings prisms were removed and dynamic postural control intervention focusing on upweighting of both magnocellular and parvocellular visual systems with positive results yielding increased postural control, and decreased subjective report of dizziness with ability to return to work and outdoor hobby activities including hiking.

Outcomes: Reason for referral included complaints of patterned carpets and "busy" environments causing dizziness and poor balance when ambulating on unstable surfaces. Initial evaluation objective measures as follows; ABC Scale 40, Oculomotor exam: hypometric saccades in horizontal plane, normal NPC, negative Cover/Uncover/Alternate Cover Test, negative visual midline shift testing. Vestibular exam: positive bilateral head thrust, abnormal VOR, normal VOR cancellation, DGI 22/24, and Berg Balance Scale 56/56, abnormal mCTSIB with eyes closed on foam. Following removal of prism lenses, and rehab focused on integration of the parvocellular and magnocellular vision systems during dynamic postural control patient's discharge scores as follows; ABC 40.6%, normal VOR, DGI 24/24, able to hold 30 seconds modified CTSIB eyes closed on firm and foam, Cervical JPE < 4.6 degrees in all directions, mild impairments with dual task cognitive demands during gait, though patient self-discharged due to improvement.

Discussion: Postural control with both static and dynamic balance activities improved, as did subjective reports of dizziness symptoms and improved balance confidence following physical therapy intervention focusing on the integration of the parvocellular and magnocellular visual systems after removal of previously prescribed prism lenses post-concussion. This case study highlights the importance of follow up post-prism prescription due to principles of neuroplasticity continuing over time and the brain's inherent ability to adapt. Earlier integration of parvocellular and magnocellular inclusion in post concussive rehabilitation may prevent parvocellular bias in visual processing with long term use of prism lenses leading to postural control deficits.
ABSTRACT BODY:
Purpose/Hypothesis: Symptoms after a mild traumatic brain injury (mTBI) may persist for several months to years. Pupillary dilation is an innovative, real-time, neurophysiological measure of cognitive workload where increasing workload is associated with greater pupil dilation. The purpose of this pilot study was to examine if persistent symptoms contribute to increased cognitive workload during walking tasks and increased complaints of mental fatigue.

Number of Subjects: Subjects who were 40-80 years of age with persistent symptoms after a mTBI (Glasgow Coma Scale 13-15) (n=6) and healthy controls (n=4). Duration since last concussion was 29.8 weeks (range 4-73 weeks).

Materials and Methods: All subjects completed a neurological exam, the Post-Concussion Symptom Scale (PCSS), and Mental Fatigue Scale questionnaire (MFS). Subjects walked down a 60-foot walkway that was 12 inches wide while looking ahead [Straight walking (SW)] and while turning their head (HT) to identify 12 letters and their colors on the wall. Pupillary responses were recorded and transformed to the Index of Cognitive Activity (ICA) using the EyeWorks™ Analyze software. Wilcoxon rank sum test was used to examine the differences between groups in all outcome measures. Spearman’s correlations were used to determine the relationship between ICA values, post-concussion symptoms and MFS score.

Results: Ten subjects, 6 with mTBI (60 ± 6.1 years) and 4 controls (56 ± 1.3 years) completed the study. Higher cognitive workload was seen for the mTBI group during the SW task in the right eye [0.41 ±0.07 versus 0.29 ± 0.06; (p=0.02)] and left eye [0.41 ± 0.09 versus 0.28 ± 0.07; (p= 0.041)]. No differences were noted in ICA values during walking with head turns. Symptoms on the PCSS score that were correlated with higher cognitive workload in the right eye during SW were headache (r=0.72, p=0.02), drowsiness (r=0.7, p=0.23), light sensitivity (r=0.67, p=0.04), feeling foggy (r=0.74, p=0.02), difficulty concentrating (r=0.64, p=0.04), and visual problems (r=0.69, p=0.03). Scores on the MFS correlated with higher cognitive workload in the right eye during SW (r=0.77, p=0.01) and HT (r=0.66, p=0.04).

Conclusions: Persistent symptoms after a mTBI may increase the cognitive workload needed to perform walking tasks. These symptoms may increase the mental fatigue experienced by patients when walking both while looking ahead and with head turns to scan their environment.

Clinical Relevance: Individuals after a mTBI may decrease their activity levels if they experience fatigue with simple tasks. Reduced activity levels can lead to deconditioning and isolation. Future studies examining cognitive workload during activities of daily living like shopping, walking across the street, and exercising can help to further elucidate the impact of persistent symptoms on daily activities.
ABSTRACT BODY:

Purpose/Hypothesis: Concussion assessment requires a multi-modal approach including the assessment of self-reported symptoms as well as performance on cognitive tests and measures of postural stability. We sought to investigate differences in performance on cognitive and balance testing based on symptom severity following concussion. The aim of the study to determine the relationship between performance on cognitive and balance tests and symptom severity.

Number of Subjects: 1257 high school and collegiate athletes (66% male, 36% female) who had sustained a concussion, had a healthy baseline assessment and at least 1 follow-up injury assessment utilizing the Cleveland Clinic Concussion Application (C3 App) were included.

Materials and Methods: A retrospective analysis of prospectively collected data was conducted. Athletes were stratified into two groups for comparison: symptom score ≤7 or >7, utilizing the 27-item graded symptom checklist (total possible symptom score 162) within the C3 App. Assessments were identified as occurring during the acute (0-7 days post injury), sub acute (8-20 days post injury), or post-concussive (≥21 days post-injury) phase. Performance on each module of the C3 Logix were analyzed with separate linear mixed effect models for each module compared within-phase differences. Models included a random component for each athlete, as well as a random component for each time phase nested within each athlete. The main effects and interaction of the symptom score group along with the time phase group was modeled as fixed effects for each test module. Within-time group comparisons were completed by testing contrasts of least square means.

Results: Performance on each of the C3 App outcome measures (SRT, CRT, PST, Trails A, Trails B, and the Balance Error Scoring System) were significantly better in athletes reporting a symptom score of ≤7 compared to those reporting a symptom score >7 at each of the phases. Significance for each module at each phase was tested at P < .05.

Conclusions: Athletes with a symptom score of > 7 performed worse on all measures than those with symptom score ≤ 7, regardless of time from injury.

Clinical Relevance: Return to play criteria and clearance should rely on a comprehensive evaluation, and time from injury alone should not be used an indication of recovery.
TITLE: What Is the Impact of Utilizing Voms for Patients Sustaining a Concussion? a Systematic Review
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Brain Injury SIG
AUTHORS: Steven Lesh, Derek Straus, Erick Tunnell, Nathan Rogers

ABSTRACT BODY:
Purpose/Hypothesis: The purpose of this systematic review was to determine the efficacy of using Vestibular/Ocular Motor Screening (VOMS) as an assessment tool in the overall management of patients with concussions from a diagnostic and prognostic standpoint. Of the current diagnostic measures, the King-Devick test is the only widely used tool that addresses vestibular/ocular symptoms, but it only assesses saccadic eye movements. VOMS includes ocular motor functions such as pursuit, convergence, and accommodation, all of which may be affected by a concussion. Inclusion of these ocular aspects may make VOMS a more comprehensive tool for the assessment of patients who have sustained a concussion.

Number of Subjects: 8 studies were included for analysis in this systematic review.

Materials and Methods: A systematic review of recent literature was completed to identify evidence related to the clinical question. The search was completed by utilizing EBSCOhost. A PRISMA strategy utilizing key words identified 1,276 articles and 5 outside articles were identified independently from the database search. After applying screening criteria, 8 articles were included for data extraction and analysis. Two reviewers assessed quality of evidence using the check list developed by Downs and Black (modified by Kennelly). A neutral third-party reviewer was utilized to resolve disagreements, leading to a consensus quality rating of good/fair/poor.

Results: Quality of articles was determined to be good for all eight articles. 1,209 youth, high school, and college athletes were included by the authors from a variety of sporting teams. Through cohort and cross-sectional studies, the internal consistency, reliability/validity across different populations, normative values, and prognostic values of VOMS were determined. Multiple studies found the internal consistency to be high, while VOMS also demonstrates a lower percentage of false-positive rates when compared to King-Devick. VOMS was found to be reliable/valid across multiple populations, though females have a tendency to report more VOR-related symptoms. Positive results on select VOMS subset items (VOR, VMS and NPC) were shown to be of strongest diagnostic value. As of now, vertical saccades is the only VOMS measure to show prognostic value.

Conclusions: The high reliability, internal consistency, and low false positive rates indicated in the research support the efficacy of using VOMS in conjunction with other concussion management tools. VOMS assesses important aspects of vestibular/ocular symptoms that other concussion screening tools do not currently measure. This enhances the VOMS tool’s ability to more accurately diagnose the presence of a concussion. Continued research should be conducted to determine the prognostic value of each of the VOMS subset tests.

Clinical Relevance: With continued research, VOMS may be the clinical tool needed to more accurately assess patients with concussions due to its internal consistency, reliability/validity, and low false positive rates. VOMS is easy to administer, with little to no additional costs, and does not require a baseline test. Inclusion into established diagnostic protocols would not drastically change the amount of time needed to assess a patient with a concussion. The added cost to value ratio to a standard assessment session is worth close consideration by all physical therapist who work regularly with patients sustaining concussions.
TITLE: Test-Retest Reliability of Post-Concussion Examinations in Healthy Young Adults: A Pilot Study
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Brain Injury SIG
AUTHORS: Gabrielle Diaz, Karla Denise Easterling, Tyler Luchtefeld, Janet Perry Slaughter, Meredith Flowers, Ryan Henry McGlawn, William Cody Pannell, Ryan Michael Babl, Kimberly J. Curbow-Wilcox, Jennifer C. Reneker

ABSTRACT BODY:

Purpose/Hypothesis: The purpose of this study was to assess the test-retest reliability of the following tests: Post-Concussion Symptom Scale (PCSS), convergence testing, cervical joint-position error test (JPE), dynamic visual acuity (DVA), and the cranio-cervical flexion test (CCFT), all which are a part of a comprehensive battery of tests used when assessing individuals following a concussion.

Number of Subjects: A total of 32 subjects were recruited via convenience sampling at the start of the study. Two subjects completed 1 out of 3 sessions, 6 subjects completed 2 out of 3 sessions, and 24 subjects completed all 3 testing sessions.

Materials and Methods: All examiners completed training on correct administration and scoring of each outcome measure prior to the start of the study. Healthy adults between the ages of 18-28 years old who had 1) no history of concussion or whiplash in the past two years and 2) no current symptoms of neck pain, concussion, inner ear/upper respiratory infection, Meniere’s disease, or other diagnosed vestibular or neck issues were recruited to participate in the study. Subjects were excluded if they had any observed nystagmus or fixed postural deficits of the cervical spine. Subjects completed initial testing on day 1 with follow-up examinations on day 7 and day 28. Each participant completed testing with consistent examiners and consistent test sequencing. The test order was as follows: PCSS, convergence, JPE, DVA and CCFT. A Pearson correlation coefficient was conducted for the PCSS, convergence, JPE, and CCFT. A Spearman’s rho correlation coefficient was performed for the DVA. IBM SPSS version 24 was utilized for all data analysis.

Results: A strong linear relationship was found between all three test days for the DVA, with a correlation between \( r = 0.741 - 0.896 \), indicating excellent reliability. Convergence testing had good test-retest reliability as well \( r = 0.721 - 0.875 \). The correlation between all three days for the PCSS showed a large relationship \( r = 0.600 - 0.674 \). The control section of the CCFT demonstrated moderate to good reliability between all testing days \( r = 0.304 - 0.597 \), whereas the endurance section of the CCFT showed a poor relationship \( r = 0.147 - 0.172 \). The correlation coefficients for the cervical JPE test widely ranged from poor to moderate in all three test conditions (right, left, extension) and was inconsistent across all three test examinations \( (r_{rt} = 0.038 - 0.325) \), \( (r_{lt} = -0.001 - 0.469) \), \( (r_{ext} = 0.243 - 0.542) \).

Conclusions: Statistical analysis showed a large correlation for DVA, convergence, and PCSS, a medium correlation for CCFT-control, and a small correlation for CCFT-endurance and JPE. This indicates that DVA, convergence and PCSS all have good test-retest reliability, CCFT-control has moderate reliability and there is poor reliability for JPE and CCFT-endurance.

Clinical Relevance: Based on the results of our study, the DVA, convergence test, and PCSS can reliably be used by clinicians to assess for change, whereas the results when using the CCFT and JPE should be interpreted with caution.
Influence of Incline Prone Positioning on Backward Disequilibrium after a Neurological Insult: A Case Report

**Background and Purpose:**
Backwards disequilibrium (BD) is an abnormal postural behavior in which there is a disruption in one’s perception of postural vertical that results in a posterior position of the center of mass with respect to the base of support. After a neurological injury, BD can limit a person’s functional mobility and increase their risk of falling. Although general recommendations have been made for treating BD, appropriate intervention strategies for this population lack specificity. A possible treatment strategy that has demonstrated a promising short term improvement in one patient with BD is prone lying. Therefore, the purpose of this study case report is to explore treatment ideas that may improve posture and balance in patients that demonstrate BD in order to gain a better understanding of treatment approaches that are effective with this condition.

**Case Description:**
The patient was a 19-year-old male that presented with BD following a traumatic brain injury from a fall that resulted in a skull fracture and subdural hematoma. The patient demonstrated impairments in both gait and balance that appeared to primarily be caused by BD. As a result, the patient was treated for BD for 3 days with 6 minutes of incline prone lying followed by a treatment plan based on the 5 standards of care for BD [1) Standing back against wall; 2) Sit to stand transition; 3) Stand to sit transition; 4) Continuous stepping; 5) Stepping backwards]. Measurements of static standing balance were recorded immediately pre- and post-incline prone lying on day one as well as on day 4 which did not involve intervention.

**Outcomes:**
The patient demonstrated immediate improvements in static standing balance with bilateral upper extremity support after incline prone lying for 6 minutes. The average time that the patient was able to maintain static standing over three trials improved from a pre-intervention time of 13.2 seconds to a post-intervention time of 32.0 seconds. Additionally, the improvements seen after the initial treatment were retained after only 3 days of intervention with incline prone lying followed by treatment using the 5 standards of care for BD.

**Discussion:**
In this case report, incline prone lying lead to immediate improvements in BD. One possible explanation for the improvements seen could be that there was a recalibration of the patient’s reference to vertical that was brought on by overweighting the somatosensory contribution to gravity perception. Although immediate improvements seen may have been temporary, it is hypothesized that this temporary improvement in performance may have allowed the patient to more successfully complete other interventions at higher intensities for longer durations in order to promote more permanent changes. Future research should focus on replication of this data in larger patient populations to determine if incline prone lying can be used as an intervention to consistently produce improvements in static standing balance.
Implementing a Screening Process for Benign Paroxysmal Positional Vertigo in Inpatient Rehabilitation for Brain Injury

**Purpose/Hypothesis:** Recent clinical practice guidelines recommend screening for Benign Paroxysmal Positional Vertigo (BPPV) to reduce unnecessary diagnostic testing and maximize the efficient delivery of treatment interventions but provide minimal guidance on effective screening procedures. Despite published evidence reporting the co-occurrence of BPPV and brain injury (BI), symptoms of BPPV can often be missed in this population or attributed to other concomitant conditions, such as blood pressure or medication issues. Thus, this inpatient rehab-based pilot project was designed to study the effects of routinely screening inpatients with BI for BPPV by observing measures across three critical domains: 1. Therapist, 2. Patient, and 3. Program. A secondary aim was to collect pilot data on the utility of the screening tool and agreement between therapist-reported screening procedures and results from the Dix-Hallpike maneuver.

**Number of Subjects:** 23

**Materials and Methods:** A screening tool was developed by clinician experts in vestibular rehab based on 4 cardinal symptoms of BPPV: (1) presence of dizziness, (2) intermittent symptoms, (3) symptoms provoked by positional changes, and (4) transient symptom duration. Two primary methods were utilized: (1) Using an online training module, physical therapists were trained to administer the screening tool. Surveys related to perceived confidence were administered before and after completing the training. (2) Inpatients with BI reporting symptoms of dizziness were rendered the screening tool, referred for a vestibular consult and completed a follow-up satisfaction survey.

**Results:** 9 inpatients (6 females, 3 males), mean age 66 years old (SD 16.57), were screened for BPPV and underwent a vestibular examination. 14 physical therapists (experience levels 0-6+ years treating individuals with BI) completed the training module. 2/14, 9/14 and 3/14 therapists reported feeling ‘very confident’, ‘somewhat confident’, and ‘low confidence’ with screening for BPPV before training, with these numbers improving to 4/14, 10/14, and 0/14 post training, respectively. 80% of surveyed therapists reported that the screening tool was ‘very feasible’ to use, and 100% reported that the screening tool would be a valuable addition to screening for BPPV in the BI population. Results from the screening tool were in agreement with the Dix-Hallpike maneuver in 7 out of 9 (78%) cases. Barriers to implementation of the screening process included communication challenges and short lengths of stay. Facilitators included physician knowledge and support of the study. 75% of patients reported it was ‘very important’ that their dizziness symptoms were evaluated.

**Conclusions:** Implementation of a screening tool for BPPV was feasible in the inpatient rehab setting. Our screening tool may be a valid assessment for screening for BPPV when comparing its results to that of the gold standard Dix-Hallpike maneuver.

**Clinical Relevance:** Consequences of BPPV include reduced participation in rehab programs, reduced quality of life, and increased risk for falls. Due to the co-occurrence of BPPV in the BI population, rehab programs should consider screening for this condition.

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Brain Injury SIG
AUTHORS: Anne K. Galgon, Gabriela Alorda, Michelle Marzolini, Brittnay Grimm, Jordan Spector

ABSTRACT BODY:
Purpose/Hypothesis: Patients with persistent symptoms after a concussion are increasingly referred to physical therapists for treatment. However, there is limited research to guide physical therapists on clinical decision making when managing individuals after concussion. The purpose of this pilot study is to determine applicability, feasibility and practicality of a grounded theory qualitative approach investigating physical therapists decision making in the management of concussion. We hypothesis that experienced therapists use a problem based approach attained from physical therapy management strategies integrating concussion specific information.

Number of Subjects: 3

Materials and Methods: The pilot study utilized a grounded theory approach with purposeful sampling of 3 experienced clinicians recruited from an online survey regarding clinical experience in concussion management. Inclusion criteria for subjects included; agreement to participate in a 45 minute interview, > 3 years practice experience with patients who have sustained a concussion, and treatment of >15 patients with concussion in the last year. Interviews utilized case study examples along with semi-structured questions specific to physical therapy patient management model. Interview sessions were recorded, transcribed and independently coded by 3 researchers using traditional and direct content analysis. Consensus was used to identify and define common themes and to classify themes into factors that drove decisions. Post interview member checking was use to verify themes, definitions and classifications.

Results: The findings of this study confirmed that a grounded theory design is both feasible and logical to explore clinical decision making in concussion management among experienced clinicians. All clinicians demonstrated expert clinical decision making strategies, including recognizing meaningful patterns, case dependent problem solving, and use of hypothetico-deductive reasoning and evidence to support decisions. Eleven common themes emerged to include; acuity-chronicity, injury circumstances, management since onset, prior medical history, symptoms severity, symptom type, environmental factors, personal factors, complexity, patient goals, and classification of impairments. Themes were then assigned as factors that affected decision making during examination, diagnosis, prognosis, selection and progression of interventions or assessment of outcomes in individuals post-concussion.

Conclusions: This pilot approach confirmed the use of grounded theory to identify expert clinician reasoning in concussion management in this smaller sample and can be applied to larger populations and potentially various geographical regions to assess commonalities and/or differences.

Clinical Relevance: The long-term outcome of this research will be to establish a conceptual framework for physical therapists to utilize when examining, developing a plan of care, and providing interventions for patients with post-concussion symptoms.
TITLE: Vision Therapy for Oculomotor Dysfunction or Vision Deficits Following Acquired Brain Injury
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Brain Injury SIG
AUTHORS: Jeffrey M. Hoder, Cassidy Holland

ABSTRACT BODY:

Purpose/Hypothesis: Visual impairments following an acquired brain injury occur in 60% of cases of stroke and up to 69% of TBI cases. These vision impairments can have significant impact on mobility, quality of life, and morbidity. Interventions that are easily accessible may be adopted by physical therapists for earlier integration into the rehabilitation process. The purpose of this review is to examine the literature regarding the use of visual and oculomotor interventions to treat oculomotor dysfunction, visual field deficits, and hemispatial neglect caused by traumatic brain injury or stroke, and to provide a set of clinical recommendations to physical therapists treating these populations.

Number of Subjects: 1,108 participants across 27 studies

Materials and Methods: Five databases (PubMed, CINAHL, PsycINFO, Embase, and Scopus) were searched in accordance with PRISMA guidelines for articles investigating oculomotor interventions in the brain injury population that included stroke, TBI, and concussion. Included articles were analyzed for methodological quality using the Modified Downs and Black checklist. Articles were included if the population was primarily adults; patients demonstrated oculomotor dysfunction, visual field defect, or hemispatial neglect due to stroke or traumatic brain injury; and the intervention utilized had an oculomotor focus.

Results: Of 2,502 screened articles, twenty-seven studies met inclusion criteria. The majority of studies were found to be of good or fair methodological quality. A variety of oculomotor interventions were utilized, the majority of which were computer-based exercises or stimulation. Non-computer-based exercises tended to be highly variable in dose and administration, with a greater risk of bias. The vast majority of interventions fell under the body structures and functions category of the ICF model, while the outcomes utilized were more evenly distributed across the model. All articles reported significant improvement in at least one outcome measure after intervention.

Conclusions: In this review, many types of oculomotor interventions were shown to be effective in improving oculomotor dysfunction and other vision deficits. Across the studies reviewed, there was significant variability between intervention types, dosage, and outcome measures assessed; however, there appeared to be effect crossover between domains of the ICF model, meaning that interventions that fall under one domain have the potential to improve functioning in a different domain. While there may be value in physical therapists administering light stimulation and non-computer based oculomotor exercises, confidence in proper technique and dose is poor.

Clinical Relevance: More research is needed on the benefits of additional manual types of oculomotor intervention that can be integrated into a physical therapist’s clinical care, as most interventions studied rely on computer programs which are not accessible to every physical therapist. However, physical therapists with access can use these interventions to improve vision dysfunction in patients with stroke or traumatic brain injury.
Cryotherapy and Self-Reported Fatigue in Individuals with Multiple Sclerosis: A Systematic Review

Purpose/Hypothesis: Multiple Sclerosis (MS) is a degenerative neurological condition believed to be caused by a progressive, autoimmune-mediated inflammatory response within the central nervous system which leads to demyelination and axonal damage. A growing body of anecdotal evidence and academic research has indicated that cooling therapy may increase function and decrease the symptoms of MS. The aim of this systematic review is to determine the effects of cooling interventions compared to placebo/sham or no treatment on self-reported fatigue in individuals with MS.

Number of Subjects: N/A

Materials and Methods: The authors searched two databases (PubMed and EMBASE) through November 12, 2018 using search terms related to cooling techniques and MS-related fatigue. Inclusion criteria included: 1) English language, 2) humans diagnosed with MS, 3) use of cooling therapy before or during activity, 4) use of an objective, self-reported measure of fatigue, and 5) use of any experimental design. Patients with comorbidities unrelated to MS were excluded. A risk of bias assessment was performed by two authors utilizing quality assessment tools related to the type of study including PEDro, NIH Quality Assessment for Case Series Studies (NIHQACSS), and the NIH Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group (NIHQATBASNCG).

Results: Eight studies were included for review. Six studies showed statistically significant (p< 0.05) differences between groups in favor of the cooling group. Four studies showed significant effect sizes in favor of the cooling treatment within and between groups: 1 small ($\eta^2_p$ of 0.091), and 3 large (d > 0.8). PEDro scores for six studies ranged from 4/10 to 6/10. One study had a NIHQACSS score of 9/9, and one study had a NIHQATBASNCG score of 9/12.

Conclusions: Three of the four studies that examined chronic cooling showed large effect size favoring the cooling group. The exception is a case-series with no reported effect size that showed decreased average fatigue. Three of the four studies that examined acute cooling showed statistically significant differences favoring the cooling group with the exception reporting a small, significant effect size that favored the cooling group. Seven of eight included studies showed some benefit of cooling intervention on fatigue. Therefore, based on a moderate level of evidence, cooling treatments may serve as an option for those dealing with MS-related fatigue.

Clinical Relevance: The current review provides evidence that cryotherapy, particularly after long-term use, may decrease subjective reports of fatigue in individuals with MS. This decrease in overall fatigue may indicate cryotherapy would be beneficial as an adjunct treatment in order to increase tolerance to maintenance therapy of cardiovascular and strengthening exercise with energy conservation and therefore improve fatigue in activities of daily living.
TITLE: Effect of Continuous Vs Intermittent Walking on Time to Fatigue in Persons with Multiple Sclerosis
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Degenerative Diseases SIG
AUTHORS: Herbert Karpatkin, Evan T. Cohen, Anna Noelle Rubeo, Rosangelis Rodriguez, Lourdes Giselle Rodriguez, Rachel Nierenberg
ABSTRACT BODY:
Purpose/Hypothesis: Diminished walking endurance is common in persons with MS (PWMS). Previous studies have shown that PWMS walk farther in 6 minutes when using intermittent walking (IW) [i.e. with interspersed rest breaks] than continuous walking (CW) [without breaks] but it is unknown whether PWMS can walk greater distances or longer duration when using IW for periods longer than 6 minutes. The purpose of this study is to compare distance and time walked on a treadmill at a fixed velocity utilizing IW or CW. We hypothesized that PWMS would be able to walk greater distances and for longer duration when walking intermittently than when walking continuously.

Number of Subjects: Six women and five men with MS (Extended Disability Status Score median (IQR) 4.5 (3.0), mean age (sd) 60 (5.9), mean Multiple Sclerosis Impact Scale (sd) 82.4 (22.0), mean Fatigue Severity Scale (sd) 5.0 (1.2)) participated in the study.

Materials and Methods: A crossover design was used. Participants were randomized into two order groups: IW then CW, or CW then IW. Both conditions were performed on a treadmill. The IW condition included alternating 30 seconds of walking and 30 seconds of seated resting. The CW condition consisted of continuous walking without breaks. Participants wore an overhead harness for safety. Baseline walking speed was determined with an overground 2-minute walk test (2MWT). After a brief rest, participants completed a 100mm-long visual analog scale for fatigue (VAS-F). Participants walked on the treadmill at the fastest pace up to the 2MWT speed until they either lost their balance or asked to stop. Participants then completed a second VAS-F. The differences between the pre- and post-test VAS-F were calculated as delta VAS-F. Walking time (WT) and walking distance (WD) were recorded. After one week, participants returned and performed the crossover condition. Difference in WT, WD, and delta VAS-F were analyzed with paired-samples t-tests with an alpha level of p=.05.

Results: Participants had significantly longer WT in the IW condition (10.3 minutes) than in the CW condition (6.3 minutes) (t(10)=2.469, p=.033). Participants also had significantly greater WD in the IW condition (536.2 m) than the CW condition (457.5) (t(10)=2.376, p=.039). There was no difference in delta VAS-F between conditions (t(10)=.620, p=.549). IW enabled participants to walk at best-pace for a longer duration and for greater distance than CW, without a concomitant increase in delta VAS-F.

Conclusions: These findings further support the use of IW training to improve walking endurance in pwMS. Adding rest breaks during endurance training enabled participants in this study to walk farther and longer, increasing the volume of activity. Comparative effectiveness studies should be conducted to determine whether IW training is superior to the traditional model of CW training to improve walking endurance.

Clinical Relevance: In persons with MS, greater walking distance can be achieved with an intermittent walking training program than with a traditional continuous walking program. The higher volume of walking activity delivered during an IW program may result in a superior training effect.
Purpose/Hypothesis: Upper extremity pain and disability are common in people with Parkinson disease (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, Timed Functional Arm and Shoulder Test, 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. Data has been collected on 17 participants (mean age 71.2 (6); 14M, Hoehn & Yahr score 2.3 (0.7); duration of PD diagnosis 14.1 years (8.1)) without active shoulder or cervical pathology, and who were considered able to perform the test safely.

Materials and 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 is 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, 11/17 used half gallon weight. The TFAST scores were variable ranging from 4-121 reps, mean reps were 56.8 (30.2). Reliability and measurement error estimates (n=16) are as follows: ICC 0.96 (0.88-0.98); MDC90 14.1, SEM 6.1. The correlations with TFAST scores for each scale were DASH (r = - 0.60); UPDRS Part II (r= - 0.37) and Part III (r= - 0.62).

Conclusions: Preliminary results show feasibility and excellent reliability of the TFAST in people with PD. The total TFAST reps were 24% lower and more variable compared to the published norms for older adults. The DASH self-report and UPDRS self-report were moderately correlated to TFAST performance. For people with PD, the DASH may provide insight on upper extremity pain and disability that a patient may experience, mean DASH scores were 32.9 (14.1) indicating moderate disability.

Clinical Relevance: A 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, multiple sclerosis, stroke etc.
The Immediate Effects of Customized Auditory Cueing on Gait in People with Parkinson’s Disease

Purpose/Hypothesis: The purpose of this study was to assess the immediate effects of a specialized musical composition on gait in people with Parkinson’s disease (PD). Incorporation of auditory cueing, typically via metronome, to improve gait has been successfully used in rehabilitation for decades. The Synchronized Optimization Auditory Rehabilitation (SOAR) tool is a new software method for delivering customized musical cues. The use of musical cues in the form of pattern sensory enhancement (PSE) has improved functional outcomes through interventions that melodically, rhythmically, and tonally facilitate movement. The SOAR tool has shown excellent interrater reliability between physical and music therapists and is preferred by people with PD over the metronome. The author hypothesized that the participants would show significant improvements in velocity, cadence, step length, and step width.

Number of Subjects: Twenty subjects with PD were tested. The subjects were Hoehn and Yahr stages I – IV.

Materials and Methods: The subjects completed testing of the spatiotemporal parameters using the Zeno Walkway System during a single session. First participants walked across the mat without auditory cueing. Next, the participants ambulated using the SOAR tool with the physical therapist creating and modifying the musical cue based on observational gait analysis. Once the most optimal gait pattern was noted by the physical therapist, the participants’ spatiotemporal parameters were measured while using the created auditory cue. The data was analyzed using a paired-samples t-test.

Results: On average, the participants showed improvements in cadence (p=0.02) and bilateral step length (p=0.009), but not velocity (p=0.20) or step width (p=0.09) when using the SOAR tool as compared to no auditory cue.

Conclusions: The immediate effects of the SOAR tool were positive. While there was not a significant improvement in velocity the subjects were not trained in the use of the SOAR tool, they were simply instructed to walk to the beat. The immediate improvement in cadence and step length indicate the possible benefit that the SOAR tool could have on velocity if proper rehabilitative intervention was completed.

Clinical Relevance: The use of the SOAR tool during ambulation could be an effective intervention for improving gait in people with PD. Intervention studies and training need to be completed to determine the impact on velocity and long-term benefits.
**Title:** Boxing to Improve Sleep Quality and Daytime Sleepiness in Individuals with Parkinson’s Disease: Pilot Study  
**Current Section:** Neurology  
**Current Sub-Category:** Degenerative Diseases SIG  
**Authors:** Linda Marie Denney, Cynthia Ivy, Michelle McKay, John Manning, Kaitlyn Landess, Marcus Webster, Macy Marie Urrutia, Patricia S. Pohl  

**Abstract Body:**  
**Purpose/Hypothesis:** Over 95% of individuals with Parkinson’s Disease (PD) suffer from at least one sleep-related dysfunction. Sleep behavior disorder (RBD) and excessive daytime sleepiness are non-motor signs of PD that impact mobility and increase risk of falls. Meditative and multi-modal exercise have been shown to improve sleep in individuals with PD. However, it is unknown if there is a relationship between the intensity of exercise and sleep quality. Boxing is a high-intensity exercise that has become a popular activity with the PD community and results in improved mobility. The purpose of this study is to determine if high-intensity exercise, i.e. boxing, has an effect on sleep and daytime sleepiness and the impacts on mobility in individuals with PD.  

**Number of Subjects:** Ten (7 M, 3 F) community-dwellers with PD, Hoehn & Yahr I-III, between the ages of 55-81 years participated in a supervised community-based boxing program. Average length of diagnosis was 57 months. All were independent with walking in the community without an assistive device.  

**Materials and Methods:** Participants were fitted with a heart rate monitor during training and were encouraged to exercise at 80-85% of their maximum heart rate. Training consisted of one-on-one 30-minute boxing sessions with a certified boxing coach bi-weekly for 6 weeks. The training included combinations, heavy bag and focus mitt drills. Participants wore hand wraps and boxing gloves, however no sparring was involved. Members of the research team supervised each boxing session and led brief warm-up and cool-down exercises. Outcome measures for sleep quality, daytime sleepiness, depression, and mobility were taken at baseline, post-training (6 weeks), and 12 weeks. An activity worksheet was completed by each participant during weeks 7-12.  

**Results:** Monitoring during training revealed that participants achieved 60-85% of their target heart rate. Twelve training sessions were completed by each participant. There were no adverse events. A Repeated Measures ANOVA revealed significant improvement (p < .05) for the Hamilton Depression Scale (p=.02) and in the cognitive dual task Timed Up-and-Go over time (p=.04). There was a trend toward improved scores for the Parkinson’s Disease Sleep Survey (PDSS) and Epworth Sleep Scale (ESS) for daytime sleepiness after the 6 weeks of boxing training. Subjective comments supported these improvements.  

**Conclusions:** The results of this study suggest that individuals with PD can safely participate in a high intensity boxing program that may improve sleep quality.  

**Clinical Relevance:** High intensity exercise may improve sleep quality and reduce daytime sleepiness in individuals with PD. Although not predicted, changes in dual task performance suggest that the cognitive demands inherent in boxing, such as sequencing combinations, may be another benefit of this intervention. This would have relevance for functional mobility such as moving about the house, community or worksite while focus is on tasks in each environment.
Title: Reactive Balance Control Training in a Person with Stiff Person Syndrome: A Case Report

Current Section: Neurology

Current Sub-Category: Degenerative Diseases SIG

Authors: Jenna Kathleen Paynter, Joseph Matthew Dannels, Stephanie Jones Greenspan

Abstract Body:

Background and Purpose: Stiff person syndrome (SPS) is a rare neurologic condition affecting one to two people per million, mostly women in their 40s. The etiology is unknown but may be autoimmune as 60% of people with SPS (PwSPS) have anti-glutamic acid decarboxylase antibodies, known to inhibit the formation of gamma aminobutyric acid (GABA). Without adequate GABA, motor neurons fire continuously, preventing muscle relaxation. People with SPS present with rigidity of the trunk and proximal lower extremities (LEs) due to agonist-antagonist co-contraction and hyperlordosis. Sensory stimuli can trigger muscle spasms that are superimposed on the sustained muscle contractions. Many PwSPS report fear and anxiety related to everyday auditory and tactile stimuli, which cause spasms and falls. Four case reports describe physical therapist (PT) management of PwSPS comprising different interventions: functional mobility, strengthening, active range of motion, and stretching. The combination of perturbation and gait training to decrease fall risk and fear of falling (FOF) has not been described. Some research has shown the benefits of perturbation training in older adults and treadmill training with a harness in people with other neurologic conditions. The purpose of this case report is to describe outpatient PT management using task-specific perturbation training combined with gait training to decrease fall risk and FOF in a person with SPS.

Case Description: The patient was a 53-year-old female with a history of low back pain and difficulty walking. A course of orthopedic physical therapy increased her symptoms before she was diagnosed with SPS and prescribed Diazepam and Rituximab. When referred for neurologic physical therapy, she reported 9 falls in 5 months. She presented with lumbar and right LE muscle stiffness, spasms, and impaired coordination but normal LE strength. She was classified as being at high risk for falls via gait speed (0.33 m/s) on the 10-meter walk test using bilateral quad canes and had high FOF as indicated by a score of 40/64 on the Falls Efficacy Scale International (FES-I). Her goals were to decrease falls and use public transit independently. Intervention included 6 sessions of progressive treadmill and over-ground gait training with and without body weight support (via a LiteGait). Three sessions were combined with reactive balance training interventions of perturbations applied at the hip and shoulder, a moveable platform, an escalator simulation, and treadmill acceleration and deceleration using the LiteGait.

Outcomes: After 7 sessions, the patient’s gait speed increased by 0.39 m/s (Minimally Clinically Important Difference = 0.13m/s) and FES-I score decreased by 1 point (Minimal Detectable Change = 0.52).

Discussion: Task-specific reactive balance and gait training can decrease fall risk and FOF in a patient with SPS, adding to the existing literature showing positive outcomes for functional mobility training. Future studies should investigate the effectiveness of gait and task-specific reactive balance training in a larger cohort of PwSPS.
Background and Purpose: Cervical dystonia (CD) is a painful condition that can affect those with Parkinson's disease (PD) and affect their functioning \(^2\text{,}^3\). It is characterized by painful, prolonged muscle contractions (typically of the sternocleidomastoid, suboccipitals, and upper trapezius) that cause involuntary twisting and positioning of the neck. Treatment options include physical therapy (PT), medication, and botulinum toxin injections to address pain, spasms, and headaches \(^1\). Currently, there is no consensus on the most effective treatment for CD. Recently, trigger point dry needling (TDN) has been shown to provide improvements in patients with cervical pain \(^4\) and disability \(^6\). This case report describes the use of TDN along with traditional PT treatment to address cervical impairments in a patient with PD and CD.

Case Description: A 74-year-old male with a 15-year history of PD was referred to PT for CD. His chief complaint was neck pain and difficulty playing golf. He reported seeing a physical therapist (traditional exercise and manual therapy) and a chiropractor (manual techniques) over the course of the previous 3 years as well as botulism toxin injections 6 months prior. These previous treatments gave him little to no relief of his symptoms. Upon examination, the client presented with significant torticollis posture positioned in right sidebend and left rotation. Additionally, he had complaints of decreased lower extremity strength, poor walking endurance, and falls. Interventions included dry needling with electrical stimulation (ITO®-ES-130® and Pointer Excel II LT) to the suboccipitals and upper trapezius. Electrical stimulation intensity was to patient’s tolerance with a frequency of 4 Hz and applied for up to five minutes \(^4\). He also received manual therapy, postural reeducation, balance training, general strengthening, and gait training.

Outcomes: The patient was seen 2 times per week for 6 months. Dry needling treatment was performed once per week. He demonstrated improvements in cervical extension (Lacking 5\(^\circ\) to 2\(^\circ\)), cervical rotation (Improvement of 27\(^\circ\) and 20\(^\circ\) for left and right rotation respectively), occiput to wall measurement (7.7cm to 5.8 cm), decreased pain via visual analog scale (6 to 4), and improved Cervical Dystonia Impact Profile-58 (81/100 to 34/100). Further, prior to our intervention, when in a supine position the patient’s head was suspended 3.8 cm above the mat. Upon discharge, the patient demonstrated an improved ability to lie supine with his head resting comfortably on the mat. Most importantly, the patient reported moving more easily and was able to resume playing golf.

Discussion: This case report describes the positive effects of the use of dry needling in conjunction with traditional PT for a patient with PD and CD. To our knowledge, this is the first report that describes the use of dry needling to address impairments in a person with with CD and PD. The improvements in his pain, cervical ROM, occiput to wall measurement, and CDIP-58 are indicative that he benefited from dry needling in conjunction with traditional therapy whereas previously he was unable to find relief.
Purpose/Hypothesis: Falls among persons with Parkinson (PwP) lead to progressive loss of mobility independence and confidence that ultimately may reduce survival. Prevalence rates for falls in these patients greatly exceeds those in age matched controls and predicting falls in this population has proven to be difficult. The Timed Up & Go Test is a valid and reliable clinical tool used to measure gait and balance in PwP, however the fall risk cut off time has been debated in the literature (<8,10,12,13.5 secs). Recent literature has shown the 3-meter Backward Walk test (3 MBW) demonstrated similar or better diagnostic accuracy than the TUG for detecting retrospective falls in healthy older adults. People walking faster than 3.0 secs were unlikely to have fallen whereas people walking slower than 4.5 were very likely to have fallen in the past year. The purpose of this study was to evaluate the diagnostic accuracy for the 3MBW test in PwP in a retrospective cohort of PwP and predict fall cutoff scores in relation to other commonly used measures.

Number of Subjects: 176

Materials and Methods: Retrospective data from a cohort of 176 PwP (124 males and 52 females) with an average age of 72.5±7.8 years who attended a physical therapy clinic and PD community outreach program that utilized the 3-meter BW test as part of the screening and testing process was analyzed. The 3-meter BW test previously introduced by Carter et al. in healthy adults, was utilized in this group of PWP of varying disease severity. The relationship of the 3MB test was to disease severity, age, retrospective fall risk, determined by a retrospective 6-month fall report and correlation to other valid and reliable fall risk and gait speed assessment/outcome tools such as the TUG regular, TUG cognitive and the 5 time sit to stand was analyzed.

Results: PwP who fell had a significantly slower 3MBW (6.4 vs 4.5s), TUG reg (11.3 vs 7.5s), TUG cog (15.3 vs 9.4s), and 5xSTS (18.2 vs 11.6s). Using Receiver Operating Curve (ROC), optimal cutoffs were evaluated for different measures and fall history (yes/no). The most optimal cutoff in terms of sensitivity for 3MBW, TUG reg, TUG cog, and 5xSTS were 4.2, 7.3, 9.8, and 12.9 seconds, respectively. Compared with the other measures (TUG reg, TUG cog, and 5xSTS), the diagnostic accuracy of the 3MBW to detect falls at 4.2 s was similar and did show significant change in area under the curve (AUC) when compared to established norms for fallers in TUG reg (7.3 vs 12.21 s), TUG cog (9.8 vs 16.5 s), and 5xSTS (12.9 vs 16.0 s).

Conclusions: In a study of PwP, the 3MBW test demonstrated better diagnostic accuracy for falls in the past year compared to commonly used established norms.

Clinical Relevance: PwP have difficulty walking backwards and the 3MBW test can be used to more accurately predict falls in this population.
TITLE: Acute Changes in Gait Characteristics in People with Parkinson’s Utilizing Nordic Walking Poles
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Degenerative Diseases SIG
AUTHORS: Jamie Joanne Haines, Erica Haug, Hannah Rose Schmidt

ABSTRACT BODY:
Purpose/Hypothesis: The purpose of this study was to assess if Nordic walking (NW) can induce acute changes in gait characteristics in people with Parkinson’s disease (PwPD) compared to normal walking. A secondary purpose was to gain insight into participants’ perception about using NW poles.

Number of Subjects: Nine participants with Parkinson’s disease (PD) were recruited as a sample of convenience.

Materials and Methods: Participants performed 2-Minute Walk Tests (2MWT) in three separate trials; without the use of NW poles (Trial 1), with the use of NW poles (Trial 2), and a repeated trial without the use of NW poles (Trial 3). Gait characteristics were assessed using the APDM Opal system. Measures for gait speed, stride length, and lateral step variability were analyzed using a one-way repeated measures analysis of variance (ANOVA). Perceptions about using the NW poles were collected via interviews.

Results: There were no statistically significant changes noted in gait speed ($p=0.766$), stride length ($p=0.594$), or lateral step variability ($p=0.600$) from Trial 1 to Trial 3. Statistically significant reduction in gait speed ($p=0.010$) was noted from Trial 1 to Trial 2 and significant increase ($p=0.004$) from Trial 2 to Trial 3. Most participants reported using the walking poles improved sense of stability and confidence.

Conclusions: The results of this study found no improvements in gait parameters when only given a brief training session. PwPD have difficulty with tasks that have a cognitive and physical component such as using walking poles, which may explain the reduction in gait speed.

Clinical Relevance: Long term training with NW poles may be needed to see changes in gait characteristics because practice can lead to increased automaticity of movement which is an aspect of movement control that PwPD are lacking. However, the practice of a task can make it more familiar and decrease the difficulty. While gait parameters were not significantly changed, subjective interviews may have shown some benefit. If NW poles can improve a person’s confidence in walking and their willingness to exercise, they can use it to manage their PD symptoms and improve their quality of life.
TITLE: Does Training Reactive Postural Adjustments in Parkinson’s Disease Improve Impairments, Activities, and Participation?

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: Clifford L. Barnes, Marcia B. Smith, Jacob Berndl, Elizabeth Boshears, Graham Daub, Kelly Elizabeth Ely, Rachel Garbrecht, Annie Govig, Stacey Heronema, Joshua Thomas Holland, Bryan Michel, Hannah Price, Nicole A. Reed, Alexandra Tagen, Katherine Whitney, Katherine Olmedo

ABSTRACT BODY:

Purpose/Hypothesis: People with Parkinson’s disease (PD) develop postural instability (PI) that is refractory to medications. PI includes less flexible patterns of postural sway. Physical therapists (PT) tackle PI with interventions that address motor learning concepts to challenge postural alterations with novel tasks and repetitions shown to promote neuroplastic changes. The aim of this study was to determine if a high intensity balance program would improve reactive postural stability in PD in International Classification of Function (ICF) classifications.

Number of Subjects: Twenty-two men and women, mean age 66.13 ± 6.25 years, whose PD ranged from Hoehn & Yahr stages 1-3 (median 2) participated. All scored at least 27 on MMSE.

Materials and Methods: Outcome measures examined impairment, activity, and participation levels at baseline, post-intervention, and 1 month post- intervention’s end: m-CTSIB measured static balance; while Proprio5000™ assessed reactive dynamic motion; and GaitRite™ assessed temporal gait. Community Balance & Mobility Scale (CBMS) assessed high level locomotor tasks. Activity specific Balance Confidence (ABC), PDQ-8, and SF-36 measured participation.

Twice weekly for 4 weeks subjects completed intensive training sessions that provided progressive perturbations using an algorithm based on baseline data developed for the Proprio platform that randomly altered its movement by tilt, direction, and speed (2°-25°, random 360°, and 12.6°/s to 126°/s, respectively). Postural perturbations occurred at least 1/s for 30 minutes, for a minimum of 1800 perturbations/session.

Results: Significant improvement (p<.05) in DMA score and time for reactive balance was observed. Although trends for improvement in outcomes were noted, these did not translate to statistically significant differences over time for static balance, gait speeds (comfortable or fast), ABC, PDQ-8 or SF-36. However, clinical improvement (MCID = 95) was seen in comfortable gait velocity (mean=0.18m/s) post-intervention.

Conclusions: High level functioning subjects with PD who received an intensive progressive balance program significantly improved reactive balance stability and time on task. The Proprio5000™ permitted the PT to administer an intensive reactive balance intervention that met criteria for challenge and repetition. Trends in improvement in measures of activity and participation were noted. Greater changes in outcome measures may be realized with intervention programs that last longer than 8 sessions in 4 weeks.

Clinical Relevance: Results of this study encourage practitioners to adopt challenging, intensive balance interventions.
TITLE: Can Treadmill Training with Musical Cueing in Individuals with Progressive Parkinson’s Disease Improve Ambulation?

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Degenerative Diseases SIG
AUTHORS: Kristen Prejean Barta, Derrick Ferguson Campbell, Sharon Dunnivan-Mitchell

ABSTRACT BODY:
Purpose/Hypothesis:
The purpose of this study was to measure the effectiveness of a specialized musical composition in combination with treadmill training to impact gait parameters and balance in people with progressive Parkinson’s disease (PD). Incorporation of auditory stimulation, typically via metronome, to improve movement has been successfully used in rehabilitation for decades. Treadmill training, also frequently used in treatment of PD, has shown short- and long-term improvements in stride length, cadence, stance and swing phase. Music assisted therapy utilizing expertly designed musical composition, known as informed composition, has recently become available for use in rehabilitation in collaboration with music therapists. Combination of an informed musical composition with treadmill training was tested to determine if positive improvements were seen in people with PD. The authors hypothesized that the participants would show significant improvements in gait, balance, and confidence with functional mobility.

Number of Subjects: Four subjects with a diagnosis of PD were recruited. Three of the four subjects completed the study. Subject 1 was rated to be Hoehn and Yahr stage III and Subjects 2 and 3 were rated stage IV.

Materials and Methods: Single subject series research of A0-B-A1 design, where the B phase consisted of combination treadmill training with musical cueing three times per week for six weeks. During each phase, participants were tested three times using the following measures: MiniBESTest, Dynamic Parkinson Gait Scale (DYPAGS), Activities Balance Confidence Scale, 6-minute walk test (MWT), velocity, cadence, and step length. The data was analyzed using a two standard deviation band method to demonstrate statistical significance.

Results: Subject 1 demonstrated significant improvements in the MiniBESTest, DYPAGS, 6-MWT, velocity, cadence, step length. Subjects 2 and 3 exhibited less consistent results with all measures and overall larger standard deviations indicating the variety of the outcome measures during testing.

Conclusions: Subject 1, the highest functioning participant at baseline, showed significant improvements in gait and balance throughout the intervention. Subjects 2 & 3 demonstrated less improvement as a result of the intervention, however where characterized by greater fluctuation in functional mobility at baseline. These participants required an assistive device for ambulation and had a history of frequent falls.

Clinical Relevance: The use of a specialized musical composition in combination with treadmill training could be an effective intervention for improving gait and balance in people with PD earlier in the disease process.
TITLE: Concept Mapping of Patient-Reported Outcomes for Parkinson’s Disease to the ICF Model
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Degenerative Diseases SIG
AUTHORS: Elizabeth Diane Thompson, Darcy Schwartz Reisman, Carole A. Tucker
ABSTRACT BODY:
Purpose/Hypothesis: Parkinson’s disease (PD) is a neurodegenerative condition affecting multiple body systems and areas of function such as walking, tremor, cognition, mood, sleep, speech, and digestion. PD is also characterized by considerable individual variability in clinical presentation, necessitating careful and individualized assessment through outcome measures designed for those with PD. However, it is unclear how completely each of these tools represent the full range of health and wellness concepts that may be affected in PD. The purpose of this work was to describe the content of three of the most highly-recommended PD-specific patient-reported outcome measures (PROMs) by mapping each item to the World Health Organization’s International Classification of Functioning, Disability, and Health (ICF).
Number of Subjects: No participants were used; this work solely involved concept analysis of the items in PD-specific outcome measures.
Materials and Methods: Three PD-specific PROMs were included in this analysis: the Parkinson’s Disease Questionnaire – 39 items (PDQ-39), the Parkinson’s Impact Scale (PIMS), and the Parkinson’s Disease Quality of Life Questionnaire (PDQL). The content of each item in each tool was assessed to determine how it could be linked to one of four ICF domains: body structures, body functions, activities/participation, and environment.
Results: All items in the PIMS, PDQL, and PDQ-39 could be mapped to at least second-level classification codes in ICF domains. Of the PDQ-39 items, 19/39 related to activities/participation, 13/39 related to body functions, and 7/39 related to environmental factors. Of the PIMS items, 2/10 related to body functions, 2/10 related to environmental factors, and 6/10 (60%) related to activities/participation. Of the PDQL items, 24/37 (64.9%) related to body functions, while 13/37 related to activities/participation.
Conclusions: The PIMS, PDQL, and PDQ-39 map well to the ICF. Each includes content related to multiple domains, with the greatest representation of the body functions and activities/participation domains, though differences in representation of more granular categories varied across the three tools. The PIMS and PDQL also include a small number of items related to environmental factors. The three tools combined addressed 5/8 categories in the body structures domain, 6/9 in the activities/participation domain, and 2/5 in the environmental factors domain, with the PDQ-39 providing the most comprehensive coverage. However, none of the tools addressed issues related to body structures, and only 13/30 categories within body functions, activities/participation, and environmental factors were addressed.
Clinical Relevance: Due to the differences in ICF domains and areas of function addressed with each of these patient-reported outcome measures, therapists should consider using more than one diagnosis-specific tool when assessing perceived function and quality of life in individuals with Parkinson’s disease. Further research should explore more comprehensive PROM systems with wider coverage of ICF domains that may more completely illustrate the effects of PD on the whole individual.
TITLE: Comparison of Upper Extremity Capacity Measures to Performance in Persons with Multiple Sclerosis

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: Tara Andrade, Heather M. DelMastro, Elizabeth S. Gromisch, Albert C. Lo, Jennifer A. Ruiz

ABSTRACT BODY:

Purpose/Hypothesis: To determine which capacity measures (Nine Hole Peg Test, NHPT; Box and Block Test, BBT; or Test d’Evaluation des Membres Supérieurs de Personnes Agées, TEMPA) is a better predictor of upper extremity (UE) impairment (defined by the Disability of the Arm, Shoulder, and Hand questionnaire; DASH) in persons with Multiple Sclerosis (pwMS).

Number of Subjects: 257

Materials and Methods: This was a cross-sectional study of a random sample of pwMS, as part of a larger study funded by the National Multiple Sclerosis Society. Demographics and disability level (Patient Determined Disease Steps; PDDS) for participants were collected along with the following measures: DASH, NHPT, TEMPA, and BBT at a one-time visit. Scores for each extremity were combined to create a bilateral score (Comb-NHPT, Comb-BBT, total-TEMPA). UE impairment was defined as 2.0 SD above the normative mean on the DASH. Descriptive statistics characterized the sample. Receiver-operating-characteristic (ROC) curves estimated the classification accuracy of each predictor, with the optimal cut-off scores calculated using the Youden Index. A stepwise logistic regression, with UE impairment as the outcome, controlled for significant demographic variables and determined which capacity measure accounted for the most variance.

Results: The Comb-NHPT had an 83.4% classification accuracy, with the cut-off score (54.32s) yielding a sensitivity of 69.8% and specificity of 79.4%. The Comb-BBT had a classification accuracy of 84.5%, a sensitivity of 68.3% and specificity of 86.6% for its optimal cut-off score (91.25 blocks). The total-TEMPA had the highest classification accuracy (85.6%), with a sensitivity of 74.6% and specificity of 85.6% for the cut-off score of 148.07s. The three capacity measures did not have significantly different classification accuracies or sensitivities (p>0.01). The Total-TEMPA and Comb-BBT had higher specificity than the Comb-NHPT (p<0.01), but did not differ between themselves (p=0.71). The logistic regression revealed PDDS accounted for the most variance, followed by the Comb-BBT, the latter accounting for 8% of the variance. The Comb-BBT was the only measure found to significantly predict UE impairment (b= 0.06, Wald X² =18.27, p <0.01). The odds of having UE impairment increased with lower Comb-BBT scores.

Conclusions: The Comb-BBT was found to be the best predictor of UE impairment as defined by the DASH, compared to the Comb-NHPT and Total-TEMPA.

Clinical Relevance: There is a lack of literature specifically regarding UE capacity and performance measures in pwMS. The BBT is a good predictor for UE impairment, which is beneficial clinically as it is relatively quick and simple to administer.
**ABSTRACT BODY:**

**Purpose/Hypothesis:** Freezing of Gait (FoG) is one of the major gait disturbances seen in Parkinson’s Disease (PD). While medications such as levodopa can improve some of the symptoms of PD, there are no medications that have been proven to slow the progression of this disease. Exercise has been shown to improve motor and non-motor symptoms of PD. While several studies focused on the effectiveness of exercise on FoG in individuals with PD, there is not a consensus on the most effective form of exercise. The purpose of this systematic review was to analyze the existing literature to determine best practice for improving FoG.

**Number of Subjects:** n/a

**Materials and Methods:** Three databases were searched including PubMed, PEDro, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL). Search terms included: Therapeutic Exercises, Freezing, Gait, Parkinson’s Disease and Exercise. A total of 8 articles were analyzed to be included in this systematic review.

**Results:** This review provides evidence-based support that exercises such as those involving treadmill training, slackline training, action observation training, or aquatic obstacle training may be beneficial in reducing FoG in individuals with PD. Literature suggests that cueing programs as an adjunct to physical therapy may be beneficial in improving FoG in individuals with PD. There are a variety of underlying physiological mechanisms that may contribute to improvement in FoG; however, the researchers are unable to determine the exact mechanism for this improvement. It is suggested that cueing can shift attention to the task, resulting in improved gait parameters which is believed to translate to decreased FoG. Action observation training can lead to increased recruitment of the motor network and mirror neurons, which has been found to be functionally correlated to decreased FoG. It is suggested that more complex and functional a task is, the more likely it will translate to better outcomes for individuals with PD. At least 12 sessions over a period of 4-6 weeks may be appropriate to see short term improvements in FoG in individuals with PD. Inconsistencies between exercise protocols in terms of exercise and duration make it difficult to determine which intervention is most appropriate.

**Conclusions:** This systematic review provides evidence that exercises such as treadmill training, slackline training, programs supplemented by individualized cueing, action observation training, or aquatic obstacle training may decrease FoG in individuals with PD. Without more information and stronger evidence from RCTs, we cannot determine with certainty which type of exercise program is most effective in decreasing FoG in PD. Future research should focus on consistency in protocols to determine the most appropriate intervention for FoG in individuals with PD.

**Clinical Relevance:** FoG lead to increased number of falls and increases fear of falling in individuals with PD. Cueing in addition to gait training may help improve FoG which could be beneficial for individuals with PD in decreasing number of falls. Clinicians should consider implementing cueing techniques as they may significantly improve balance outcomes and quality of life in individuals with PD.
TITLE: Variability in Interday Physical Activity in Individuals with Parkinson Disease Compared to Healthy Older Adults.

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Degenerative Diseases SIG
AUTHORS: Samuel Jewell, Sujata Pradhan

ABSTRACT BODY:

Purpose/Hypothesis: Movement variability can be the result of a number of factors such as level of skill acquisition, age, individual preference, and/or health condition. Movement disorders lead to physiologic, cognitive and functional changes and symptom fluctuation that may influence movement variability. Previous research with Parkinson’s disease (PD) suggests an overall reduction in physical activity (PA) and that adults with PD showed more inter-day variability during turns while walking. However, little is known about the impact PD may have on variability in PA. The purpose of this study was to compare inter-day PA variability in adults with PD to that in healthy older adults (HOA). We hypothesized that there will be less inter-day variability in PA quantity and intensity in PD compared to HOA.

Number of Subjects: 30 individuals with PD and 30 age matched HOA

Materials and Methods: Participants wore a continuous activity monitor (Fitbit Charge HR) for 14 days. Average time spent in each intensity of PA and sedentary time per day was calculated over the 14 days, along with standard deviation (SD) and coefficient of variation (CV). A t-test was used to determine the difference in variability with an alpha set at 0.05.

Results: Both groups were similar with respect to age, gender, and number of comorbidities. The PD group took 43.4% less average daily steps compared to the HOA group (p<0.001) and completed 53.2% less average daily minutes in high intensity PA (p<0.001) but there was no significant difference in the CV for these variables. The PD group spent significantly less time in moderate intensity activity (PD=14.5 min, HOA=30.4 min, p<0.001) and showed a significant difference in variability based on CV (PD=136.3, HOA=103.5, p<0.05). Similarly, the PD group spent less time in light activity (180.8 min) compared to HOA (258.9 min) (p<0.001) and the variability was significantly different (CV-PD=28, HOA=21.5, p<0.05). The amount of time being sedentary was significantly greater in the PD group (HOA=659 min, PD=881.4 min, p<0.001) Variation was less in the PD group compared to HOA (CV-PD=11.3, HOA=18.2, p<0.001).

Conclusions: Individuals with PD complete significantly less, and have more variability in the amount of moderate and light intensity PA. Despite significant differences in the number of steps taken and the time spent in high intensity activities between groups, there was no difference in the inter-day variability. The PD group had significantly less variable and a higher daily average of sedentary time compared to HOA.

Clinical Relevance: More consistent sedentary time and less consistent engagement in moderate and light intensity activity in the PD group suggests a sustained pattern of physical inactivity in this population. Further research is needed to understand what factors contributing to the inter-day variability in PA to mitigate sustained inactivity and to achieve PA levels recommended by the ACSM PA guidelines for adults.
ABSTRACT BODY:

**Purpose/Hypothesis:** Outcomes of deep brain stimulation (DBS) surgery in patients with Parkinson’s disease (PD) can vary: literature supports consistent improvements in tremor, rigidity, gait symmetry and cadence, however it is not clear that balance and falls consistently improve. The objectives of this study were to 1) determine change in balance and fall risk as measured by the Mini Balance Evaluation Systems Test (Mini-BESTest) and 2) perception of function in people pre-DBS surgery and three months post-DBS surgery.

**Number of Subjects:** Eight participants (4 female) with PD (Hoehn & Yahr 1-3) who had DBS surgery and followed up 3-4 months after surgery in a multidisciplinary clinic.

**Materials and Methods:** Clinical data was recorded from subjects pre-DBS surgery, 1) on and 2) off medications, 3) post-DBS surgery with DBS off, and 4) 3-4 months post-surgery with DBS on. The Unified Parkinson’s Disease Rating Scale (UPDRS), Mini-BESTest, and Activities Balance Confidence (ABC) scale were assessed at all time points. A patient-reported scale, the Patient Specific Functional Scale (PSFS), was used to track self-reported changes in function at the first and last visit.

**Results:** Average UPDRS score was 19.63±8.08. At baseline (on meds), the average Mini-BESTest score was 24.3±6.5, ABC scores were 76.5%±5.5, and PSFS score was 5.5±2.65. The most commonly reported symptom participants hoped would improve with surgery was tremor (n=3), followed by freezing (n=2), walking (n=1), balance (n=1), and stiffness (n=1). Off meds and prior to surgery, Mini-BESTest worsened to 20.6±8.1. Following surgery but with DBS off, Mini-BESTest and ABC were 24.8±4.57 and 76.9%±27.1 respectively. Finally, with DBS on 3-4 months post-surgery, Mini-BESTest and ABC were 25.6±6.2 and 81.8%±22.8, respectively, and PSFS improved to 7.8±2.3. The symptom participants reported to be most improved was tremor (n=3), followed by walking (n=1), speech/swallowing (n=1), freezing (n=2), memory (n=1).

**Conclusions:** To our knowledge, no prior studies have assessed Mini-BESTest and ABC changes pre/post DBS surgery. In this small sample, balance and ABC stayed stable and patient reported function improved 3 months post DBS surgery. In addition, patients reported improved function in other PD-related symptoms after DBS surgery. Future DBS studies should consider including these activity and participation outcome measures of balance and fall risk as these measures may provide additional insight in assessing change post DBS surgery.

**Clinical Relevance:** Activity and participation outcome measures are important tools to assess function with DBS surgery. These outcome measures can be easily implemented in the clinic.
Purpose/Hypothesis: People with Parkinson's disease (PW PD) develop postural instability and have difficulty ambulating. At mild levels of motor involvement, PW PD remain active in their communities, yet deficits put them at risk for falls as they encounter contextual challenges. Previously, we have used the Mini-BESTest (m-BT) to assess balance and fall risk in PW PD. While the m-BT divides balance into categories (reactive, anticipatory, sensory orientation) to identify where balance impairments occur, we identified ceiling effects when documenting effects of balance interventions for those with mild PD (Hoehn & Yahr (H&Y) stages 1-2). Therefore, we explored a tool that offered greater challenges incorporating motor and cognitive tasks for static and dynamic balance. For high functioning PW PD, the Community Balance and Mobility Scale (CBMS) contained items allowing assessment of postural stability under conditions including straight line walking, turning tasks, stooping, and focused attention.

We hypothesized that the CBMS would provide challenging activities that reflect activities PWP encounter during locomotion, and eliminate the ceiling effects previously noted with the m-BT.

Number of Subjects: Twelve men and women (mean age 68.1 ±4.9 years) who were diagnosed with PD, H&Y stages 1-3 and MMSE > 27 participated in the study.

Materials and Methods: Subjects participated in a twice weekly intensive balance training program (30 min duration) of progressive perturbations using a Proprio5000™ to receive a minimum of 1800 perturbations/session aimed at improving balance at impairment, activity, and participation ICF levels. Measurements were taken at baseline, immediately post-intervention, and retention 4 weeks later.

The CBMS, a 13 item tool, uses a 6 point scale (0-5) to measure static and locomotor tasks requiring speed, performance precision, and sequenced movements. Items include unilateral stance, tandem gait, running and abruptly stopping, changing from forward to backward walking, walking while looking at a lateral target, rapid step-ups, and lateral movements.

Results: Differences in pre-post and post-retention scores were significant (t=2.295, df9, p=0.047). Values also revealed subjects achieved the 7.5 points for MDC90.

Conclusions: For mild involvement in PW PD, CMBS scores equal those of the same age-matched able-bodied group at baseline, and scores improved post-intervention and in retention.

Clinical Relevance: Because the CMBS has published MDC and age-related values, we believe it is a beneficial tool for use with PW PD who are mildly affected since it eliminates ceiling effects and allows clinicians to assess tasks that reflect community participation.
TITLE: Impact of Dual-Tasking on Mobility Tasks in Parkinson’s Disease As Described through 2D Kinematic Analysis
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Degenerative Diseases SIG
AUTHORS: Christina May Criminger, Chad Swank
ABSTRACT BODY:
Purpose/Hypothesis: People with Parkinson’s disease (PD) experience deteriorating walking patterns (i.e. decreased cadence, increased step variability) under dual tasking conditions which, negatively influences the quality of turns, and increases fall risk. Motion analysis is able to capture dynamic mobility changes in neurological disorders and may allow the rehabilitation therapist to identify key elements adversely impacting mobility. The purpose of this study was to determine the impact of dual tasking on key mobility elements during a mobility task in people with PD with two-dimensional (2D) motion analysis.

Number of Subjects: Thirty-one participants with PD completed this study [age $M=69\pm8.19$ years; Unified Parkinsonism Disease Rating Scale – motor subscale (UPDRSm), $M=23.21\pm10.03$; Hoehn and Yahr (HY), Median=2 (range = 1 to 4)] while ON dopaminergic replacement medication.

Materials and Methods: Participants performed Timed Up and Go (TUG) under single and dual task conditions ($\text{TUG}_{\text{alone}}, \text{TUG}_{\text{motor}}, \text{TUG}_{\text{cognitive}}$). 2D motion analysis application was used to quantify seven key mobility elements including: sit-to-walk (STW) [seconds (s)], walking turn time (WTT) (s), number of turn steps, turn-to-sit (TTS) (s), total number of TUG steps, total TUG time (s) and turn strategy (on-the-spot or u-shaped).

Results: Except for sit-to-walk (STW) ($p=0.289$) and turn strategy ($p=0.325$), all key elements [walking turn time (WTT) ($p=0.005$), turn-to-sit (TTS) time ($p<0.001$), number of steps during WTT ($p=0.009$), total number of steps taken throughout TUG task ($p=0.007$), and total TUG time ($p=0.002$)] were significantly different between TUG conditions resulting in greater time and number of steps to complete with increased task complexity. Turn strategy was consistent across TUG tasks despite added task complexity. No significant relationships were found between disease severity (HY/UPDRSm) and turn strategy ($\text{TUG}_{\text{alone}}$ turn strategy $r=0.158/ r=0.122$; $\text{TUG}_{\text{motor}}$ turn strategy $r=0.087/ r=0.027$; $\text{TUG}_{\text{cognitive}}$ turn strategy $r=0.090/ r=0.027$).

Significant relationships between several key elements and fall history included: $\text{TUG}_{\text{alone}}$ STS ($p=0.001/ r=0.558$), $\text{TUG}_{\text{alone}}$ stand to sit ($p=0.005/ r=0.495$), $\text{TUG}_{\text{alone}}$ turn strategy ($p=0.038/r=0.374$), $\text{TUG}_{\text{motor}}$ turn time ($p=0.002/r=0.540$).

Conclusions: Many, but not all, key mobility elements were significantly influenced by dual tasking across mobility tasks in persons with PD. Turn strategy appeared to be determined by patient preference and not influenced by task complexity or disease severity. Transitional movements and turns appear most problematic for people with PD with a fall history. The use of 2D motion analysis assisted with identification of key mobility elements impacted during the single and dual task conditions.

Clinical Relevance: 2D motion analysis may provide the clinician an affordable and portable tool to identify problematic elements of mobility in need of rehabilitation intervention beyond simple reporting of completion time.
**Title:** Can Physical Therapy Improve Quality of Life in Late Onset Tay Sachs? a Case Study

**Current Section:** Neurology

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

**Authors:** Rachel Baumstein, Iwona M. Kedzierska

**Abstract Body:**

**Background and Purpose:**
Tay Sachs disease (TSD), a rare, fatal, autosomal-recessive lysosomal storage disorder, causes a failure in lysosomal hydrolysis of GM2 ganglioside, and ultimately destruction of neuronal cells within the central nervous system. Classic TSD leads to death before age 4. Other forms exhibit slower progression, and patients may survive into adulthood. In Late Onset Tay Sachs (LOTS), symptoms manifest in late childhood or adolescents, with neuropsychiatric symptoms, cerebellar and anterior horn cell involvement, including dysarthria, dysmetria, ataxia, fasciculations, atrophy, and proximal muscle weakness, particularly at triceps, iliopsoas and quadriceps. Currently, no literature is available on physical therapy (PT) and LOTS. The purpose of this case study is to explore the role of PT in managing the function and quality of life (QOL) in a patient (pt) with LOTS.

**Case Description:**
The pt is a 24 year old female with LOTS, characterized by bipolar disorder, dysarthria, imbalance, and proximal muscle weakness. She presented to outpatient PT with complaints of difficulty keeping up with peers while walking, on stairs, performing current exercise program, and increased frequency of falls. Upon evaluation, she presented with decreased lower extremity strength, dysarthria, and ataxic gait. She was seen for 8 weekly sessions, focusing on education, therapeutic exercise, falls recovery and prevention, and introduction to adaptive equipment. This included aerobic exercise at 65% of age-predicted heart rate max, task specific training, stretches, diaphragmatic breathing, energy conservation techniques, dynamic balance training, home exercise program, and trial of lofstrand crutches.

**Outcomes:**
Outcomes measures included six minute walk test (6MWT), ten meter walk test (m/s), five time sit to stand (FTSTS), functional gait assessment (FGA), and QOL via WHOQOL-BREF. Upon follow up, the pt had improved her gait speed (0.86 m/s to 0.96 m/s), and FGA score (17/30 to 21/30). She demonstrated no significant change in 6MWT (298 m to 296 m), or FTSTS (16.2 seconds to 15.72 seconds). Raw domain scores for the WHOQOL-BREF were transformed linearly on a 0-100 scale, revealing an improvement in domain 1 (physical health, 19/100 to 44/100), and decrease in QOL in domain 2 (psychological, 56/100 to 31/100), domain 3 (social relations, 31/100 to 6/100) and domain 4 (environment, 38/100 to 19/100).

**Discussion:**
The pt improved in gait speed and balance, relating to her complaints of inability to keep up with friends and frequency of falls. She did not improve in endurance and strength, however PT may play a role in the preservation of function in patients with LOTS. Her improvement in physical health QOL sharply contrasts to her decline in the psychological, social relations, and environment domains. A team approach included working with a neuropsychologist to address these changes. Future research is warranted to validate outcomes measures for this pt population, and explore the interaction between aerobic exercise, ganglioside biosynthesis, and physical function.
ABSTRACT BODY:

Purpose/Hypothesis: There is clear evidence regarding the benefits of strength or endurance exercise for persons with multiple sclerosis (PWMS). The use of a multimodal exercise program (i.e. one that combines strengthening and endurance training) has been used in other pathologies, but there is little evidence for its use in PWMS. The purpose of this research was to examine the effect of a multimodal exercise program on physical performance, quality of life (QOL) and fatigue in PWMS.

Number of Subjects: N/A

Materials and Methods: A search of Ovid MEDLINE, Scopus, and CINAHL databases was conducted in September 2018, using keywords “multiple sclerosis”, “combined training”, “multimodal”, and “combined exercise”. Inclusion criteria were experimental or quasi-experimental studies, in English, with a combined strength and endurance training intervention applied to a sample of PWMS. Threats to internal validity were examined using the PEDro scale. Two team members developed consensus ratings for each study. The 11-item scale was operationalized by assigning 1 point for each “yes”, thus higher scores indicate fewer threats to internal validity.

Results: Seven studies met criteria and were included in the review. Internal validity was generally moderate (median PEDro score = 4; range = 4-9, IQR 4). Participants in the studies had mild to moderate MS-related disability. Four studies measured spatiotemporal (ST) parameters of gait, two measured walking endurance, two measured strength, two measured QOL, and three measured fatigue. In general, participation in a multimodal exercise program resulted in significant improvements in ST parameters of gait (e.g. gait speed and step length), walking endurance, QOL, fatigue, and some elements of strength.

Conclusions: The use of a multimodal exercise program for PWMS resulted in a variety of benefits across measures of physical performance, QOL and fatigue, without any apparent risk of harm. Although these were all positive outcomes, there are limitations in the literature. Most notably, there was marked heterogeneity between protocols which made comparisons between studies difficult. Also, the majority of participants had moderate MS-related disability. Further studies should be conducted to compare the effectiveness of multimodal exercise for people with high and low levels of MS-related disability to improve generalizability of these findings. Furthermore, comparative effectiveness between these protocols would help to define which is superior.

Clinical Relevance: Clinicians should be confident to prescribe a multimodal exercise program to PWMS with mild to moderate disability to address problems related to gait and walking, strength, QOL and fatigue. There was some consistency in the protocols from which recommendations can be derived: aerobic activity at an RPE of 11-14 and resistance training at 40-70% of 1RM in all major muscle groups, performed 2-3 times/week are likely to provide benefits. Physical Therapists should use these findings along with their clinical judgement to ensure the best outcomes for patients with MS.
Purpose/Hypothesis: The Clinch Token Transfer Test (C3t) is a seated dual task assessment that combines performance of a bi-manual, coin transfer and manipulation task with secondary cognitive tasks of increasing complexity. The dexterity and executive function demands of the C3t are designed to evaluate dysfunction in basal ganglia circuitry in people with Parkinson’s disease (PwPD). The purpose of this study is to determine if the C3t conditions differ significantly between healthy controls and PwPD and are sensitive to disease severity; and 2) to determine if task prioritization differs between the C3t and Timed up & Go (TUG) when performed with a secondary cognitive task in PwPD.

Number of Subjects: 26 individuals with idiopathic PD, Hoehn & Yahr (H&Y) I (n=13) and H&Y II-III (n=13), and 13 age, gender and education matched controls were included.

Materials and 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, C3t and TUG test. The C3t and TUG were performed under both single and dual task (DT) conditions. Time, accuracy and movement scores were generated for the C3t allowing for evaluation of motor and cognitive dual task cost (DTC).

Results: There was a significant main effect of condition (F(2,35)=123.35; p<0.001), indicating a significant difference between baseline, complex and dual tasks across all participants. There was a significant interaction effect of group and condition (F(4,72)=4.374; p=0.003). Post-hoc analysis revealed significant difference between healthy control and moderate PD group on baseline (p=0.001), complex (0.044) and dual task (p=0.022) conditions. There were no significant differences between healthy control and mild PD group on baseline (p=0.133), complex (0.803) and dual task (p=0.071) conditions. For C3t, all participants demonstrated mutual interference showing decline in both motor and cognitive performance; for the TUG, participants demonstrated a varied cost prioritization profile. There was no significant difference in total costs between groups for the TUG (F(2,36)=0.446; p=0.643) or for the C3t (F2,36)=0.292; p=0.748). There was a significant difference between total dual task cost for the C3t compared to the TUG across all groups (t=-11.04; p=0.000).

Conclusions: The C3t is sensitive enough to differentiate between HC and PwPD (H&YI-III). All participants demonstrated mutual motor and cognitive interference during the C3T DT condition. Prioritization patterns differ significantly between C3t and DT TUG, and people may prioritize cognitive and motor tasks differently when performing seated vs upright tasks.

Clinical Relevance: The C3t is a functionally based dual-task designed to target impairments that arise with basal ganglia dysfunction across disease stages. This standardized, seated DT assessment could potentially be used with individuals of a range of disability levels and disease progression and could be a valuable tool to evaluate and monitor change in dual task ability in PwPD.
TITLE: Predictors of Improvements in Respiratory Function Following Resistive Inspiratory Muscle Training in Advanced Multiple Sclerosis.

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: Lisa Emmett Doyle, Min H. Huang, Donna K. Fry, Alexander Burnham, Nathan Houston, Keelin Shea, Hannah Smith, Jessica Goode, Elizabeth Khitrik, MacKenzie E. Kolanda, Lauren Elizabeth Wiske

ABSTRACT BODY:

Purpose/Hypothesis: To identify predictors of improvements in inspiratory muscle strength in persons with advanced multiple sclerosis (MS).

Number of Subjects: 38 non-ambulatory persons (29 women, age 60 ±8.5) with advanced MS in a long-term care facility. Inclusion criteria were age>18 years, Expanded Disability Status Scale (EDSS) >=6.5, current non-smoker, no MS exacerbation 2 months prior to enrolling and during the study, and ability to communicate.

Materials and Methods: The participants performed 3 sets of 15 repetitions of resistive inspiratory muscle exercises daily using a threshold Inspiratory Muscle Trainer (IMT) for 10 weeks. They were evaluated immediately before and after the 10-week training. We recorded maximum inspiratory pressure (MIP) in cmH2O. Age- and gender-adjusted predicted values of MIP were calculated. We collected baseline information including age, body mass index (BMI), comorbidities, year post-MS diagnosis, EDSS, fatigue using Modified Fatigue Impact Scale (MFIS-5), and cognition using oral Symbol Digit Modality Test (SDMT). MIP change scores in cmH2O (MIP-CS) and predicted values (MIP%-CS), i.e. post-training MIP–pre-training MIP, were calculated. Correlation analysis of baseline characteristics with MIP change scores was performed to identify potential predictors of improvements in MIP in the regression analysis. Two separate linear regression models with MIP-CS and MIP%-CS as dependent variables were constructed.

Results: Regression model with BMI, MFIS-5, and SDMT as independent variables and MIP-CS as dependent variable was significant (F(3.25)=3.19, p=0.041, R²=0.53). SDMT was a significant predictor in the model (p=0.035). Higher score on SDMT was significantly associated with better outcomes of IMT training. BMI was approaching the significance level (p=0.056). Regression model with BMI, MFIS-5, and SDMT as independent variables and MIP%-CS as dependent variable was significant (F(3.25)=3.19, p=0.027, R²=0.55). BMI was a significant independent predictor in the model (p=0.029,). Higher BMI was significantly associated with worse outcomes in IMT. SDMT was approaching significance level (p=0.053).

Conclusions: In persons with advanced MS, those with better cognitive function and lower BMI were more likely to improve MIP after 10 weeks of IMT training. Factors such as age, gender, duration of disease, EDSS score, and number of comorbidities were not significantly associated with changes in MIP.

Clinical Relevance: Impaired respiratory function is a common finding in MS and worsens as the disease progresses. This places individuals with advanced MS at higher risk for mortality and morbidity. This study indicates that BMI and cognition may be correlated with improvements following a structured respiratory training intervention and should be considered by clinicians treating individuals with advanced MS.
Purpose/Hypothesis: Women with Parkinson’s disease (PD) experience different symptoms, different responses to dopaminergic medications and have different challenges to healthcare access, as compared to men. It is unclear if exercise research has given due consideration to inclusion of women and contrasted the effects of exercise protocols in men and women. The purpose of this review was to assess the representation of men and women in published research related to exercise for individuals with PD. The second purpose was to gather the available evidence on gender differences in responses to exercise between men and women with PD and explore trends based on type of exercise.

Materials and Methods: Peer-reviewed articles published in English language since year 2000 were collected from CINAHL, Epistemonikos, PEDro and PubMed, using search terms ‘exercise’ and ‘Parkinson*’. Methods section provided information of gender inclusion, while results section of the published articles provided information of gender differences to exercise. Two researchers selected articles reporting gender information for further analysis. Sackett Level of Evidence established the methodological quality.

Results: A PRISMA strategy utilizing key words identified 1261 articles. Screening criteria determined that 875 articles related to exercise research. Thirty-five articles of the 875 reviewed (4%) provided gender inclusion information in the methods section; of which seven articles (20%) reported gender based results. The articles reporting gender differences to exercises were case studies with small sample sizes. The case studies investigated effects of aerobic exercises and demonstrated that aerobic exercises may help improve cognitive and executive function similarly in men and women with PD.

Conclusions: There are major gaps when it comes to gender specific knowledge and perspectives in exercise research for individuals with PD. There is lack of reporting of gender inclusion in published research articles. Researchers are either not including subjects from both genders in their studies or are not reporting gender specific results despite including men and women in their research studies.

Clinical Relevance: This review highlights the historically unmet research needs of women with PD, to elicit action in addressing these needs in future research and care. Before setting up resources, there needs to be evidence to ensure that therapies help all individuals with PD, including both genders. Understanding that women and men with PD may have different responses to exercises will enable improved exercise programs and resources for them. If the scientific community consistently reports gender differences of their research trials, there will be lower gender gap in evidence-based resources. Consideration of differences between men and women with PD, to exercise effects and benefits will facilitate better-informed physical therapy and healthcare decisions.
Purpose/Hypothesis: For people with Parkinson disease (PwPD), participation in challenging, progressive, and supervised land-based group exercise programs may improve motor function, balance, and reduce falls. Limited research is available to guide the application of group exercise in the aquatic environment for PwPD. The purpose of this study was to examine the differential impact of a highly challenging group exercise program in aquatic and land-based environments on the motor function, balance, walking, and quality of life (QoL) of PwPD.

Number of Subjects: 10

Materials and Methods: Independent ambulators with idiopathic PD were recruited for a 12-week group exercise program. Those with cognitive impairment or medical comorbidities that would inhibit safe participation in exercise were excluded. Blocked randomization was used to assign participants to an aquatic group (AG) or land-based group (LG). All classes were led by a physical therapist, lasted 60 minutes, and were held 2x/week. Exercises were multi-dimensional and matched in both environments, including strengthening, stretching, balance, and gait exercises. Exercises were individually progressed based on ratings of perceived exertion to maximize the level of challenge for each patient. Pre- and post-test examinations were performed by a blinded examiner and included the mini-Balance Evaluations Systems Test (MBT), 10 Meter Walk Test, Movement Disorders Society-Unified Parkinson Disease Rating Scale (MDS-UPDRS) Part III, and Parkinson Disease Questionnaire-39 (PDQ-39). Nonparametric tests were performed to determine statistical significance and minimal detectable change scores were referenced to determine clinical significance.

Results: Ten PwPD were enrolled and 9 completed the program. No adverse events were experienced. At baseline, the participants in the LG were older and had greater balance impairment (p<.05). After participation in the 12-week program, a within group analysis revealed clinically significant improvements on the MDS-UPDRS in both groups. Changes on the MBT were statistically significant for the AG and clinically significant for the LG. There were no significant differences between groups on MBT, MDS-UPDRS, or PDQ-39.

Conclusions: This is a novel comparison of a matched aquatic and land based progressive group exercise program. Exercise in both environments improved balance and motor function for these PwPD. These improvements did not translate to improved gait velocity or QoL for participants in this study. Additional research with larger sample sizes is warranted to further investigate this clinical question.

Clinical Relevance: For PwPD, participation in physical therapist led aquatic group exercise may result in similar improvements to those previously reported on land. Effective group interventions are clinically important for PwPD, as they may provide additional benefits of decreasing social isolation, facilitating adherence to lifelong exercise, and maximizing healthcare resources.
Background and Purpose: Huntington’s disease (HD) is a neurodegenerative disorder that typically manifests in those between 30-50 years old. Signs and symptoms can include personality and cognitive changes, unsteady gait, falls, and chorea. The pre-prodromal stage involves a positive genetic test without any signs/symptoms. The presence of deficits and role for early exercise needs to be examined in pre-prodromal HD. This case report describes the role of a physical therapy intervention framework (BFIT: Balance, Functional mobility, Intensity, Trunk stability) for an individual with pre-prodromal HD.

Case Description: The participant was a 30-year old Caucasian female who had an expansion greater than 35 CAG repeats on the predictive genetic test for HD 8 years ago. Despite having the HD gene, she reported being asymptomatic. She was not seeing a neurologist. A board certified neurologic specialist physical therapist with expertise in HD evaluated her and supervised treatment. Subjective reports included feeling clumsy (trips daily), difficulty with motoric multi-tasking, no engagement in formal exercise or physical therapy, independence with functional activities, works part-time, and lives with her husband and toddler. Her past medical history includes depression and anxiety. Objective findings included veering with walking with head turns and fatigue with high repetitions of functional activities (e.g., sit to/from stand for 1 minute). She completed a biweekly 8-week program of increasing intensity utilizing the BFIT framework, including functional training through complex motor tasks, vestibular training, dual task training, balance, and core strengthening.

Outcomes: Outcome measures (taken pre, post, and at a 3 month follow up) included the 10 Meter Walk Test (10MWT), Timed Get Up and Go (TUG)-normal, TUG-cognitive, Six Minute Walk Test (6MWT), Functional Gait Assessment (FGA), Mini Balance Evaluation Systems Test (MiniBESTest), and Modified Clinical Test of Sensory Interaction on Balance (CTSIB-M) via VirtuSense Technologies®. Based on available normative values, significant changes were noted in the 10MWT, TUG-normal, and TUG-cognitive with a trend towards significance in the 6MWT. Improvements were noted in the CTSIB-M. There were no deficits and no changes noted in the MiniBESTest and FGA. The participant described an improved attitude and confidence to continue to exercise.

Discussion: This case report demonstrates promising results for early exercise (individually tailored using the BFIT framework) in an individual with pre-prodromal HD. Improvements in endurance, vestibular functioning, gait speed, and dual task were noted. This report serves as a springboard to further explore the role of physical therapy for individuals with pre-prodromal HD. While falls are known to occur early in HD, there are limitations to available balance assessments to assess falls risk and capture change following intervention in the early stages of HD. Further research with robust designs is needed to advance outcome measurement and interventions for those with pre-prodromal HD.
Title: The Effectiveness of Virtual Reality As an Intervention for Parkinson’s Disease: A Systematic Review.

Abstract Body:

Purpose/Hypothesis: In today’s technological advancements, interventions for PD are incorporating virtual reality (VR). There is growing evidence supporting the use of VR for people with PD as an effective treatment technique to improve functional mobility. There is a need for a systematic review to compile evidence on the effectiveness of VR for individuals with Parkinson’s disease. The purpose of this systematic review was to examine the evidence with regard to the effectiveness of virtual reality for improving mobility function in individuals with Parkinson’s disease.

Number of Subjects: This is a systematic review of literature including 22 studies with a total of 569 participants that met the inclusion criteria.

Materials and Methods: In December 2018, all available data was searched through electronic databases (PubMed, Scopus, PEDro, and CINAHL) using the following terms: virtual reality, games, and gaming with Parkinson’s disease. There were two reviewers that independently reviewed, extracted data, and assessed quality of articles. A third reviewer was utilized when there was a disagreement between the two reviewers.

Main Outcome and Measures: Functional mobility measured by timed up and go (TUG), dynamic gait index (DGI), functional gait assessment, and obstacle crossing performance. Balance was measured by the berg balance scale (BBS). Quality of life was measured using the Parkinson’s disease questionnaire – 39 (PDQ-39) and the unified rating scale for PD (UPDRS III).

Results: Results post intervention indicated that 19 out of 22 studies demonstrated a significant statistical improvement of their outcome measures following the use of VR intervention. Out of the 22 studies, 10 studies conducted a follow-up to evaluate the long-term effects of VR. Eight out of the ten studies that conducted a follow-up showed lasting effects of VR intervention.

Conclusions: Virtual reality interventions addressing balance and gait impairments appear to be a viable option in the treatment of PD. Additional benefits to the use of VR in therapeutic intervention is the improvement of QOL and reduction of depression. There may potentially be long-lasting improvements in activities of daily living and community participation as well. Limitations of these studies include small sample size, lack of control, and inconsistent interventions. Future studies should investigate long term retention and patient compliance to home-based VR.

Clinical Relevance: As the population of individuals living with PD continues to grow, emerging therapeutic interventions such as VR and gaming may play a crucial role in the treatment of PD. The mobility decline associated with PD has been shown to contribute to a decrease in daily living activities, decreased community participation, and depression. Virtual reality and gaming may have the potential to combat the mobility deficits associated with PD more effectively to improve the functional mobility and quality of life of patients.
TITLE: Standardized Walking Obstacle Course Correlates with Postural Stability in Individuals with Parkinson’s Disease

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: Sharon Lee Held, Lisa Ida-Marie Inglis

ABSTRACT BODY:

Purpose/Hypothesis: Several standardized outcome measures have been validated as assessments of postural stability, gait disturbances and falls risk for individuals with Parkinson’s disease (PD), however these tools may have limited ability to assess performance under varying environmental and task conditions that are often associated with falls and episodes of freezing. The Standardized Walking Obstacle Course (SWOC) examines functional sit to stand and gait speed, accuracy and quality under a variety of task, physical and environmental conditions. The SWOC has demonstrated validity and reliability in pediatric, geriatric and stroke populations, but has not been studied as a tool in PD. The purpose of this study was to examine the association between performance on the SWOC and clinical measures of postural stability for individuals with PD.

Number of Subjects: 19 individuals with PD (11 males; 8 females) ranging in age from 45-87 years (mean=66.7) participated in this study. Hoehn and Yahr stages ranged from 1-4 (mean 2.37).

Materials and Methods: Demographic data was recorded for each participant and all were tested during the on-phase of medication. Time, steps, stumbles, steps off path and episodes of freezing were recorded for each trial of the SWOC on 3 conditions: normal, dual task and low lighting. Measures were obtained for postural stability using the MiniBESTest, functional gait using the Timed up and Go (TUG) and balance confidence using the Activities-Specific Balance Confidence (ABC) Scale. Descriptive statistics, Spearman’s Rho and Pearson’s correlations were calculated using SPSS version 23.

Results: Time and steps on the SWOC normal and low light conditions demonstrated strong correlations with the MiniBESTest (r=-0.790 to -0.866, p<0.001) and TUG (r=0.732 to 0.830, p<0.001). Moderate correlations were found for time and steps on the SWOC normal and low light conditions with the ABC Scale (r=-0.564 to -0.590, p<0.012) and for the SWOC dual task condition time and steps with the minBESTest (r=-0.543 to -0.546, p<0.016) and TUG (r=0.625 to 0.673, p<0.004). Freezing was observed on each condition of the SWOC with 7 participants freezing on one or more conditions, while only 3 participants froze on the TUG.

Conclusions: The miniBESTest, TUG and the ABC Scale all have established falls risk cut-off scores for individuals with PD and are correlated with performance on the SWOC. The SWOC was also able to trigger freezing episodes in more participants than the TUG, indicating that the SWOC may better simulate conditions associated with freezing. In conclusion, individuals with PD with poor performance on the SWOC are more likely to demonstrate balance impairment and a fear of falling.

Clinical Relevance: SWOC is a clinically relevant tool to assess functional transitions, gait and postural stability for individuals with PD. This tool may also be a useful clinical tool to assess freezing of gait. Further research should examine the reliability and validity of this assessment to screen for postural instability and predict falls risk in individuals with PD.
Purpose/Hypothesis: Research evidence is underused by physical therapists in their practice. Numerous barriers exist to incorporating evidence into physical therapy practice. Knowledge translation (KT) smooths the transition from publication to practice and includes the synthesis, dissemination, exchange, and application of knowledge to improve health, provide more effective health services, and strengthen the health care system. Parkinson disease (PD) is a progressive neurodegenerative disease. As a result, individuals with PD may experience repeated bouts of physical therapy over the course of their disease. The use of standardized outcome measures (OMs) is critical for monitoring improvements and declines over time in people with PD. The PD Evidence Database to Guide Effectiveness (PD-EDGE) has published a list of recommended OMs to be used with individuals with PD. The purpose of this study is to examine if the implementation of a KT process facilitates the use of standardized OMs in patients with PD across four outpatient clinics.

Number of Subjects: 8 physical therapists and 2 occupational therapists from 4 outpatient clinics, owned by a single healthcare system, participated in this KT project.

Materials and Methods: Over the course of three months, meetings occurred between the research team, administration, and clinical staff to discuss the implementation of a standardized OM battery for patients with PD. Through the iterative KT process, the researchers and clinicians reviewed the PD-EDGE OMs, and assessed the evidence, clinical environment, and workflow processes to determine the standardized OM battery. The four measures agreed upon were the Five Time Sit-to-Stand, MiniBESTest, 10 Meter Walk Test, and 9 Hole Peg test. A knowledge broker was identified and served as a resource to answer therapists’ questions about administration and interpretation of the OMs. All therapists were trained in the OMs and all necessary equipment was obtained. Implementation began in July 2018 and monitoring of therapist adherence to the standardized outcome battery lasted for 6 months. To examine adherence, de-identified chart data was gathered for the 12 months prior to the intervention, 6 months of the KT intervention and 3 months after the intervention.

Results: After implementation of the KT process, therapists demonstrated an average use of 2.7 (range 0-4) measures on initial evaluation and 2.5 measures (range 0-4) at discharge on 34 patients. In a focus group interview, the therapists reported that even though they had already been using OMs, the KT process promoted consistency across therapists and sites; however, incorporating the test battery was difficult in lower functioning patients.

Conclusions: KT facilitates the incorporation of evidence into practice and promotes internal consistency of practice across clinic sites.

Clinical Relevance: Enhancing the implementation of evidence is critical for advancing the practice of physical therapy. The KT process facilitates the uptake of evidence and fosters collaboration among clinicians and researchers.
Purpose/Hypothesis: People with multiple sclerosis (pwMS) experience a decline in physical performance and muscle function during prolonged walking. This fatigability is manifested by changes in both temporospatial (TS) and kinematic (KIN) gait characteristics. This project explored the relationship between changes in muscle function and changes in gait characteristics, fatigue, and perceived exertion during prolonged walking in pwMS.

Number of Subjects: Twenty-three people [(6 men, 14 women; mean age 57.04 (+/- 6.7)] with multiple sclerosis and demonstrated walking difficulty participated in this study.

Materials and Methods: Participants completed a 12-minute walk test (12MWT) on a 58ft long track. A Modified Helen Hayes marker set was used to record lower extremity (LE) KIN data during the 12MWT. Participants rated their perceived exertion (RPE) each minute using the Borg CR10 scale. Surface electromyography (sEMG) activity during maximal volitional contractions (MVC) of the gluteus medius and maximus, quadriceps, hamstrings, tibialis anterior and gastrocnemius muscles was recorded pre and post 12MWT to assess muscle function. A visual analog scale for fatigue (VASF) measured perceived fatigue pre and post 12MWT and was recorded as ∆VASF. All sEMG and KIN data was processed using Motion Monitor. Changes in the mean frequencies (Fmean) of the sEMG power spectrum during MVC performance pre and post 12MWT were analyzed; a decrease in Fmean is indicative of muscle fatigue.

Results: Changes in Fmean of the LE muscles after 12MWT were heterogeneous. Individual muscles of each participant behaved differently; some demonstrated a decrease in Fmean while others increased. This resulted in no within-group differences. However, all participants demonstrated a decrease in Fmean in at least 1/3 (range = 33-67%) of the muscles. The percentage of muscles (%MF) correlated with the ∆VASF (r ) and the ∆RPE from minute 1 to minute 12 (rS = .545, p = 0.016). There was no correlation between %MF and distance, cadence or LE gait KIN.

Conclusions: pwMS demonstrated physiologic signs of neuromuscular fatigue in some LE muscles with prolonged walking. Neuromuscular fatigue was variable across subjects and within the participants’ muscles tested, and not related to gait TS or KIN characteristics. However, a relationship between the extent of LE muscle fatigue and self-reported fatigue and exertion was found. The noted variability in the changes in muscle function in response to prolonged walking should be investigated; it is unclear why the Fmean decreased in some muscles and increased in others.

Clinical Relevance: Further exploration of neuromotor behavior with prolonged walking in pwMS is needed to make clinical recommendations; however, the heterogeneous muscle responses to prolonged walking noted in this exploratory study suggest that pwMS may benefit from personalized exercise programs specific to the neuromuscular impairments of individual muscles to combat the perception of fatigue.
ABSTRACT BODY:
Background and Purpose: Progressive supranuclear palsy (PSP) is the most common atypical Parkinson’s Disease (PD). PSP is characterized by postural instability, early falls, impaired speech and swallowing, bradykinesia, axial rigidity, subcortical dementia, and decreased perception of postural sway. A defining characteristic is vertical gaze palsy. Other oculomotor abnormalities in patients with PSP include diplopia, slow and hypometric saccades, impaired smooth pursuit and abnormal linear vestibular ocular reflex (VOR). There is limited evidence for physical therapy (PT) in individuals with PSP. Influence on balance with EMT has not yet been investigated. Incorporating EMT within Parkinson’s PT may address oculomotor dysfunction, optimize balance, and decrease falls in individuals with PSP. The purpose of this study is to investigate the influence of EMT and PT on balance, sensory integration, and falls in individuals with PSP.

Case Description: Five participants diagnosed with PSP were recruited from Emory University’s Movement Disorder Clinic. All participants were ambulatory without assistive device, had poor response to levodopa, and presented with early falls, axial rigidity, and vertical gaze palsy. All participants demonstrated hypometric and slow vertical saccades and presented with a positive unilateral Head Impulse Test (HIT). Two participants reported horizontal diplopia with down-gaze. Participants completed 1 hour sessions, 2-3x/week for 6-8 weeks. Parkinson’s PT exercises addressed balance, gait, rigidity, bradykinesia, and posture. EMT consisted of gaze stabilization exercises, saccadic training, and visual scanning. EMT was initially done via single task training and was later completed in conjunction with static/dynamic balance activities. Exercises were progressed after participants mastered exercises in single task setting.

Outcomes: Outcomes included The MiniBESTest, Modified Clinical Test of Sensory Interaction on Balance (CTSIB-M), and reported falls. All participants’ MiniBESTest scores improved and exceeded the established clinical minimal detectable change. The most significant improvement on the MiniBESTest occurred in participant 5, as score increased from 7/28 to 18/28 (MDC = 5.5). CTSIB-M scores improved in all participants with observed decreased postural sway, specifically on conditions 2 through 4, most notable improvement was in participant 1 as CTSIB-M total increased from 36/120 to 97/120. All participants reported decreased fall frequency after initiating PT. 4 participants denied falls after completing PT. One participant continued to report falls; however, the frequency of falls decreased from 20 falls/week to 3 falls/week.

Discussion: Decreased falls, improved sensory integration, and improved mobility were observed in all participants after PT with EMT. Ocular and vestibular exercises appear to optimize balance in individuals with PSP, though more research conducted through randomized control studies is needed. EMT cannot be solely attributed to improved balance, as PT intervention included balance exercises.
Purpose/Hypothesis:
Robot-assisted gait training (RAGT) has emerged within the past 10 years as an approach to enhance walking. 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 multiple sclerosis (MS).

Number of Subjects:
15 subjects with MS (Average Age 52)

Materials and Methods:
A licensed therapist applied an individualized treatment protocol using RAGT 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. 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 2 sessions. Gait outcomes were assessed using a pressure sensor gait mat prior to and following treatment.

Results:
Subjects were subdivided into two groups: improved or not improved based upon changes in temporal and spatial gait characteristics. Improvement was categorized as a positive change of 10% or greater in speed and step length, as well as a positive 3% change in stance/swing ratio. 8 patients showed positive improvement in all 3 categories. An Independent t-test was used to compare between group differences in dosing. Comparisons between speed and number of sessions were not statistically significant (p>0.05); however, session duration was significantly longer for individuals who did not improve (p = .02). Significant differences were found for repetitions: mean and total steps (p < .05) but not stairs (p=.07), which were greater in the group that did not improve.

Conclusions:
Individuals with MS demonstrated significant improvement in gait speed, step length and symmetry following RAGT. The amount of practice was statistically less for the individuals demonstrating improvement in gait outcomes. The group demonstrating gait improvements averaged 382 less steps per session resulting in 3300 fewer overall steps at the end of training. The average number of sessions for subjects in both groups was not statically significant (7.6 to 9.9); however, the amount of time-spent training was 6.5 minutes longer per session for the non-improvement group.

Clinical Relevance:
These findings support limited repetitions over time as a potential critical factor for gait improvement in individuals with MS. Previous literature and clinical trials have focused on speed/total practice amount, which were not significant. Daily accurate practice with focused moderation in total practice volume was critical for these individuals. RAGT offers a gait training environment that enables therapists to monitor, collect and manage dosing parameters allowing for a more focused treatment approach without over fatiguing the individual.
TITLE: A Retrospective Analysis of Group-Based Boxing Exercise on Measures of Physical Mobility in Parkinsonian Subjects

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: James Sonne, Kyle Patrick Joslyn, Katherine Reus, Michelle Angulo, Sarah Guettler, Morris Casano Beato

ABSTRACT BODY:

Purpose/Hypothesis: Parkinson’s disease (PD) is characterized by a slowing of motor movement along with resting tremor, rigidity and postural instability. Approximately 60,000 new individuals are diagnosed with PD each year in the United States with an estimated 1.5 million Americans currently diagnosed. The disease affects 1% of the population over the age of sixty, and prevalence increases with advancing age. The burden of PD is estimated to double in 20 years. We hypothesize that significant improvements will be observed in subjects participating in a six-month duration, circuit-oriented, non-contact boxing program incorporating balance, strength, and endurance skills.

Number of Subjects: Subjects were separated into two groups based on severity of PD symptoms, an early stage Hoehn and Yahr (H&Y) group (n=24) and a late stage H&Y (n=4) group. Those unable to perform the tests on initial screening were excluded from the study. A total of 24 subjects were included in the early stage H&Y group, 7 female and 17 male, ranging in age from 43 to 80 years.

Materials and Methods: Subjects were tested for the Time Up and Go test (TUG), 10-meter Walk Test (10MWT), and 30-second Chair Stand Test (CST); at the initial and six-month time points. For six months the subjects in the study participated ad libitum in the group-based boxing program. Significance was determined using a one-way paired t-test with an alpha level of 0.05.

Results: No significant changes were observed with the subjects in the late-stage group. The subjects in the early stage group exhibited statistically significant improvements over a 6-month time span in measures of Timed Up and Go (TUG, p=0.037, 6.2% improvement), and 10-meter walk test (10MWT, p=0.026, 12.4% improvement). Thirty-second Chair Stand Test (CST, p=0.054) was trending toward significance within the subject group used in this study. In the 10MWT, the minimal detectable change of 0.25 m/s was observed in 14 of the 18 subjects. However, in the TUG test, the minimal detectable change of 3.5 seconds was not observed in any of the subjects.

Conclusions: Subjects with early stage PD symptoms can improve in measures of physical mobility by participation in a group-based, circuit-oriented, non-contact boxing program. Subjects with late-stage PD symptoms are likely too late in the disease progression to benefit from such a program. While not every individual improved on every measure to a minimal detection level, as a group, statistically significant improvements were observed. Early involvement in activities that promote physical activity may prolong mobility in Parkinson’s patients.

Clinical Relevance: This study supports and expands on the current body of knowledge that non-contact boxing group exercise improves measures of physical mobility in early stage PD subjects. Improvements in mobility with late-stage PD subjects may be limited with this type of intervention.
Purpose/Hypothesis: People living with Parkinson’s disease (pwPD) are twice as likely to experience a fall compared to people with other neurological conditions and nearly 70% of pwPD will experience at least one fall each year. Parkinson’s disease (PD) is often characterized by motor symptoms (i.e. bradykinesia, tremor, and rigidity) but important non-motor symptoms such as sleep disturbances, impaired bowel and bladder function, impaired cognition and mood are also present in pwPD. Past studies investigating falls in pwPD have focused on motor-symptoms, but evidence regarding the relationship between non-motor symptoms and falls is limited. The purpose of this study was to examine the differences in motor and non-motor symptoms between pwPD with and without a history of falls.

Number of Subjects: 40 community dwelling adults (10 female) diagnosed with idiopathic PD, between Hoehn & Yahr stages 1-4. Individuals were identified as a faller if they reported at least one fall within last six months. Independent t-tests were used to compare motor and non-motor symptoms of fallers (n= 15, age: 71.9 ± 5.3) and non-fallers (n=25, age: 70.4 ± 7.1).

Materials and Methods: Cross-sectional study with motor symptoms assessed by measuring mobility (Timed up and Go- TUG, Timed up and Go cognitive, five time sit to stand, 10 meter walk test), endurance (6 minute walk test), dynamic balance (Mini-Balance Evaluation Systems Test) and disease burden and severity (Unified Parkinson’s Disease Rating Scale-total score). Non-motor symptoms were assessed by measuring cognition (Montreal Cognitive Assessment), fatigue (Parkinson’s Fatigue Scale), mood (Starkstein Apathy Scale, Geriatric Depression Scale), quality of life (Parkinson’s Disease Questionnaire-39), and perceived balance confidence (Activities-Specific Balance Confidence Scale). Due to multiple comparisons, P value of < 0.01 was used.

Results: Fallers were found to have increased incidence of depression (P= <0.01; d=[2.33]), less balance confidence (P= <0.01; d=[1.30]), increased apathy (P= <0.01; d=[0.94]), decreased memory and problem solving (P= <0.01; d=[1.02]), increased difficulty with cognitive task during dual task conditions (P= <0.01; d=[0.86]), and poorer quality of life (P= <0.01; d=[0.96]) when compared to non-fallers. There were no significant differences in mobility as measured by the TUG (P= 0.46; d= [0.03]), TUG cognitive (P= 0.48; d= [0.01]), five time sit to stand (P= 0.06; d=[0.90]), self-selected 10 meter walk test (P= 0.32; d=[0.17]), dynamic balance (P= 0.28; d=[0.26]), endurance (P= 0.05; d=[0.72]), fatigue (P=0.08; d=[0.50]) or disease burden and severity (P=0.03; d=[0.67]).

Conclusions: The only differences found between fallers and non-fallers were non-motor symptoms of PD with the largest differences (effect sizes ≥ 0.80) noted to be in mood, confidence, and cognition. No differences in motor-symptoms were found between fallers and non-fallers.

Clinical Relevance: Clinicians should include measures of non-motor symptoms, with specific attention to screening for depression (largest effect size), to better understand potential contributors to falls for pwPD.
Comparing the Efficacy of Stretching Brochures to Videos in Individuals with Motor Neuron Disease

**AUTHORS:** Katherine Marie Burke, Fabiola De Marchi, Amy Swartz Ellrodt, Michael Doyle, Megha Koul, Olivia Comeau, Elizabeth Adelson, Rebecca Walter, Melissa Kusy, Flor Amaya, Carissa Anderson, Jennifer A. Honda, James Chan, James Berry, Sabrina Paganoni

**ABSTRACT BODY:**

**Purpose/Hypothesis:** Joint pain and decreased range of motion are common secondary complications of motor neuron disease (MND) that can contribute to functional decline and decreased participation in daily activities. The purpose of this study was to evaluate two distinct educational interventions (brochures and videos) aimed at improving knowledge of benefits of stretching in the management of pain in individuals with MND, as well as the ability of these interventions to improve adherence to a regular stretching program.

**Number of Subjects:** There were 53 participants in this study with diagnoses of amyotrophic lateral sclerosis (83%), primary lateral sclerosis (15%), or hereditary spastic paraplegia (2%).

**Materials and Methods:** This was a prospective, randomized, interventional study in which individuals were asked to complete surveys asking questions regarding current stretching program, pain levels, and knowledge of benefits of stretching before and after receiving educational materials in format of brochures or videos. Pre- and post- participation and interest in a stretching program was compared using poisson regression with a log link and covariates for education group and participation and interest at baseline. Pre- and post- average days/week of stretching and pain were compared using a logistic regression with covariates for education group and exercise days/week at baseline. Post intervention surveys on knowledge of benefits of stretching program and utility of stretching program were compared across groups using a logistic regression with the post-study response as the outcome and education group as the only predictor. All tests were assessed at an alpha of 0.05. Statistical analyses were carried out in R (R Foundation for Statistical Computing, Vienna, Austria).

**Results:** All 53 participants completed the pre-intervention survey, and 46 (87%) completed the post survey. At baseline, 26/52 (50%) reported they participate in any stretching program. The brochure group increased participation in stretching to 67% while the video group increased participation to 82% (p = 0.17). The video group increased days/week stretching significantly more than the brochure group (2.04 and 0.62 days/week respectively, p = 0.004). There were no significant changes in pain levels or knowledge regarding importance of stretching, however significantly more participants in the video group reported usage of stretches from the materials on a regular basis (54% for brochure group and 86% for video group, p=0.024).

**Conclusions:** Educational brochures and videos are two strategies to improve participation in a stretching program and knowledge of benefits of stretching for individuals with MND.

**Clinical Relevance:** Individuals with MND value educational brochures and videos, and are willing to participate in a program to minimize risk for pain. By providing education to improve knowledge and self-efficacy, these individuals may be better equipped to prevent or address potential joint issues and incorporate preventative measures, such as stretching, into their treatment plans.
TITLE: Voltage Increases Prosaccade Error Rate in Bilateral Deep Brain Stimulation for Parkinson’s Disease

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG


ABSTRACT BODY:

Purpose/Hypothesis: The amplitude, i.e., voltage or current, of subthalamic nucleus deep brain stimulation (STN DBS) is directly related to its therapeutic effects. However, few studies have systematically investigated how individuals with Parkinson’s disease (PD) respond to amplitude manipulations. Past studies of STN DBS have reported improvement in motor aspects such as increased movement speed, reduced tremor, and reduced rigidity with stimulator amplitude set at or above 3 volts. However, in some cases there is worsened speech intelligibility at 4 volts as well as other significant negative consequences. Since the basal ganglia are critical nodes in the eye movement network, studying eye movements can provide insight into clinical efficacy of STN DBS. To further understand the extent to which amplitude can modulate performance, we studied the effect of systematically varying voltage/current while performing the antisaccade task. We chose the antisaccade task as it has both motor aspects of control such as gain, and cognitive aspects of control such as inhibitory prosaccade errors. In this poster, we report how increasing voltage/current affects performance on the antisaccade task.

Number of Subjects: Ten subjects with Parkinson’s disease (PD) with STN DBS.

Materials and Methods: Subjects completed two testing sessions. All testing was performed after a 12-hour overnight withdrawal of anti-PD medication. Voltage in both stimulators was randomly set to 0, 1, 2, 3, 3.5, or 4 volts. The practically feasible run-in period for each voltage setting was 30 minutes. Frequency, pulse width, and electrode configuration remained at clinical settings. Three voltage settings were tested on one day, and the remaining three were tested on the second day. The antisaccade task was performed under each voltage setting. Outcome variables were latency, gain, and prosaccade error rate.

Results: Voltage had a significant effect on latency (correct antisaccade latency, $F_{1, 2372} = 15.2, p < 0.01$; prosaccade error latency, $F_{1, 854} = 5.1, p = 0.02$). Increasing voltage from 0 to 2 volts was associated with a decrease in latency. Further increase in voltage from 2 to 4 volts was associated with an increase in latency. Increasing voltage was associated with an increase in gain ($F_{1, 1648} = 15.5, p < 0.01$), as well as an increase in prosaccade error rate ($F_{1, 3239} = 14.8, p < 0.01$).

Conclusions: Increasing current in the vicinity of the STN during bilateral STN DBS enhances motor aspects while worsening cognitive aspects of oculomotor function. Further research is required to elucidate the underlying neurophysiological mechanisms.

Clinical Relevance: Improving our understanding of the effects of stimulation parameters such as voltage will help clinicians improve optimization of STN DBS.
TITLE: Is Walking Self-Efficacy Related to Real-World Ambulatory Activity in Community-Dwelling Adults with Parkinson Disease?

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: Andrea Nikie Christoforou, Stephanie Amber Archer, James Terrence Cavanaugh, Cristina Colon-Semenza, Tamara Rork DeAngelis, Ryan Patrick Duncan, Daniel Fulford, PhD, Timothy Nordahl, Lisa Quintiliani, Kerri Rawson, PhD, Gammon M. Earhart, Theresa D. Ellis

ABSTRACT BODY:

Purpose/Hypothesis: Physical activity, including moderate intensity walking, has been posited to play a disease modifying role in Parkinson Disease (PD). Yet, people with PD consistently demonstrate low levels of ambulatory activity relative to their age-matched healthy peers that cannot be entirely explained by clinical presentation or disease severity. Recent studies suggest that cognitive-behavioral factors, such as self-efficacy, may also play a role. While a relationship between balance self-efficacy and walking capacity and walking patterns in people with PD has been suggested, the role of self-efficacy in “real-world” brisk walking has yet to be investigated. Thus, the purpose of this study is to investigate the relationship between self-efficacy of walking with actual ambulatory activity, including brisk walking in a real-world environment.

Number of Subjects: 23

Materials and Methods: Preliminary baseline data from a larger randomized control trial were analyzed. People with mild to moderate PD (Hoehn and Yahr (H&Y) 2-3) who were independent ambulators but not engaged in brisk walking for more than 90 minutes per week were enrolled. Ambulatory activity was measured using a Step Activity Monitor worn for 7 days. Mean daily values were calculated for the total accumulated number of steps and for the total number of minutes of moderate-intensity stepping. Walking self-efficacy was measured using the Self-Efficacy for Walking Scale – Duration (SEW-D) which assesses participants’ confidence in their ability to successfully complete incremental 5-minute intervals (5 to 40 minutes) of walking at a moderately fast pace. The relationship between self-efficacy and ambulatory activity was assessed using Spearman’s correlation coefficient.

Results: Baseline data from 23 people (mean age 68.4 (7.2), 69.6% male) with mild to moderate PD (H&Y 2.5: 14; H&Y 2: 9) were analyzed. Mean daily steps for the sample was 6882.0 ± 2832.9 with a median 9.3 minutes (Q1-Q3=1.4-17.0) of at least moderate intensity stepping daily. Participants reported a median of 6.5 (out of 10; Q1-Q3=2.5-8.8) on the SEW-D. A significant correlation was observed between participants’ SEW-D scores and both mean daily step count (Spearman’s Rho=0.46, p=0.03) and minutes of moderate intensity ambulation (Spearman’s Rho=0.43, p=0.04).

Conclusions: Self-efficacy in walking duration was found to be significantly correlated with daily ambulatory activity, including brisk walking, explaining nearly 20% of the measured ambulatory behavior and providing further support of the importance of self-efficacy in ambulatory activity in people with PD. More data are forthcoming. Larger, more diverse samples will allow further exploration of the relative contribution of self-efficacy compared to disease-related symptoms and other contributing demographic factors.

Clinical Relevance: These findings suggest that self-efficacy may be an important target of exercise interventions aimed at increasing physical and ambulatory activity in people with mild to moderate PD.
Purpose/Hypothesis: Exercise is important in the management of Parkinson disease (PD) yet individuals with PD are less active than their age-matched peers. Non-motor symptoms, specifically, deficient motivation, may mediate decision-making for exercise in people with PD due to the impaired mesolimbic dopaminergic pathway. The purpose of this study was to determine if effort-based decision-making related to exercise was different in people with PD compared to healthy age-matched controls. We set out to determine if components of motivation (apathy and the anticipation of pleasure) predict decision-making for exercise in people with PD, controlling for the physical measures of age, physical capacity and disease severity.

Number of Subjects: 32 people with PD and 23 age and education matched controls

Materials and Methods: An effort-based decision-making paradigm using a novel, continuous, exercise task (cycling) was implemented. Disease severity and physical capacity were measured. Components of motivation were measured using the Apathy Scale and the Temporal Experience of Pleasure Scale- Anticipatory Pleasure scale. Hierarchical logistic regression models tested the effect of effort, reward and trial at the individual level as well as sex and the presence of PD at the group level. Additional exploratory analyses tested the mediating effect of age, disease severity, physical capacity as well as apathy and the anticipation of pleasure at the group level.

Results: There were no significant differences in baseline characteristics, including depression and physical activity in those with PD and controls. Reward, effort and trial number were all significant predictors of decisions in both people with PD and controls. The anticipation of pleasure, controlling for age, disease severity and physical capacity, was a significant predictor of decisions for exercise in people with PD (odds ratio = 1.172, p<0.001 for exercise task; odds ratio= 1.216, p=0.009 for button-pressing task). This relationship was not found for controls.

Conclusions: People with PD who are receiving dopamine replacement therapy, are physically active, and are non-depressed responded similarly to effort and reward valuations compared to those without PD. The anticipation of pleasure was a significant predictor of decisions for exercise in people with PD only.

Clinical Relevance: Increased anticipation of pleasure and the use of rewards may enhance engagement in high effort exercise among persons with PD and should be investigated in future studies.
Purpose/Hypothesis:
Spinal muscular atrophy (SMA) is a progressive neuromuscular disease that results from dysfunctional segmental sensory motor circuits. SMA Type III patients walk independently, but experience progressive weakness, gait impairments and fatigue. Prior work has identified weakness in hip flexors (HF), hip adductors (HAd) and knee extensors (KE), while plantarflexors (PF), dorsiflexors (DF), hip abductors (HAb), hip extensors (HE) and knee flexors (KF) are relatively preserved. Patterns of muscle weakness reflect the location of spinal motor neuron pools, segmental innervation of muscles, and muscle fiber type. This study proposes different models representing the strength of select combinations of lower extremity muscles, and assesses the relationship of each model to ambulatory function. We hypothesize that pattern of segmental innervation will predict ambulatory function.

Number of Subjects: 23

Materials and Methods:
Ambulatory SMA III patients (78.2% male), ages 10 – 56 years, enrolled in two clinical studies (NCT01166022 and NCT02895789) were included. Strength of 16 lower extremity muscle groups was assessed using the Medical Research Council (MRC) score; ambulatory function was measured by performance on the 6 minute walk test (6MWT).

Three models were investigated. Model 1 included HAb and KF based on prior biomechanical studies. Model 2 was based on spinal cord location of motor neuron pools; model 2A included muscles with medially located motor neuron pools (HF, HAd, HE, HAb) and model 2B included muscles with laterally located motor neuron pools (KE, KF and DF). Model 3 was based on segmental innervation of muscles, with model 3A innervated segmentally by L1-L3 (HF, KE, HAd) and model 3B innervated segmentally by L4-S2 (KF, HE, HAb, DF). PF, strong in all, was excluded to eliminate a ceiling effect.

Relationships were assessed using Pearson correlation coefficients. Linear regression analysis evaluated the models’ ability to predict ambulatory function.

Results:
All models were correlated with 6MWT distance; model 1 (r=0.62, p=0.001); 2A (r=0.67, p=0.0005), 2B (r=0.54, p=0.007); 3A (r=0.48, p=0.02), and 3B (r=0.71, p<0.0001). Regression analysis was not applied to model 2 because of the heterogeneity of motor neuron pool orientation and the inability to confirm location. Regression analysis revealed that model 3B predicted 6MWT distance (β=0.670, p=0.003), whereas model 3A did not (β=0.073, p=0.715).

Conclusions:
Muscle strength was associated with function across all models. Muscles innervated by lower lumbar and sacral segments were the best predictors of function. Groups comprising muscles with predominantly slow twitch fibers were typically less affected in SMA. However, adaptive changes in fiber type, specifically hypertrophy of slow twitch muscle fibers, and their impact on strength patterns, require further study.

Clinical Relevance:
Defining physiologic mechanism(s) underlying weakness may identify selective muscle groups that are important for function; allowing for more targeted interventions in SMA.
TITLE: Impact of Functional Decline on Sleep in Patients with Amyotrophic Lateral Sclerosis.

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: Renee M. Brown, Penny J. Powers, Austin McCarthy, Megan Howard, Cailey Marlene Daluga, Christopher Munguia

ABSTRACT BODY:

Purpose/Hypothesis: Amyotrophic Lateral Sclerosis (ALS) is a progressive motor neuron disease that results in loss of voluntary motor control. Death usually results from respiratory insufficiency. Denervation of inspiratory muscles leads to decreased time in Rapid Eye Movement (REM) sleep, sleep fragmentation and overall poor sleep quality. The purpose of this study was to determine if there was a correlation between disease progression as determined by their scores on the ALS Functional Rating scale (ALSFRS), and their quality of sleep (Pittsburg Sleep Quality index - PSQI), daytime sleepiness (Epworth Sleepiness scale –ESS) and sleep routine (Sleep Hygiene questionnaire HYG).

Number of Subjects: Sixty-five individuals with ALS completed the PSQI, ESS, and HYG questionnaires.

Materials and Methods: Any individual diagnosed with ALS and willing/able to complete the surveys was eligible to participate. Subjects consented and complete the questionnaires during an ALS clinic visit. ALSFRS scores were obtained from the medical record at that time (n=51). ALSFRS score ranged from 7 to 40, indicating wide range of disease severity.

Results: Responses on the sleep hygiene questionnaire indicated that 35% took a nap in bed and 54% used a screened device before bed. Urinary issues (49%) and muscle cramps (55%) affected their sleep. 43% used a flat bed whereas only 20% used a hospital bed. The most common item reported that would improve their sleep was being able to elevate their bed. On the PQLI, 30% of the individuals took longer than 2 hours to get to sleep, 46% reported getting between 6-8 hours of sleep a night. The top reasons for having difficulty sleeping were waking up in the middle of the night or too early, having to use the bathroom, room temperature and pain. Using Spearman’s correlation, there was a significant negative correlation (p=.038) between their ALSFRS score and their daytime sleepiness (ESS) (r= -.291), indicating the as ALS had a greater impact on their functioning (the lower their ALSFRS score), they experienced greater daytime sleepiness.

Conclusions: Patients with ALS experience sleep challenges that can affect the quality of life. Healthcare providers should routinely query ALS patient about their sleep to determine possible intervention to improve their quality of sleep. Addressing urinary issues, muscle cramps, and pain may improve their quality of sleep. Advocating for a hospital bed with elevating head may also assist in sleeping. Patient education related to screen use, sleeping environment and sleep hygiene may also help patients improve their sleep.

Clinical Relevance: Physical Therapists should include sleep questions as part of their regular assessment of ALS patients. Addressing issues that impact their sleep, advocating for hospital beds, and providing education on sleep hygiene may improve the quality of life for individual with ALS.
Background and Purpose: Limited research exists examining effective physical therapy (PT) interventions for individuals with Progressive Supranuclear Palsy (PSP).\(^1\text{-}^5\) Research suggests that treadmill training (TMT) has a positive effect on gait function in people with Parkinson’s Disease, which has clinical features similar to PSP.\(^6\text{-}^7\) The purpose of this case study is to report the effects of high intensity TMT in an individual with PSP.

Case Description: Single-subject, 76-year-old female with moderate to severe PSP (Hoehn & Yahr Stage 4; PSP Rating Scale 64) who participated in PT for 14 weeks. Interventions focused on overground gait training (OGT) first 7 weeks and TMT at high intensity speeds (0.36-0.49m/s) with a safety harness last 7 weeks. Subject reassessed 8 weeks after discharge. Gait speed and daily steps from a patient-reported activity log were collected at week (wk) 0, 7, 14, and 22. Health-Related Quality of Life Questionnaire for Patients with Progressive Supranuclear Palsy (PSP-QoL) was used and Global Rating of Change Scale (GROC) was administered at discharge.\(^8\)

Outcomes: Changes in gait speed and daily steps, respectively, were -0.07m/s and 115.8 ft/day after OGT (wk 7); 0.12m/s and -87.8 ft/day after high-intensity TMT (wk 14); -0.12m/s and -127.8 ft/day (wk 22). A clinically meaningful increase in gait speed (MCID ≥0.05m/s)\(^9\) and decreased fall frequency was found during TMT weeks. PSP-QoL scores improved by 20% (initial 50%; discharge 70%) during PT but returned to baseline at follow-up. PSPRS scores increased from 64 (wk 4) to 74 (wk 22), indicating apparent worsening of PSP.\(^10\) Subject/caregiver rated perceived overall improvements in walking and transfers (GROC 3/5; 2/5).

Discussion: Subject made no improvements in gait speed during OGT, but spatial gait parameters improved and less physical assistance was required. It is possible that OGT speeds were not fast enough to impact gait speed due to distractibility, fatigue, or assistance level. TMT was found to positively impact gait speed and fall frequency during weeks 7-14, but carryover was limited. Conversely, daily steps declined during this period, possibly due to fatigue from TMT. In addition, subject showed fluctuations in daily function at home and in PT, likely related to the progressive nature of PSP and its impact on attention, cognition, sleep, balance, and vision. This was confirmed by higher PSPRS scores at follow-up, most notably in bulbar and limb-motor subscales. Interestingly, severity of gait impairment subscale remained unchanged. It is unknown whether the mode of gait training could have contributed to these results or whether any form of gait training may have made a difference. Patient had a fall in wk 19 and showed a downward trend in activity level in weeks 17-19, which may have also limited carryover of TMT. In conclusion, outcomes suggest high intensity TMT may be effective in improving gait function in people with PSP, however, carryover appears to be limited. Larger-scale research is needed to further assess effectiveness of high intensity TMT on gait in people with PSP.
TITLE: Training of Dual-Task of Gait in Persons with Multiple Sclerosis
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Degenerative Diseases SIG
AUTHORS: Gregory Andrei Brusola, Marissa Francis Lyon, Daniel Wingard, Katy Eileen Mitchell, Jennifer Ellison, Peggy Blake Gleeson, Toni Roddey

ABSTRACT BODY:

Purpose/Hypothesis:
It is well established that gait in persons with multiple sclerosis (MS) can be affected by motor and sensory symptoms of MS. However, gait control also requires the integration of higher-order cognitive functions. Impairments in certain cognitive domains have been related to increased gait variability and fall risk in persons with MS within the dual-task (DT) paradigm. This case series, as part of a larger pilot study, examined the effects of a gait-specific DT intervention on gait, DT performance, and fatigue. Specifically, the hypotheses were (1) the gait-specific DT training will induce changes in spatiotemporal gait mechanics and DT performance compared to single-task (ST) training alone, (2) the DT training group will differ in functional measures of walking and fatigue.

Number of Subjects: 6
Materials and Methods:
5 female and 1 male with relapsing-remitting MS, mean age 53.5±12.4 years old, were randomized into ST (n=2) or DT (n=4) training. The ST group performed gait training with a physical therapist 3 days/week for 6 weeks. However, the DT training group also performed concurrent cognitive tasks: serial subtraction by 3, verbal fluency, and information processing speed with a working memory task. Both groups walked in 2-min bouts followed by feedback of performance. Measurements taken at baseline, mid- and post-intervention, and 1-month follow up were cadence, step length, gait speed, motor and cognitive DT cost (DTC) during the modified Walking and Remembering Test (mWART); 2-minute walk test (2MWT); 12-Item Multiple Sclerosis Walking Scale (MSWS-12); and Fatigue Scale for Motor & Cognitive Functions (FMC).

Results:
At post-intervention, the DT group demonstrated improvements in DT step length (4.67%), DT velocity (6.38%), 2MWT (13.61%), and MSWS-12 (-11.03%). The DT group demonstrated improvements in absolute measures, but DTC of cognitive performance, step length, velocity, and cadence compared to baseline changed by 7.45%, -7.01%, -8.62%, -3.66%, respectively. The ST group also showed improvements in step length (6.73%), DT velocity (10.67%), 2MWT (24.73%), and MSWS-12 (-5.11%) on the DT condition of the mWART. The ST group showed improvements in DTC of step length, velocity, and cadence, while DTC of cognitive performance improved. Minimal changes were observed for the FMC (DT 6.69%, ST -3.57%).

Conclusions:
Although increases in DTC were observed at post-intervention in the DT group, improvements in absolute measures of gait parameters were observed. This case series showed that the DT group did no better than the ST group in affecting DT performance and measures of gait.

Clinical Relevance:
With the prevalence of cognitive impairment in persons with MS, increased fall risk and gait disturbance may be linked to cognitive impairment and difficulty to DT. Although our understanding of factors related to gait dysfunction in MS continues to grow, discrepancies in the literature regarding appropriate treatment strategies targeting DT of gait persist. Establishing a standardized framework as a basis to develop a personalized intervention for DT of gait becomes necessary to improve the reproducibility of results and optimize clinical outcomes.
TITLE: For Persons with Parkinson’s Disease, Does Speed Dosed Training Improve Motor Symptoms and Motor Performance?

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG


ABSTRACT BODY:

Purpose/Hypothesis: There is evidence that training the cardiovascular and neuro muscular systems reduces motor symptoms, such as bradykinesia and rigidity, as well as improves the system being trained. (Uhrbrandt, et al. 2015) However, it is unclear whether the gains made from training, specifically speed dosed training, will transfer to motor performance. The aim of this study was to determine if there is evidence that speed-dosed training on reduces motor symptoms and improves motor performance (or activities) such as walking in persons with PD.

Number of Subjects: N/A

Materials and Methods: PubMed and CINAHL databases were used to search for articles published between Jan 1, 2015 - Oct 15, 2018. Search terms were generated using a PIO format combined with Boolean operators AND and OR, using both key words and exploded MESH Terms (underlined) as follows: Population (P) (Parkinson*) AND Intervention: (Exercise OR physical fitness OR bicycling OR exercise therapy OR walking speed OR high intensity OR speed OR mobility) AND Outcomes: (Timed up and Go (TUG) OR 6 Minute walk test (6MWT) OR UPDRS OR walking speed OR RPM OR cycling speed OR walking distance OR mobility OR motor symptoms). Articles were included if 1) Patients had Parkinson’s Disease 1-3 on the Hoehn & Yahr (H & Y), 2) interventions were exclusively dosed on speed, 3) motor symptoms were measured with the UPDRS, 4) motor performance outcomes were reported, 5)they were levels 1 or 2 on the Oxford Center for Evidence Based Medicine (CEBM).

Results: Four articles met the inclusion criteria (Bang et al. 2016, Ridgel et al. 2015, Uygur et al. 2017, Marusiak et al. 2015). Their level of evidence ranged from 1b-2b. Participants (91 total) had an average age of 65 years old and H and Y between 1-3. Training, dosed on speed, was performed on Nordic Treadmill walking (1 study) and some form of stationary bicycling (3 studies). Interval training was the primary mode (3 studies) with one study using continuous cycling. Dose ranged between 120 minutes and 1440 minutes, between 2 sessions and 24 weeks). All studies reported significant improvements in the UPDRS, three had clinically meaningful improvements. There was also a positive correlation (R = .72) between exercise dose and motor symptoms. As exercise dose increased, motor symptoms decreased. Significant motor performance improvements were reported for all studies. Clinically meaningful improvements in the TUG (based on fall risk reduction) were reported for (2 out of 3) studies. Both studies that looked at walking speed showed clinically meaningful improvement. Speed training improved both untrained and trained activities such as reaction time test and upper extremity (UE) tasks (Uygur et al. 2017) and UE function. (Ridgel, 2015). Marusiak et al. (2015) interpreted decreased motor symptoms were a result of increased BDNF that improve the functioning of altered neural networks in the basal ganglia.

Conclusions: Modest evidence supported that speed training reduced motor symptoms measured by the UPDRS and improved motor performance in balance and walking speed for persons with PD.

Clinical Relevance: For persons with PD H&Y 1-3, speed training using a bicycle or walking on a TM with Nordic poles (120-1440 minutes) reduces motor symptoms and improves motor performance.
ABSTRACT BODY:
Purpose/Hypothesis: Based on upper extremity reaching studies in people with Parkinson’s disease (PD), it is known that PD results in motor learning deficits. Specifically, those with PD can learn through implicit (unconscious adaptation) and explicit (using conscious strategy) learning, but do so slower than healthy adults. Additionally, during explicit upper extremity learning, people with PD have difficulty with savings (i.e., the ability to relearn a task faster when it is done a second time). However, little is known about learning and saving deficits in walking, though walking is often impaired in PD. This work was a preliminary comparison of learning and saving during implicit and explicit walking tasks in people with PD and healthy adults.

Number of Subjects: Ten people with PD (65.4 ± 6.54 years, 7M, all Hoehn & Yahr stage 2) and two age matched healthy adults (ages 59 and 57, 1M) have participated in the study thus far.

Materials and Methods: Subjects completed two sessions of treadmill walking with motion capture to measure step length. Each session consisted of a locomotor learning task (i.e., Learning), walking without perturbations or instructions, and then the locomotor learning task (i.e., Relearning). Learning and Relearning during one session consisted of implicit adaption on a split-belt treadmill, while the other session consisted of an explicit task with visual feedback. Split-belt walking required participants to adjust to a perturbation and return to step length symmetry, while the visual feedback required subjects to take a longer step with one leg to match targets on a screen. Order of the sessions was counterbalanced, and the number of steps per subject was the same in both sessions.

Results:
Implicit Learning: During Learning, all subjects initially showed asymmetric stepping when belts were split; however, healthy adults improved mean step symmetry index (SSI) from -0.069 to 0.031, while those with PD only improved SSI from -0.203 to -0.060 (where an SSI of 0.00 represents symmetry). At the beginning of Relearning, both healthy adults and those with PD were more symmetric than at the beginning of Learning (SSI= 0.005 and -0.079, respectively), thus, showing savings.

Explicit Learning: During Learning, healthy adults increased their step length by 7 cm, resulting in frequently hitting the target. Those with PD also increased step length, but only by 5.1 cm, which was not enough to hit the target frequently. When compared to Baseline, both groups increased their step length more during early Relearning than during early Learning (healthy adults 4.9 cm vs 4.2cm, PD 4.3 cm vs 3.4cm), again showing savings.

Conclusions: Individuals with PD learned a new walking pattern through both implicit adaptation and explicit learning, although those with PD learned less than healthy adults. Despite this, both groups demonstrated savings during Relearning.

Clinical Relevance: Though locomotor learning is impaired in individuals with PD relative to healthy adults, those with PD demonstrate savings of what they have learned when the walking task is subsequently reintroduced.
Purpose/Hypothesis: The progressive neurodegeneration of multiple sclerosis (MS) associates with a wide range of functional impairments that often lead to physical challenges and psychological distress. While our understanding of the benefits of mindfulness practice in MS is emerging, no studies to date have investigated the beliefs and attitudes surrounding the practice of mindfulness in individuals with the disease. According to the Theory of Planned Behavior (TPB), the beliefs and attitudes a person holds towards a certain behavior underpin their intention to approach and engage in that behavior. The purpose of this theoretically-grounded, exploratory study was to examine the beliefs, attitudes and intentions of adults with MS toward mindfulness-based practice.

Materials and Methods: The Mindfulness in MS survey was developed following Ajzen’s model for constructing a standard questionnaire for the TPB such that representatives of the research population were interviewed to elicit readily accessible behavioral outcomes, normative referents, and control factors. Participants then completed the Mindfulness in MS survey through a web-based platform. Correlations and multiple regression analyses were conducted to determine the independent and collective contribution of the beliefs, attitudes, subjective norms and perceived behavioral control on intention to practice mindfulness.

Results: Each measure in the Mindfulness in MS survey was found to be reliable with a Chronbach’s alpha of .81, .97, .62, .84, .94, .75, and .80 for intention, attitude, subjective norm, perceived behavioral control, behavioral beliefs, normative beliefs, and control beliefs, respectively. Moderate to very high statistically significant associations among constructs of the survey indicated parsimony between the survey and the TPB. Regression results showed that the overall intention of engaging in mindfulness practice was best predicted by the attitudes of the individual with MS (R = .66, R² = .43, F₆,₃₃₈ = 42.86, p < .001).

Conclusions: These findings demonstrate that attitudes about mindfulness practices impact a person’s intention to practice mindfulness as an intervention to mitigate MS symptoms and improve quality of life.

Clinical Relevance: Stress may exacerbate the inflammatory process of the central nervous system in MS, and mindfulness meditation has been shown to reduce physiological markers associated with stress. Furthermore, research has indicated that mindfulness practice can improve physical health, fatigue, and levels of chronic pain in those with MS. It has also been shown to improve coping, resilience and overall quality of life in this patient population. As these results demonstrate, people with multiple sclerosis will choose to participate in mindfulness practices based on particular attitudes. Future clinical studies and patient education may play significant roles in enhancing understanding of and the intention to practice mindfulness in persons with MS.
TITLE: Effects of Cycling Cadence Variability on Motor Function and Cortical Inhibition in Parkinson's Disease

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: Jessica Axelrod, Alexander Jeffrey Garbin, Yu-Chen Chung, Stephanie Nicole Yassa, Angela Ridgel, Beth E. Fisher

ABSTRACT BODY:

Purpose/Hypothesis: Prior research has demonstrated that forced cycling drastically improves motor symptoms commonly experienced by individuals with PD. Further, the degree of improvement is predicted by the variability in one’s cadence. However, the mechanisms behind these changes are poorly understood. The purpose of this study was to assess the effect of cadence variability (degree of complexity) on motor function and cortical inhibitory mechanisms during forced and voluntary cycling in adults with Parkinson’s disease (PD). We hypothesized that an increase in cortical inhibition, a cortical mechanism that is reduced in individuals with PD, may be responsible for the motor improvements secondary to forced cycling.

Number of Subjects: 4

Materials and Methods: Individuals with mild to moderate PD underwent three 30-minute cycling sessions consisting of high cadence variability forced cycling (HCV), low cadence variability forced cycling (LCV), and voluntary cycling (VC) while off medication. During the two forced cycling sessions, cadence was set to 80 rpm, while participants were encouraged to maintain this same cadence during voluntary cycling. Motor function was assessed using the Unified Parkinson’s Disease Rating Scale III and cortical inhibitory mechanisms were assessed using a transcranial magnetic stimulation paradigm of short interval cortical inhibition (SICI) before and after each cycling session. Variability in cadence and power during each session was calculated using entropy analysis.

Results: Mean cadence was greater during HCV and LCV relative to VC (80.3 & 81.4 vs. 75.5 rpm). Cadence variability was higher during HCV (1.4) compared to LCV (1.1), while power and power variability were higher during LCV (4.6 & 0.32) compared to HCV (2.9 & 0.14). We observed the greatest increase in cortical inhibition as indicated by reduced SICI following HCV (Pre 0.724, Post 0.527) while the greatest improvement in UPDRS was seen following LCV (5.5).

Conclusions: While our inhibitory and behavioral changes following high and low cadence variability forced cycling at first seem counterintuitive, we postulate they may be secondary to different mechanisms. Specifically, increased modulation in kinematic output and somatosensory input during the high cadence variability condition may be responsible for increased inhibition. The increased power and power variability in the low cadence variability condition is indicative of greater kinetic variability and motor output, potentially resulting in the observed greater impact on motor behavior. Further, these effects are less apparent in the voluntary cycling condition due to their significantly lower cadence.

Clinical Relevance: One session of low variability cycling appears to produce a clinically meaningful improvement in UPDRS scores. However, the neural measures collected may not fully reflect the clinical changes observed. Further research is required to confirm these initial findings and explore additional neurophysiological mechanisms.
TITLE: Diminished Muscle Oxygen Uptake and Fatigue during Submaximal Exercise in Individuals with Spinal Muscular Atrophy.

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: Julia Cocchi, Margarethe Emery Hauschildt, Ashley M Goodwin, Ashwini K Rao, Carol Ewing Garber, Michael P McDermott, Darryl C De Vivo, Jacqueline Montes

ABSTRACT BODY:

Purpose/Hypothesis:
Spinal muscular atrophy (SMA) is a progressive neuromuscular disease due to homozygous deletion of the SMN1 gene and the inadequate production of full-length SMN protein by the SMN2 gene. People with SMA type III, a milder phenotype, are able to stand alone and walk despite proximal weakness. Fatigue and exercise intolerance are common symptoms in these individuals. Reduced aerobic capacity and diminished muscle oxygen uptake has been demonstrated during maximal exercise but responses to submaximal exercise have not been explored in SMA. Physiologic fatigue during ambulation has been demonstrated using the 6-minute walk test (6MWT). The purpose of this study was to examine muscle oxygen uptake and quantify fatigue during submaximal exercise in ambulatory individuals with SMA and aged-matched controls. We hypothesized that during submaximal exercise muscle oxygen uptake would be lower and that there would be fatigue in SMA.

Number of Subjects: 24

Materials and Methods:
Thirteen ambulatory children and adults with SMA and eleven healthy aged-matched controls (range 12 - 56 years) participated. Oxygen uptake was measured in the left vastus lateralis muscle using near-infrared spectroscopy (NIRS) as change in deoxygenated hemoglobin (ΔHHb) between the warm-up period and the end of a 10-minute submaximal exercise test performed on a recumbent cycle ergometer. Submaximal workload was pre-determined as 40% of peak workload achieved during a cardiopulmonary exercise tolerance test. Target intensity was 3 – 5 on the OMNI scale of perceived exertion. The 6MWT was included to assess ambulatory function and fatigue. Fatigue was defined as the percent change in workload or distance walked by comparing the first minute performance to the last minute performance of the submaximal cycle exercise and 6MWT, respectively, with a positive value indicating fatigue. Wilcoxon rank sum tests were used to compare SMA and control participants. A Pearson correlation coefficient was used to evaluate the relationship between the fatigue measures.

Results:
Change in HHb was lower in SMA (median -0.01; IQR -1.55 – 1.15) than in controls (median 6.02; IQR 2.47 – 8.25) (p < 0.001) during submaximal cycle exercise. There was a decrease in workload during submaximal cycle exercise in individuals with SMA (median 10.0%; IQR 0 – 50) and not in controls (median 0%; IQR 0 – 0) (p = 0.125). Fatigue was observed during the 6MWT in SMA (median 16.2%; IQR 12.3 – 17.1) but not in controls (median 3.7%; IQR 0.8 – 6.3) (p = 0.008). There was no association between fatigue on the 6MWT and submaximal cycle exercise (r = 0.09; p =0.844).

Conclusions:
Individuals with SMA demonstrate diminished muscle oxygen uptake during submaximal exercise and experience fatigue during submaximal cycle exercise and walking than healthy controls.

Clinical Relevance:
Individuals with SMA often experience fatigue when performing repetitive tasks which contributes to decreased ability to perform daily activities. Understanding the mechanism underlying the physiological response to exercise in SMA may reveal additional therapeutic targets.
Background and Purpose: Polymyositis (PM) is a rare inflammatory progressive muscle disorder. Worldwide annual incidence is estimated at 3.9-4.1 cases per million people. Differential diagnosis includes Inclusion Body Myositis (IBM) and Dermatomyositis (DM). Abnormal muscle physiology exists in these three idiopathic inflammatory myopathies directly affecting endurance, strength, postural control, functional mobility, and activities of daily living (ADL’s). Prior research has reported successful strength and endurance training programs which influence anti-inflammatory cytokines, VO2Max, and muscle fiber physiology. The purpose of this case report was to evaluate the effect of an intensive balance-based rehabilitation program using a prescribed dosage of 50% maximal intensity on dynamic balance and ambulation ability in an older adult with polymyositis.

Case Description: A 76-year-old male, with a new diagnosis of “IBM vs. PM”, reported inability to stand from a chair and a history of immediate weakness after personal strength training and treadmill walking. Balance-based training during 8 (1-hour) outpatient sessions emphasized use of the BORG-10 scale to maintain dosage intensity below 50% maximal perceived exertion. Outcome measures included: Berg Balance Scale (BBS), Functional Gait Assessment (FGA), 10-Meter Walk Test (10MWT), 2-Minute Walk Test (2MWT), Five Times Sit to Stand Test (5xSTS), and the Activities-specific Balance Confidence Scale (ABC).

Outcomes: At the tenth visit, clinically significant improvements were noted in five out of seven functional outcome measures: BBS (41 to 46/56), 10MWT preferred (0.64m/sec to 0.82m/sec), 10MWT fast (0.76m/sec to 0.94m/sec), 5xSTS (23.18sec to 17.08 sec), and ABC (35.9% to 62.5%). Although the FGA and 2MWT did not yield clinically significant improvements, improvements from evaluation to progress note were still evident: FGA (12/30 to 19/30) and the 2MWT (97.5m to 106.7m).

Discussion: Patients with PM have abnormal muscle fiber physiology; thus it was hypothesized concurrent abnormal postural control would exist. To address these postural control deficits, usual care balance-based activities were chosen with the novel component being the 50% intensity dosage. Prior research has used 60-70% intensity for strengthening protocols. A dosage of 50% perceived intensity during balance-based training may be beneficial for an older adult with polymyositis. Muscle fiber physiology changes and long term carryover are unknown and may likely be reliant on patient compliance. Further research would be beneficial to assess length of intervention and muscle fiber changes via biopsy with a larger sample size.
Purpose/Hypothesis: Fatigue have been identified as a barrier to exercise in people with multiple sclerosis. Specifically, people fear that exercise will increase feelings of fatigue. The benefits of exercise for people with multiple sclerosis are well documented and include maintenance of physical function and feelings of self-management. The purpose of this systematic review is to identify the type of exercise regimen and prescription, including both aerobic and resistance training that may have the greatest impact on fatigue perception.

Number of Subjects: 326 articles were initially reviewed. Six met all inclusion criteria.

Materials and Methods: The literature search was completed in April of 2018. Three databases were utilized including PubMed, Scopus, and Ovid MEDLINE. The search terms included “multiple sclerosis” AND “aerobic exercise” OR “aerobic training” AND “cognitive fatigue” OR “physical fatigue” OR “mental fatigue” OR “muscle fatigue” OR “fatigue” AND “perception”. MESH terms were utilized during the PubMed search to expand result return. An abstract review was conducted for 326 articles, followed by a full-text assessment of 13 articles. The review resulted in 6 articles meeting all of the inclusion criteria. These articles were assessed using the PEDRO Scale.

Results: Six articles met the inclusion criteria with PEDRO scores ranging from 2 to 9. Four of the six studies assessed found important improvements in fatigue after engaging in a multi-faceted exercise program.

Conclusions: Interventions implemented 2-3 times per week that included both resistance and aerobic training at an intensity of 30-60% of 1RM or 65-75% of age-predicted maximum heart-rate respectively. Increasing frequency of exercise to four to five times a week may negatively impact the perception of fatigue.

Clinical Relevance: Precision of exercise dosage may be important in improving feelings of fatigue in people with multiple sclerosis.
ABSTRACT BODY:
Purpose/Hypothesis: Gait impairments are a consequential aspect of Parkinson disease (PD), contributing to disability,1,2 falls,3 and reduced quality of life.4 They are exacerbated during turning5,6 and other complex walking tasks that are common in daily life, with over half of individuals with PD reporting difficulty turning. Impaired turning is associated with freezing of gait and increased risk for falls,7 making turns an important target for rehabilitation. Prior research demonstrates short-term benefits of treadmill training to improve walking speed.8,9 The purpose of this study was to determine the effects of a treadmill training program on turning in people with PD.

Number of Subjects: Preliminary results from five participants are reported. Eligibility criteria were: (1) a diagnosis of PD (Hoehn & Yahr stages 1-3); (2) no dementia; (3) no severe medication fluctuations; (4) no history of neurosurgery for PD; and (5) no orthopedic, neurologic, or cardiovascular conditions that impact cognition or walking.

Materials and Methods: Participants completed six 1-hour sessions of treadmill training consisting of 30 minutes (6 blocks x 5 minutes) of active gait training interspersed with 5-minute break periods. Gait training combined verbal cues emphasizing improved gait pattern quality (e.g., increased upright posture, stride length, and consistent heel strike) with incremental treadmill speed increases. Pre- and post-training assessments included two turning tasks (180-degree turns, figure-8 turns) quantified using full-body 3-dimensional motion analysis. The start and end of turns were defined using the rotational velocity of the pelvis. Primary outcomes used to characterize turn performance were the time to complete the turn (s) and the turn peak velocity (degrees/s). Paired t-tests were used to compare pre- and post-training performance.

Results: Participants were, on average, 69.6 years of age with a disease duration of 9.7 years and Hoehn & Yahr stage 2. For 180-degree turns, training did not affect time to turn (pre: 2.5 s; post: 2.5 s) or turn peak velocity (pre: 142 degrees/s; post: 151 degrees/s). Similarly, time to turn (pre: 3.8 s; post: 3.3) and turn peak velocity (pre: 132 degrees/s; post: 150 degrees/s) were unchanged for figure-8 turns after training.

Conclusions: Turning performance did not improve for either turning task after the treadmill training program. Turning requires intersegmental coordination of the legs, trunk, and head, modification of foot placement to change direction, and increased postural stability and is known to be impaired in PD.10 Though the verbal cues provided during treadmill training could potentially generalize to turning performance, treadmill training was specific to straight-line walking.

Clinical Relevance: Mobility in the home and community requires frequent turns, and turns are particularly impacted by PD. Understanding if the benefits of treadmill training extend to complex, non-linear walking tasks is critical to optimizing interventions targeting safe and effective mobility.
Purpose/Hypothesis: Declines in the amount and intensity of natural walking behavior in people with Parkinson disease (PD) may precede declines in motor behavior, gait, and balance. Physical interventions targeting walking behavior in PD may have the greatest impact on slowing the progression of disability. Despite a lack of supporting evidence, however, clinicians may be more likely to rely on quick performance measures of walking speed, capacity, and balance to make inferences about a patient’s walking health, rather than direct measures of natural walking behavior. Our primary purpose, therefore, was to examine the extent to which clinical walking measures might predict natural walking behavior in early to mid-stage PD. Secondarily we sought to explore differences in the predictive capability of clinical measures between relatively less active and more active participants.

Number of Subjects: 28

Materials and Methods: Data were collected from 20 males and 8 females (age 69.0 ± 7.0 years; Hoehn & Yahr Stages 2.0-3.0) as part of the baseline assessment for a larger prospective study of individuals with PD. Clinical measurement of comfortable walking speed (10 Meter Walk Test; 10MWT), capacity (6 Minute Walk Test; 6MWT) and balance (Mini-BESTest; MBT) were collected from participants prior to wearing a Step Activity Monitor for seven days. Walking behavior was defined as the mean number of daily (1) steps and (2) minutes of moderate-intensity walking. Subgroups of less and more active participants were created post-hoc based on a cutoff of 7,500 daily steps. Non-parametric bivariate correlations were used to characterize relationships between clinical and walking behavior measures.

Results: Participants collectively displayed variable walking speed (10MWT = 1.19 ± 0.2 m/s), capacity (6MWT = 478.3 ± 94.3 m), balance (MBT = 19.2 ± 3.1), daily steps (7683 ± 4386), and daily minutes of moderate-intensity walking (8.1 ± 9.8). For the full sample, correlations between each clinical and walking behavior measure were positive but relatively weak (0.12 < ρ < 0.44). Among less active participants (n = 15), 10MWT and 6MWT correlations with daily steps and moderate intensity minutes were somewhat stronger (0.54 < ρ < 0.66). Among more active participants (n = 13), correlations were similar to the full sample, with the exception of 10MWT vs. daily steps (ρ = -0.80, p < 0.001).

Conclusions: The small, preliminary sample included a range of clinical walking performance and natural walking behavior representative of individuals with early- to mid-stage PD. More data are forthcoming. Results suggested that clinical walking measures may be relatively poor predictors of natural walking behavior. Gait and balance capability may be more likely to determine the daily walking activity among those who are relatively less active than those who are more active.

Clinical Relevance: For their patients with PD, clinicians should exercise caution in making inferences about natural walking behavior based on clinical walking measures.
Purpose/Hypothesis: Postural control (PC) is a multifaceted system that integrates movement synergies, biomechanics, cognitive and sensory information to achieve upright function and respond to perturbations. Persons with Parkinson’s disease (PD) exhibit deficits in postural control, which over time lead to balance disruptions and falls. While motor system deficits have been identified in PD, research has not clarified the sensory systems that contribute to balance deficits. Therefore, the purpose of this study is to identify variables that lead to falls during the Sensory Organization Test (SOT) and to ascertain if the composite cut off score of 71 appropriately identifies falls.

Number of Subjects: Participants consisted of 23 individuals. The mean age of the participants were 66.62 (SD=10.29). All participants were on medication during testing.

Materials and Methods: The study is a retrospective design from two PD research studies held in 2018 and 2019. Inclusion criteria: Hoehn and Yahr (H & Y) scale 1-3, ages 40-84, ambulatory with or without device, a stable medical history for one month and the ability to participate in an exercise program. Exclusion criteria: hospitalized within the last three months, a second neurologic diagnosis, drug induced psychosis, or poorly controlled hypertension or cardiopulmonary pathology. SOT assessment was performed using computerized posturography. Participants wore a harness, followed the set SOT protocol and performed the six equilibrium tests (3 trials per test), which resulted in scores in equilibrium, composite and sensory ratio. Test-retest reliability of the SOT showed r=.60 to .99. A stepwise linear regression model entered 10 variables (SOT scores and demographic data) to document the proportion of variance to determine falls during SOT testing. Additionally, analysis of the coefficients were performed to determine whether the model was a significant predictor of falls. Level of significance was set at P<.05. An analysis of the composite score was performed of 71 appropriately identified fallers. Statistical analysis was performed with SPSS 26.

Results: The results of the stepwise linear regression indicated that only one variable, the vestibular ratio explained 42.9% of the model, R² = .429. Additionally, the model was significant, F(1,22) =15.748, P<.01. The vestibular score predicted falls (β =-.049, P<.01) and documented the predictive model equation: 3.739 + (-.049 *falls). The composite cut off score of 71 correctly identified 86 percent of falls during SOT testing.

Conclusions: Forty two-percent of the variance was explained by the vestibular ratio. Nine variables were excluded from the model. The SOT assessment identifies vestibular deficits which has the potential to determine fall risk in persons with PD.

Clinical Relevance: This study adds to the emerging literature that the vestibular system in persons with PD contributes to postural instability and falls. Clinicians should consider implementing the SOT to determine vestibular dysfunction.
Purpose/Hypothesis: The purpose of this study is to quantify the effects of a peripheral nerve graft implantation into the substantia nigra on gait parameters in people with Parkinson’s Disease at the time of deep brain stimulation (DBS) surgery. Our goal was to study the effects of the nerve graft on gait velocity, cadence, and step length to determine if DBS-Plus has long-term benefits on mobility. Assessment of long-term improvement (2 years) in gait parameters is an important measure in determining the effectiveness of DBS-Plus. We hypothesized that the addition of the nerve graft will have a positive influence on gait parameters.

Number of Subjects: A total of 28 participants were involved with the study but only eight of the participants had a complete data set at the 2 year follow-up mark. Participants were included in the study if they were undergoing DBS of the GPi between the ages of 40-75, able to give informed consent, showed a positive response to Sinemet (carbidopa/levodopa), and were able to tolerate the surgical procedure.

Materials and Methods: Secondary data analysis was performed on data collected from eight subjects, who underwent DBS surgery targeting the substantia nigra. Gait measures including step length, velocity, and cadence were compared during the OFF stage prior to implementation of DBS plus and after DBS plus in 6 months intervals for two years. Hoehn and Yahr (H&Y) scores were used to categorize patients into two groups. For the purpose of our study, patients with a H&Y greater than or equal to 3 were considered more severely affected (N=4), whereas subjects with a H&Y less than 3 (N=4) were considered less severely affected.

Results: The more severely affected individuals demonstrated greater improvements across various gait parameters (step length, cadence, and velocity) in comparison to those less severely affected across a two-year span. Subjects with a H&Y score of ≥3 (more severely affected individuals) showed an increase in average velocity from 68.3 ± 26.24 to 108.38 ± 28.78 m/s, an average cadence of 91.31±12.94 to 100.84 ± 5.29 steps/min, and an average step length of 48.22 ±19.15 to 66.81±14.20 inches from enrollment to two-year follow up respectively. On the other hand, subjects with a H&Y score <3 (the less affected individuals) did not demonstrate improvements in average velocity of 111. 83 ± 0.51 to 109.97 ± 2.95 m/s, an average cadence of 106.73 ± 12. 62 to 109.93 ± 12.79steps/min, and average step length of 64.43 ± 7.02 to 61.63 ± 3.95 inches.

Conclusions: We observed improvements in multiple gait parameters for individuals more severely affected with PD. The improvement in individuals was maintained over the two-year mark.

Clinical Relevance: Patients scoring >/=3 on H&Y might consider undergoing DBS-Plus to help improve gait.
TITLE: Use of GPS Monitoring to Examine Community Participation in People with MS, a Case Series

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: Nicholas Koch, Brian James Loyd, Grace Hunt, Mark Eric Lester, Leland E. Dibble

ABSTRACT BODY:

Purpose/Hypothesis:
In-clinic assessments of mobility may have limited ecologic validity relative to the mobility challenges experienced in the community by people with multiple sclerosis (PwMS). As demonstrated by Hanke et. al, commercially available global positioning system (GPS) devices may provide an opportunity to measure the community mobility of neurologically-impaired populations. The purpose of this project was to report on the use of GPS monitoring to quantify community mobility of PwMS and neurologically healthy participants (NH).

Number of Subjects:
Four individuals consented to participate. An unmatched case series of 2 PwMS (59 y/o Female, 49 y/o Male) and 2 NH participants (53 y/o Male, 31 y/o Male) was used.

Materials and Methods:
Participants wore a Garmin Forerunner 935 wrist worn GPS monitor for 17 hours on a single day. Monitor data was gathered then exported for data reduction and analysis. The velocity profile of the data series for each individual was examined for the 17-hour period with driving time excluded. A cutoff of .2 m/s was used to delineate sedentary and ambulatory time with 3 m/s used as the upper limit of ambulation. Community mobility was analyzed through time spent at home, number of trips from home, and number of locations visited. A personal interview was used to confirm mobility features from the GPS monitoring.

Results:
Both the PwMS and the NH individuals averaged 1.5 trips from home during the monitoring period. PwMS averaged 6 locations visited and controls averaged 4 locations visited. PwMS had lower average time spent walking compared to NH participants (5.4h vs. 5.8h) and sedentary time (9.5h vs. 9.8h). When examining individual data, we found that one PwMS performed 9 hrs of ambulatory activity and 7.4 hrs of sedentary time, while the other had only 1.8 hrs of ambulatory time and 11.7 hrs of sedentary time. Participants identified features such as walks, house work, and other ambulatory activities on the geographic information systems map during debriefing.

Conclusions:
While debriefing and preliminary ambulatory time detection suggests possible high fidelity of data gathering with this method, areas for improvement include longer monitoring times to control for day-to-day variability in activity, addition of pedometer monitoring, and data filtering. Time spent at varying distances from home appeared to be related with commute distance, while the number of locations visited and time spent at home appeared to be relevant measures of mobility that may become more accurate with increased monitoring time. Based on these results, we are currently gathering data on an age and gender-matched cohort with a target of 10 PwMS and 10 controls to further validate this method and more robustly compare community mobility and participation.

Clinical Relevance:
Affordable GPS devices may offer a clinically practical opportunity to complement in-clinic measures of mobility by quantifying community mobility in PwMS. Work is needed to refine these methods and establish the length of monitoring periods necessary to stable data, their validity, reliability and responsiveness to change.
Purpose/Hypothesis: The purpose of this systematic review was to evaluate the effects of recreational activities on activity and participation in persons with mild to moderate Parkinson’s Disease (PD).

Number of Subjects: N/A

Materials and Methods: A literature search of ProQuest, Wiley, Science Direct, CINAHL, and PubMed/Medline was conducted using search terms: (“Parkinson's disease” OR “Parkinson disease” OR "PD" OR “Parkinsons disease” OR “Parkinson’s”) AND (“mind-body exercise” OR “fitness” OR “recreational activities” OR “hobbies” OR “exercise”) AND (“RCT” OR “Randomized Controlled Trial” OR “Randomised Controlled Trial”). Selection criteria included: RCT design, participants with mild to moderate PD, and recreational activity as an intervention (defined by leisure activity or non-conventional PT treatment). Two reviewers independently assessed each study for methodological quality and came to consensus based on PEDro guidelines.

Results: A total of 927 articles were screened for eligibility. Following detailed appraisals, 15 RCTs fulfilled the selection criteria. PEDro scores ranged from 3 to 9/10 (avg=6.25). Samples ranged from 10 to 90 subjects (580 total) with mild to moderate PD (H&Y Stages I-IV). Recreational activities were performed 1-2 days per week (60-90 min/session) averaging 21 weeks duration (range: 8 wks-2 yrs). No adverse events were reported. Primary outcome measures for activity and participation included the UPDRS and PDQ. Seven out of 15 studies found statistically significant improvements in UPDRS scores within groups for using various types of dancing (-8.05, -21.0, -7.2 pts), Turo Qi (-6.2 pts), and yoga (-10.9, -10.6 pts) and between groups for Irish step dancing (-7.2 pts), Turo Qi (-6.2 pts) and Tai Chi (-6.4 pts). Four out of 15 studies found statistically significant improvements in PDQ scores within group for boxing (-4.0 pts) and yoga (-11.5 pts) and between groups for Tai Chi (-7.65 pts), yoga (-16.7 pts), Irish Set dancing (-8.4 pts) and tango (-7.5 pts). Subgroup meta-analyses showed improved overall mean differences (MD) for activity and/or participation as indicated by UPDRS scores (n=12; MD=-6.704; 95% CI [9.48, -3.92]) and PDQ scores (n=6; MD=-6.066; 95% CI [-10.41, -1.71]). The effects of improved patient-reported outcomes in recreational interventions were more pronounced as they were significantly associated with continuing exercise outside of the study intervention.

Conclusions: There is moderate evidence in support of using various recreational, leisure activities to improve activity and participation levels in persons with PD. Limitations included small sample sizes, self-report outcome measures, and lack of long term follow-up. Further research is needed to determine the most optimal training parameters to promote long-term improvements in function based on type of activity.

Clinical Relevance: Clinicians should consider referrals for recreational programs that promote increased activity and participation as part of the long-term management of disease progression in persons with PD. The most successful programs that exceeded Minimal Clinically Important Difference (MCID) values for the PDQ (-4.72 pts for meaningful improvement; Horvath et al., 2017) and UPDRS (-3.25 pts for meaningful improvement; Horvath et al., 2015) included tai chi and yoga, alone or combined with traditional therapy, for an average of 60 minutes, 2-3 times per week over 12-24 weeks. These options provided safe, motivational methods that may help improve adherence to reduce functional decline in patients with PD.
ABSTRACT BODY:

Purpose: The purpose of this special interest report is to present a retrospective examination of the feasibility of implementing a physical therapist led group exercise class for long-term care (LTC) residents with Huntington’s disease (HD).

Description: Individuals with HD, a neurodegenerative disease, have extensive needs in their twilight years and typically require the services of a LTC facility. Individuals with HD in LTC may experience a sense of disconnection from their previous community and a sense of isolation. An inability to participate in the typical activities planned for LTC residents due to the clinical manifestations of HD can compound a sense of isolation within the LTC facility. Examination of community and group programs for the HD population suggest a promising avenue for continued mobility and exercise. Structured exercise is beneficial for those in the early stages of HD. There is a need to explore outreach efforts to create and implement group exercise programs for individuals in the late stages of HD living in a LTC facility.

Summary of Use: A team of volunteers, consisting of a physical therapist, a neurological physical therapy resident, and two Doctor of Physical Therapy (DPT) students provided a structured exercise program at a facility for residents with HD for 1 hour weekly for 4 weeks. A safe participant to volunteer ratio was set at 4:1 due to varying functional and cognitive levels. An average of 10 individuals, between the ages of 30-60, participated weekly. Approximately 4 of the participants ambulated independently or with an assistive device, 5 needed physical assistance to ambulate/transfer, and 2 were wheelchair users. The focus of the group was to engage each participant and promote physical activity. Each week the program included flexibility, core strengthening, balance, and functional activities. Exercises were bidirectionally modified based on falls risk to achieve an appropriate level of challenge with no reports of fatigue. There were 2 near falls and 1 fall during a transfer secondary to poor balance with no injuries incurred. Anecdotally, the participants were positive about the experience, citing benefits of being together as a group and getting to know new people through exercise. The LTC staff shared their perceptions of the benefits of the participants engaging in something together to decrease isolation.

Importance to Members: This is the first report describing the feasibility of a group exercise model for people with HD in a LTC facility. Previous research describes the benefits of group exercise in community dwellers with HD, and it is important that these opportunities be continued into the LTC facility. Many lack access to group activities at this stage in the disease process. Future research should be conducted to examine the benefits of group exercise on physical function and quality of life in this population with robust designs. Incorporating staff as volunteers can enhance the working relationships between participants and staff. The inclusion of outside volunteers and students offers an expanded community and patient and staff education resources.
TITLE: Therapist and Patient Perspectives on Large Amplitude Functional Movements in the Treatment of Parkinson’s Disease

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: Taylor Morgan Kitkowski, Kaitlyn Sandifer, Tarang Kumar Jain, Valerie A. Carter

ABSTRACT BODY:

Purpose/Hypothesis: Approximately 10 million people worldwide are currently estimated to be living with Parkinson’s disease. The existing evidence suggests the beneficial effects of large-amplitude functional movements on patients with Parkinson’s disease (PwP), however there is no study addressing the beliefs that physical therapists and PwP have about these exercise programs. Knowing the perspectives of therapists and PwP on the use of large-amplitude functional movements can pave the way for more research into identifying the exact mechanism and benefits that these patients are getting from these exercise programs. The purpose of this study was to investigate the beliefs surrounding the use of large-amplitude functional movements in the treatment of Parkinson’s disease.

Number of Subjects: 88 survey respondents (62 therapists and 26 PwP) met the study inclusion criteria: practicing physical therapists who focus on the care of PwP or patients who have been diagnosed with Parkinson’s disease.

Materials and Methods: Links to an online survey were distributed to the physical therapists and clinical sites through personal email, members of the Academy of Neurologic Physical Therapy – American Physical Therapy Association, and posted on the social media pages of several online support groups for PwP. The survey consisted of 16 and 24 questions for therapists and PwP, respectively. The survey was designed to gather information about therapists and PwP use of large-amplitude functional movements and their beliefs about effectiveness of large-amplitude functional movements in managing signs and symptoms associated with Parkinson’s disease.

Results: 104 responses to the survey were recorded. 18 responses were discarded because either they did not meet the inclusion criteria or were incomplete. Of the 62 therapists, approximately 38% were certified specialist and practicing for >20 years. Nearly 92% of the clinicians utilized large-amplitude functional movements and about 80% thought of it to be more effective than other exercises. Approximately 92% of them agreed that patients respond positively to these exercises and improve on most of their symptoms however, there was no clarity on effectiveness of one technique over the other. Of the 26 PwP, nearly 85% of them indicated participation in the large-amplitude functional movement exercises and reported significant improvement in their severity of symptoms as a result of these exercises (p<.05). The improvements were most noted in health-related quality of life (84%), balance (69%), walking speed (65%), coordination (65%), strength (61%), and fall risk (50%).

Conclusions: Results from this survey highlight the beneficial effects of large-amplitude functional movements to reduce symptoms, restore function, and improve quality of life, with promise to slow disease progression in PwP.

Clinical Relevance: Therapists and PwP, both indicated amplitude focused functional movement training is safe and easy to use with many potential benefits, that include improved physical functioning, quality of life, balance, gait speed, and strength in PwP.
TITLE: Does Balance Correlate to Community Life in Individuals with Parkinson’s Disease?

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Degenerative Diseases SIG
AUTHORS: Jordana Christine Lockwich, Ling-Yin Liang, Patrick Harvey Kitzman

ABSTRACT BODY:
Purpose/Hypothesis: Identify the correlation between balance test scores obtained from the NeuroCom® and an individual’s community integration, quality of life and balance confidence.

Number of Subjects: Nineteen individuals with Parkinson’s disease living in the community were recruited for this study. Inclusion criteria included diagnosis of Parkinson’s disease from a physician, past medical history clear of any dual neurological conditions that may affect balance, the ability to stand independently for 30 seconds, and sufficient level of cognition to comprehend questionnaires. Excluded from the study were participants who exceeded the weight limit for the balance harness and individuals that could not obtain transportation to the site.

Materials and Methods: Participants completed three NeuroCom® balance tests including the Sensory Organization Test (SOT), Motor Control Test (MCT), and Adaptation Test (ADT). SOT assesses individuals’ ability to use visual, somatosensory, and vestibular systems for postural control. MCT assesses participants’ ability to maintain balance when exposed to sudden surface translations. ADT measures the ability to minimize postural sway when exposed to a sudden change in surface inclination. A higher SOT score indicates better balance performance. A higher MCT score indicates a longer response latency. A higher ADT score indicates less efficient balance control and higher sway energy is required to maintain balance. Three questionnaires were used to evaluate the functional level of the participants. Quality of Life was assessed using Parkinson’s Disease Questionnaire (PDQ). Lower scores of PDQ reflect better quality of life. Activities-Specific Balance Confidence (ABC) Scale evaluated confidence level in performing activities. A score of zero represents no confidence and a score of 100 represents complete confidence. Community Integration Questionnaire (CIQ) was administered to measure community integration of participants. A higher score represents greater independence and community integration. The Pearson product-moment correlation coefficients between balance performance and questionnaires scores were calculated.

Results: The results showed that SOT had a strong correlation to PDQ (r = -0.510) and ABC (r = 0.530). Participants with a better SOT balance performance had better quality of life and a higher confidence level in performing activities. A strong correlation was found between MCT and CIQ (r = -0.617). A prolonged response latency to a sudden surface translation was related to lower independence and community integration. ADT had a medium correlation to PDQ (r = 0.490) and ABC (r = -0.453). A higher sway energy was linked to a lower quality of life and lower confidence level in performing activities.

Conclusions: Our findings suggest that individuals with Parkinson’s disease who live in the community with poor balance performance demonstrate decreased community integration, quality of life, and balance confidence.

Clinical Relevance: Our study showed that individuals with Parkinson’s disease who have better balance performance also have improved community integration, quality of life and balance confidence. Interventions targeting balance such as training in unpredictable environments and uneven terrains may need to be incorporated with individuals with Parkinson’s disease to improve quality of life and community engagement after diagnosis.
TITLE: Barriers to Prescription of Aerobic Exercise By Physical Therapists for People with Neuromuscular Disease

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Degenerative Diseases SIG

AUTHORS: Kimberly Carter, Ann Coleman, PT, DPT, MSSW, Richard John Kasser, Kunal Singhal

ABSTRACT BODY:

Purpose/Hypothesis:
The Centers for Disease Control (CDC) has stated that 150 minutes of moderate intensity aerobic exercise per week is recommended for everyone but 56% of people with a mobility impairment get no aerobic exercise. Neuromuscular disease (NMD) is a heterogeneous group of disorders that cause functional limitations resulting in reduced physical activity and participation subsequently leading to increased risk of metabolic syndrome and other co-morbidities. Aerobic exercises are recommended by current guidelines and routinely prescribed for people with NMD by physical therapists (PT). Even though the research on benefits of aerobic exercises in this population is limited, it is essential to understand the barriers to exercise prescription as a first step in designing therapies that might be efficacious. A survey of PTs who work with this population will help determine how aerobic exercise is most commonly prescribed and barriers to prescription of aerobic exercise.

Number of Subjects: 35

Materials and Methods:
A cross-sectional web-based survey of licensed PTs that are practicing direct care in the United States or Canada and had evaluated a patient with neuromuscular disease in the last 12 months were eligible to complete the survey. The survey was developed after appropriate permission was obtained to adapt another survey on aerobic exercise prescription for current research. REDCap was used to deploy the survey and for data management. Percentages were determined from the respondents' answers for each question. Percentages were determined from the respondents’ answers for each question.

Results:
The survey had a total of 78 respondents with 35 completing the survey instrument. All the respondents were PTs performing direct care in a clinical setting with an average experience of 20 years, 39.2% were board certified neurologic specialists and the majority worked in an outpatient clinic setting. More than 60% of the respondents agreed that aerobic exercise should be incorporated in a treatment program irrespective of the diagnoses. Lack of exercise equipment (50%) was the biggest institutional barrier followed by lack of time. Fatigue level (52.4%) was the highest patient specific barrier. Concern about cardiac status (58.8%) and medical stability (52.9%) were the biggest safety barriers.

Conclusions:
This research is the first attempt at understanding potential barriers to aerobic exercise prescription in people with NMD. Lack of proper exercise equipment is the biggest institutional barrier, even though, most research recommends specialized equipment and accessible fitness facilities with swimming pools. Median weekly frequency and duration of aerobic exercise does not meet the CDC guidelines which is likely due to the next most selected institutional barrier of lack of time.

Clinical Relevance:
Despite the lack of specific parameters, lack of accessible equipment and lack of time, PTs are prescribing aerobic exercise for most patients with NMD. In the short term, institutional barriers can be resolved by working with community facilities.
Purpose/Hypothesis: Gaining a greater understanding of the associations between different brain regions, dual task (DT) performance, and gait/balance is an important part of understanding the pathophysiology of dementia. Therefore, our purpose was to explore how motor and cognitive brain volumes were associated with the following:

1. motor dual task effect (mDTE) - change in motor performance while performing a cognitive task;
2. cognitive DTE (cogDTE) - change in cognitive performance while performing a motor task;
3. combined DTE (cDTE) - change in combined motor and cognitive performance while performing a dual task;
4. modified attention allocation index (mAAl) – quantification of the amount of motor or cognitive task prioritization; and,
5. gait and balance performance.

Number of Subjects: 166 individuals with CI (mild cognitive impairment or dementia).

Materials and Methods: We performed a retrospective analysis of data from patient records. MRI sequences were obtained on a Siemens TIM Verlo 3T scanner. Volumetric data were generated by NeuroQuant®. DT measures (i.e., mDTE, cogDTE, cDTE, mAAl) were calculated using the Timed Up and Go cognitive with serial subtraction by three. Gait and balance measures included the Mini-BESTest, Five Times Sit to Stand, 10 Meter Walk Test (preferred and fast), and the 6 Minute Walk Test.

Results: Greater cogDTE was associated with decreased volume in both motor and cognitive relevant brain regions. While mDTE was not consistently associated with cognitive relevant brain volumes, greater mDTE was associated with slightly larger motor brain areas. The pattern of association of the cDTE and brain volume was similar to cogDTE. mAAl associations indicate that as brain volumes decreased DT performance became more motor prioritized. cogDTE is more strongly associated with performance on measures of gait and balance compared to mDTE. Decreased gait and balance performance were associated with greater motor task prioritization.

Conclusions: cogDTE appears to be the primary driver of loss of automaticity when compared to the mDTE in those with CI. Smaller motor and cognitive brain region volumes and decreased gait and balance performance are associated with motor task prioritization in those with CI, which is in contrast to healthy older adults. While many of our findings were expected and in line with other research, the unexpected positive correlation between motor brain volumes and mDTE suggests a complicated interaction among brain regions, pathophysiology, and gait/balance in this population. In addition, our results suggest that as the disease progresses and there is a decrease in motor and cognitive brain volumes, motor prioritization becomes the dominant strategy during DT conditions.

Clinical Relevance: Change in gait speed is often used as the primary outcome measure for dual tasking. Our findings suggest that cogDTE may have a stronger association with gait and balance ability for individuals with CI. Based on our findings, we suggest that clinicians measure cognitive performance during dual tasking in addition to motor performance.
ABSTRACT BODY:
Background and Purpose: Recent data suggests that 87.6% of individual with Parkinson’s Disease have reported complaints of low back pain (1). Of these individuals, less than 20% reported receiving treatment for their pain. Individuals with pain are more than twice as likely to have balance impairments, live a more sedentary lifestyle (2) and show a significant reduction in quality of life assessments (3). Interventions including amplitude training, strengthening and stretching are well documented treatments to address typical Parkinson’s related impairments but have not demonstrated efficacy in pain reduction (4,5,6). Manual therapy has been shown to be beneficial in reducing disability and pain in addition to improving range of motion and quality of life in individuals with neck and back pain (7,8). However, relatively little evidence is present regarding the benefits of this type of treatment in those with neurologic diagnoses. The purpose of this case series is to demonstrate the feasibility of the addition of manual therapy in the treatment of two individuals with Parkinson’s disease.

Case Description: Two individuals were treated in an outpatient physical therapy setting. Both individuals were clinically diagnosed with Parkinson’s Disease (PD) and also reported complaints of low back and neck pain. Both individuals demonstrated forward flexed posture, limited spinal range of motion and truncal strength deficits. Throughout the course of treatment, pain was rated using the Numeric Pain Rating Scale (NPRS). Upon evaluation, both individuals were determined to be high fall risks based on scores from the Modified Clinical Test of Sensory Interaction in Balance (mCSTIB) and the Mini Balance Error Systems Test (mini-BEST). At the beginning of each treatment session, each patient received manual therapy treatment consisting of soft tissue mobilization, thoracic and cervical mobilizations and/or thoracic manipulation based on individual clinical presentation. The patients then participated in active interventions including amplitude training, balance training, strengthening and mobility exercises.

Outcomes: Patient One was seen for 16 visits while Patient Two was seen for 23 visits during the course of their plan of care. Patient One demonstrated a 50% improvement in cervical and lumbar extension and rotation while Patient Two demonstrated a 50% improvement in cervical and lumbar extension and 40% improvement in cervical and lumbar rotation. Back and neck pain also completely resolved for both individuals based on NPRS scoring. Both patients exhibited clinically significant improvements in all 6 strength tests as well as an average improvement of 18 seconds on the mCTSIB and 9 points on the mini-BEST.

Discussion: Both patients reported subjective reduction in pain in addition to objective improvements in range of motion following manual therapy intervention that exceeded the minimal clinically important difference for each measure. The reduction in pain and improved range of motion enabled increased tolerance of the subsequent active interventions that followed the prescribed manual therapy. In addition, range of motion, strength, pain and functional mobility all improved significantly and were maintained at discharge. In addition, both patients were no longer classified as fall risks based on outcome measures assessed. The outcome of this case series suggests that manual therapy may be a viable adjunct treatment for patients with Parkinson’s disease and postural dysfunction. However, more research needs to be conducted to demonstrate efficacy in treatment.
Title: Qigong to Improve Sleep Quality and Inflammation in People with Parkinson’s Disease: Potentials and Challenges

Current Section: Neurology
Current Sub-Category: Degenerative Diseases SIG

Authors: Sanghee Moon, Caio V. M. Sarmento, Michael Clark Steinbacher, Sue M. Lai, Yvonne Marie Colgrove, Kelly E. Lyons, Irina V. Smirnova, Wen Liu

Abstract Body:
Purpose/Hypothesis: Non-motor symptoms (NMS) such as sleep disorders, anxiety, depression, fatigue, and cognitive decline are commonly reported by people with Parkinson’s disease (PD). Past studies showed that Qigong, a mind-body exercise, may alleviate symptoms, improve inflammation status, and increase quality of life in a variety of medical conditions. However, the lack of evidence from randomized controlled trials makes healthcare professionals hesitant to recommend Qigong exercise to people with PD. The purpose of this study was to examine potential benefits of Qigong exercise on NMS and inflammatory status in people with PD.

Number of Subjects: 32

Materials and Methods: Participants with mild to moderate PD (Hoehn and Yahr stage I to III) were randomly assigned in Qigong (experimental, n=16) or sham Qigong (control, n=16). Each arm received 12 weeks of either Qigong or sham Qigong intervention. Clinical questionnaires, neuropsychological tests, and activity monitoring were used to assess sleep quality (primary outcome) and other NMS. The serum levels of inflammatory biomarkers (IL1β, IL6, TNFα) were measured using a high-sensitivity antibody-based multiplex assay.

Results: A total of 17 participants (Qigong (n=8); sham Qigong (n=9)) completed the study, while 15 participants (Qigong (n=8); sham Qigong (n=7)) withdrew during the intervention period. After 12 weeks of intervention, the Qigong group showed significant improvement in sleep quality (p < 0.05) and overall NMS (p < 0.05). Similar results in sleep quality (p < 0.05) and overall NMS (p < 0.05) in the sham Qigong group were found, but no significant difference was observed between groups. The levels of IL1β and IL6 showed trends to decrease in the Qigong group after 12 weeks, with no significant difference between groups. A further analysis showed moderate to strong correlations between changes in the levels of IL1β and sleep quality.

Conclusions: Qigong exercise may help alleviate sleep disorders and other NMS in people with PD, but more randomized controlled trials with larger sample sizes are needed. A high withdrawal rate (47%) in this study may be due to a cognitive impairment such as memory loss that could affect the participants’ learning and practicing the Qigong exercise. We observed low intervention fidelity in some participants even at the end of the intervention period. Future studies should address issues related to participants’ limitations and improve fidelity of the intervention. Furthermore, the underlying mechanism behind the effect of Qigong exercise remained unclear, even though changes in IL1β levels correlated significantly with improvements in sleep quality. Further studies need to more rigorously explore the role of inflammatory biomarkers.

Clinical Relevance: NMS can significantly impact quality of life in people with PD. Current treatment options for PD are primarily focused on the treatment of motor symptoms. Qigong exercise may be a safe and cost-effective approach to improve NMS in people with PD.
Purpose: Idiopathic Normal Pressure Hydrocephalus (iNPH) is a neurological disorder characterized by a clinical triad of symptoms including urinary incontinence, dementia and gait dysfunction associated with ventriculomegaly in the exclusion of other underlying causes. The primary treatment for iNPH begins with a cerebrospinal fluid (CSF) diversion trial to assess improvement in symptoms. If improvement occurs, the insertion of a ventriculoperitoneal shunt (VPS) may be indicated. However, not every patient with this triad responds well to VPS insertion and the procedure has a risk of post-surgical complications that could lead to more mobility deficits. The purpose of this framework was to include outpatient neuropsychology and physical therapy (PT) assessments to screen patients prior to admission for CSF diversion trial. These evaluations provide patients and families with education, resources and alternative options if the CSF diversion trial does not improve their symptoms. This framework aims to utilize evidence based tools to determine the impact of CSF diversion on gait and mobility for potential VPS placement.

Description: The interdisciplinary team consists of neurosurgery (NS), neuropsychology, and PT. The extensive screening evaluations occur at the outpatient clinic, before inpatient admission. This novel concept has allowed PT and Neuropsychology to assist with determining if patients are appropriate for admission for a CSF diversion trial. The outpatient evaluations identify any baseline impairments a patient may have or any barriers that may prevent them from returning home after hospital admission. Prior to admission, PT completes the 10 Meter Walk Test, Timed Up & Go, Tinetti Performance Oriented Mobility Assessment and Berg Balance Scale. Once admitted, the patient is seen by PT and Neuropsychology, with improved efficiency for both providers and patients due to previous outpatient assessment. PT follows the patient for 4 days during admission for CSF diversion, repeating the same tests; Neuropsychology re-assesses on day 4. These providers consult with the NS team to assist with determining candidates for VPS placement.

Summary of Use: This novel approach presents the framework for an interdisciplinary team to collaborate on the evaluation of patients with iNPH who may be admitted for a CSF diversion trial. Since our implementation in September 2018, 22 patients have gone through the outpatient evaluation program, 18 have been admitted for CSF diversion trial and 10 have received a VPS. 1 has completed a 6 month follow up.

Importance to Members: Inclusion of an outpatient PT assessment for patients with probable iNPH can play a role in the screening, discharge planning and education prior to hospital admission and creates an immediate fall risk action plan with recommendations to optimize patient outcomes regardless of response to CSF diversion.
Purpose/Hypothesis: This Systematic Review compares the efficacy of pharmacotherapy (PH) to mirror therapy (MT) for the treatment of phantom limb pain (PLP) in an outpatient setting.

Number of Subjects: Ten randomized and quasi-randomized controlled trials were included in this systematic review. Seven of these articles investigated the efficacy of MT and three evaluated PH.

Materials and Methods: Our search in the PubMed and CINAHL databases yielded 281 articles. Following a systematic screening process, we identified 271 articles that were either duplicates or did not meet our inclusion criteria, leaving ten articles remaining. The authors performed an independent meta-analysis for each intervention category, pooling the effect sizes of all articles that reported the necessary data. We used the PEDRO scale to assess the quality of each article.

Results: Study population sizes varied from 3-180 participants and contained more males than females. The mean age of participants ranged from 33 to 66. All studies examined pain with either the Numeric Rating Scale or Visual Analog Scale. The meta-analysis showed large effect sizes for reducing pain in both the MT and PH groups. Of the MT articles, the studies that had longer and/or more frequent sessions, as well as a higher baseline level of education within the patient population yielded larger effect sizes. The pooled effect of the four MT studies included in the meta-analysis was 0.901. The pooled effect size of the two drug studies included was 2.167, however, this was accompanied by a large confidence interval encompassing zero (CI= -1.48-5.81). The effect size of the drug mexiletine was small (.2740) while the effect size of morphine was large (4.079). While morphine had the greatest effect size, many participants experienced undesirable side effects, whereas there were few reports of adverse side effects in the MT articles. Removing the effect of morphine from the data, the MT pooled effect size was greater (0.901) than the remaining PH effect size (0.274).

Conclusions: Results showed large effect sizes for reducing pain in both the MT and PH groups demonstrating both treatment categories should be considered effective in treating PLP. It appears, however, those who wish to treat their PLP must choose between greater time and emotional investment with MT versus the unpleasant side effects of PH. Therefore, we conclude that the treatment of PLP calls for a holistic, patient-centered plan of care that takes into account lifestyle, motivation and patient goals. MT should be considered a frontline treatment option for patients with the education and time to implement it.

Clinical Relevance: In light of today's opioid epidemic, there is a need and obligation to explore successful pain-relieving treatments that do not come with the risk of addiction. This review is the first to directly compare two common interventions used in the management of PLP. Our findings call attention to MT as an intervention that should be considered an effective, low risk alternative to opioid-based pain relief in patients with PLP.
Background and Purpose: Recent research has demonstrated the benefits of exercise to facilitate recovery after a concussion. Multiple types of active treatments including sub-threshold aerobic exercise, cervical, vestibulo-ocular and cognitive therapies have shown to be beneficial in concussion recovery. However, the populations in these studies are primarily limited to sports-related concussion. Evidence is limited regarding the efficacy of rehabilitation in the non-athlete, specifically for concussions sustained via motor vehicle accident. As a result, the purpose of this case series is to illustrate the feasibility of an irritability based approach to rehabilitation of non-sports related concussion.

Case Description: Eight individuals were seen in an outpatient physical therapy setting for treatment of concussion from June 2017 to January 2019. The patients had an average age of 35.5 years and included six females and two males. All eight individuals sustained his or her concussion due to a motor vehicle accident. The average time between concussion and initiation of physical therapy intervention was 178.13 days. Each individual completed a six phase irritability based treatment algorithm consisting of exertional, cervical, vestibulo-ocular and manual therapy components to match his or her individual symptom profile. Irritability was classified based on severity of symptoms and level of provocation of symptoms with testing or intervention. Irritability level was determined independently for each individual category symptoms: cervical, vestibulo-ocular and physiologic in order to tailor the intervention to each patient’s individual deficits.

Outcomes: All patients demonstrated cervical, vestibulo-ocular and balance impairments on initial evaluation. Upon completion of therapy, all patients demonstrated full resolution of subjective symptoms. In addition, all individuals improved beyond minimally clinically important difference (MCID) of the Balance Error Scoring System (BESS) with an average improvement of 19.25 errors. All patients cleared the Buffalo Concussion Treadmill Test upon discharge. Focus on Therapeutic Outcomes (FOTO) scores matched subjective and objective improvements with a mean discharge score of 91.38, an average improvement of 30.5 points. Each individual significantly exceeded the average predicted clinical change of 16.5 points for the outcome measure. In addition, all individuals subjectively reported a full return to all prior activities without limitations at discharge.

Discussion: All patients demonstrated resolution of subjective and objective impairments at discharge. The outcomes of this case series suggest that the use of an irritability-based approach may be feasible in treating individuals with non-sports related concussion, though more research is needed to validate these findings.
TITLE: Feasibility and Effectiveness of Destination Rehab's Adventure Group Program  
CURRENT SECTION: Neurology  
CURRENT SUB-CATEGORY: General  
AUTHORS: Carol-Ann Nelson, Evan T. Cohen  
ABSTRACT BODY:  
Purpose/Hypothesis: Individuals with neurologic conditions often become isolated from their community, spending significant time at home doing sedentary activities. Increasing physical activity and decreasing sedentary time are important recommendations for those with chronic conditions. Self-efficacy and social support also play a critical role in improving participation. Destination Rehab’s Adventure Group (AG) was created to improve confidence, independence and community participation through a group program for adults with neurologic conditions. Our purpose was to describe feasibility and effects of the AG program on self-efficacy related to balance, falls and community integration.  
Number of Subjects: Nine participants (age range 40-79) took part in the program. Four had Parkinson’s disease, three had stroke, one with corticobasilar degeneration, and one had cervical dystonia.  
Materials and Methods: The AG intervention occurred bi-monthly for 7 months and included multiple facets. The program was run by a Physical Therapist with volunteer support from local rehabilitation professionals. Sessions included participant education, peer support, and physical activity aimed at enjoying the great outdoors. All activities were chosen and prioritized by the group at the start of the program. Activities included hiking, kayaking, biking, and others. Pre- and post-intervention measurements included the Activities-Specific Balance Confidence Scale (ABC), Falls Efficacy Scale (FES), and Community Integration Questionnaire (CIQ). Due to the small number of participants, descriptive statistics were used to examine program effectiveness.  
Results: The intervention is feasible. Seven participants completed the 7-month-long program. Attrition was due to health factors unrelated to the AG intervention. Attendance was >80% for those who completed the program. Participant feedback was overwhelmingly positive. Costs were approximately $5,000 and included staffing, supplies, meeting space, and outdoor equipment. These costs were covered by a Pro Bono Incubator Grant from Move Together. No safety issues related to the AG program occurred. Outcome data was incomplete for some participants. 5 of 6 participants had improvements in the ABC (mean change 10.5), while 1 had a decline. 3 of 6 participants had improvements in the FES (mean change 12.3). 4 of 5 participants had improvements in the CIQ (mean change 2.9).  
Conclusions: The AG was a feasible intervention for the mixed population. Positive trends in self-efficacy and participation were observed. These indicate that this intervention should be further studied through formal experimentation.  
Clinical Relevance: The application of the AG model may be a useful way to engage people in the rehabilitation process through the judicious application of peer support and enjoyable outdoor activities. Physical Therapists should consider applying similar elements, as appropriate, into the intervention plans for their patients.
Cervical dystonia is a chronic neurological condition that results in involuntary contraction of muscles in the head, neck, and shoulders. Deep brain stimulation is generally used for severe cases of cervical dystonia that have failed conservative treatment. Little is known about self-reported quality of life for patients with cervical dystonia after receiving deep brain stimulation. This case report describes the effect of deep brain stimulation combined with post-surgical physical therapy intervention.

Case Description:
The subject is a 39 year female who originally presented to physical therapy after one month of insidious onset of neck pain and spasms after transferring to a desk job. Patient reported pain with all movements of the head and neck with pain rating of 8/10. Neck spasms and pain limited work and home activities. During the course of one year of conservative physical therapy the patient also received baclofen, a TENS unit, botulinum toxin injections, and cervical spinal fusion of C3-6. She was also diagnosed with anxiety and depression disorder. After one year of no significant change of pain or spasms, consultation with a movement disorders clinic lead to a diagnosis of cervical dystonia. Due to failure to respond to conservative therapy the patient was determined to be a candidate for surgical intervention and underwent deep brain stimulation to bilateral globus pallidus internus. Post-surgical physical therapy focused on maximizing function. Six week intervention included relaxation and soft tissue work, AROM, stretching and a progressive strengthening program of cervical and thoracic musculature. Dosage was determined by fatigue. Exercises progressed from gravity assisted or minimized positions to all exercises performed in sitting with focus on strengthening and endurance.

Outcomes:
Primary outcomes measures included the neck disability index (NDI) and the craniocervical dystonia questionnaire (CDQ-24). Over the course of 6 weeks, the patient showed a change in score of 12 points on the NDI which surpasses the MDC value (8.4 points) and the MCID value (3.5 points). Greatest changed were reported in categories related to pain intensity, reading, working, sleeping, and headaches. The CDQ-24 is a disease specific questionnaire that is able to assess quality of life in people suffering from cervical dystonia. A high score (maximum of 100) indicates poor quality of life. Overall the patient's score show a change of 30 points. Most significant reported changes were in categories related to stigma, emotional well-being, and social/family life. There are no known values related to MDC or MCID for the CDQ-24, therefore it is not possible to make judgments as to whether changes are statistically meaningful.

Discussion:
The changes seen in the NDI and CDQ-24 paralleled the improvements seen in the patient's cervical strength and reduction of forward head posture. The impairment progress translated into self-reported improvement during work and activities of daily living. The findings of this study are consistent with current literature. Deep brain stimulation has been shown to have a beneficial influence on the degree of disability and severity of cervical dystonia. There is limited research available on the effects of physical therapy as an adjunct intervention post deep brain stimulation. It is suggested that a combination deep brain stimulation and PT can enhance recovery and improve functional strength, patient posture, and quality of life. Future work should also include effects on depression and anxiety.
TITLE: Movement Quality: A Novel Biomarker Based on Principles of Neuroscience
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: General
AUTHORS: Daniele Piscitelli, Mariusz P. Furmanek, Stanislaw Solnik
ABSTRACT BODY:
Purpose:
To introduce a novel biomarker of movement coordination and stability based on principles of motor control. Specifically, we propose an innovative application within the theoretical framework of the Uncontrolled Manifold (UCM) hypothesis, to objectively measure movement quality in everyday clinical practice.
Description:
Movement stability and coordination are important features of everyday motor actions. These features allow reacting to continuously changing environment or to resist unpredictable external perturbations. Neurological or musculoskeletal disorders affect stability and coordination, leading to functionally impaired movements (i.e., object dropping) or compromised movement safety (i.e., increased risk of falling). One of the current problems in physical therapy practice is the lack of objective outcome measures to assess movement quality such as coordination and stability. Recent neurophysiological findings suggest that the central nervous system (CNS) organizes motor elements (ME, such as muscles, joint angles, finger-tip forces, etc.) into task-specific ensembles to stabilize motor tasks (MT). A method to quantify this feature has been developed based on the UCM hypothesis. Briefly, UCM analysis uses inter-trial analysis to estimate two components of variance that do and do not affect a specific MT. The relative ratio of these two components is used to compute the index of stability (DV). Since this analysis provides only one DV estimate per subject, its current use is limited to experiments that require many subjects to generate a distribution of variance parameters for group comparisons. Therefore, we propose a novel use of bootstrapping estimation that allows quantifying movement quality using UCM for a single individual.
Summary of Use:
In this secondary study design, we reanalyzed previously published data from healthy control and individuals with Parkinson disease (PD) performing a wide range of MTs, i.e., multi-digit pressing and postural balance tasks. First, we estimated individual DVs for both healthy and individuals with PDs. Second, for each person, we generated a distribution of simulated DVs using a bootstrapping method. Third, we compared the experimentally obtained DVs with simulated distributions, to quantify task-stabilizing strategies of the CNS. Our findings have shown that the individually estimated UCM parameters were reliable to identify motor quality impairments in subjects with PD. Moreover, our individual analysis results were consistent with group differences (control vs. PD subjects), reported in previous publications.
Importance to Members:
Potentially this method will allow translating novel principles of motor control from theoretical neuroscience and experimental findings to physical therapy practice. UCM may be incorporated into clinical assessment and track movement quality recovery over time. Overall, measuring stability and movement quality by means of UCM may help the development of new treatment strategies based on neural control of movement. To this end, our findings are filling the gap between neuroscience and clinical practice.
Intensive Mobility Training for an Individual with West Nile Neuroinvasive Disorder: A Case Report

Background and Purpose: West Nile Virus (WNV) is an infectious disease in which most infected individuals are asymptomatic\(^1\). In rare cases the virus invades the central nervous system\(^2\) and can result in encephalitis, meningitis, or acute flaccid paralysis\(^3\). Many individuals with West Nile neuroinvasive disease (WNND) require rehabilitation\(^4\), however there is limited evidence for their physical therapy management. Two case reports\(^5,6\) detail physical therapy interventions provided for patients with asymmetric muscle weakness due to WNND in an outpatient setting. The purpose of this report is to describe physical therapy management for a patient with asymmetric muscle weakness due to WNND in an inpatient rehabilitation setting.

Case Description: A 68-year-old female presented to inpatient rehabilitation 4 weeks after onset of WNND. The patient had undergone a heart valve replacement 5 weeks prior and returned to the emergency department 8 days later with nausea and vomiting. The patient progressively became lethargic and developed acute flaccid paralysis in both upper and lower extremities.

Outcomes: Upon initial examination, left lower extremity strength was grossly 1/5 and right lower extremity strength was 2-/5 throughout all major muscle groups. The patient also presented with flaccid tone in all major lower extremity muscle groups and bilateral patellar reflexes were absent. The patient required minimal assistance to maintain static sitting balance, maximal assistance for bed mobility, total assistance for transfers, and was non-ambulatory. Physical therapy intervention consisted of 4 weeks (90 minutes a day 5-6 days a week) of intensive therapy focused on mobility training including bed mobility, transfer training, body weight supported treadmill training, and body weight supported over-ground gait in addition to progressive open and closed kinetic chain lower extremity strengthening. Following 4 weeks of inpatient rehabilitation patient was discharged home, demonstrating improved strength and functional mobility. Lower extremity strength improved to grossly 2-/5 in left lower extremity and 3-/5 in right lower extremity. At time of discharge patient was independent with all bed mobility, transferred using a slide board with contact guard assistance, and performed sit to stand transfers with moderate assistance. Patient also ambulated 15 feet with the use of an overhead harness system and minimal assistance. However, due to continued gait deficits, the patient was discharged home with an ultralight weight wheelchair to be used for household and community mobility.

Discussion: WNND is a rare neurologic disorder that can be difficult for therapist to treat due to the lack of evidence supporting the efficacy of physical therapy. This case report supports the use of aggressive mobilization for motor recovery after WNND.
SYSTEMATIC REVIEW OF RHYTHMIC AUDITORY STIMULATION EFFECT ON GAIT VELOCITY IN ADULTS WITH NEUROLOGICAL DISORDERS

ABSTRACT BODY:
Purpose/Hypothesis: Re-acquiring or modifying ambulation is a main focus area of PT’s in people with neurological system disorders. There is scant literature on how to best structure knowledge of performance augmented feedback (AF) during intervention to promote motor learning and neuroplasticity. The use of rhythmic auditory stimulation (RAS) creates an external focus of attention and is a primer/initiator/referenced target to guide rhythmic footfall. As gait velocity (GV) is used to measure change and provide other vital information, literature supports immediate gait velocity performance increases using RAS but there is a gap regarding motor learning effects. The purpose of this review is to explore GV related to motor learning using RAS during ambulation intervention in patients with neurological system disorders, including reporting confidence intervals (CIs) and meaningful clinical change to clarify the clinical significance of RAS.

Number of Subjects: Total adult subjects included 212 with PD, 86 with stroke, 22 with CP, 14 with MS, and 5 with PSP.

Materials and Methods: A comprehensive literature search following the PRISMA guidelines was conducted in 4 databases using keywords related to rhythmic stimulation, auditory cues or feedback, and gait/ambulation. Inclusion criteria were: publication date 1/1/09-4/1/19 and English language; adult subjects with primary neurological disorders who were ambulatory without physical assist; outcome measure of GV; RAS during steady state or advanced ambulation interventions; and RCT or quasi-experimental study. Methodological quality was assessed using PEDro scores and a clinical relevance scale. Data was extracted and mean GV change with CIs between and within the experimental groups were calculated.

Results: 15 RCT and 6 quasi-experimental studies were included. PEDro score ranged from 4-7. Mean intervention time was 30 minutes, with a mean frequency of 4.7 sessions/week, for a mean of 5.6 weeks. A meaningful clinical change cut-off of 0.10 m/s was used and met by 33.3% between and 66.7% within experimental groups. Comparing CIs to mean GV change found 23.8% of studies had change >0.10 m/s that fell outside the CI.

Conclusions: Although there was a trend towards RAS improving GV for meaningful change after intervention, CI interpretation considers large variability and therefore reduces the validity of the findings, likely due to small sample sizes and pilot studies data. Limitations of this review include combining heterogeneous populations, variations on RAS protocols, and lack of long-term retention data as a measure of motor learning. In conclusion, lower quality and underpowered studies included in this review limit the ability to support RAS to retain improved GV as an indicator of motor learning.

Clinical Relevance: This review has limited ability to support RAS in improving gait velocity over time as an indication of motor learning in degenerative and non-degenerative neurological system disorders. This information can help PT’s make decisions about using RAS during ambulation intervention.
ABSTRACT BODY:

Purpose/Hypothesis: The purpose of this study was to examine the acute effects of a cooling vest on gait speed, stride length, and step cadence while performing cognitive-motor dual-tasks with persons with multiple sclerosis (PwMS).

Number of Subjects: Thirteen participants with relapsing-remitting and primary progressive multiple sclerosis (Age: 56±7.58 years)

Materials and Methods: Data were collected in two sessions scheduled one week apart. During the first session participants wore a cooling vest with frozen ice packs and completed a cognitive-motor dual-task (story-telling and 6 Minute Walk Test). In the second session participants wore the vest with unfrozen ice packs (to maintain the weight of the vest) and completed the same dual-task. The dual task consisted of participants engaging in conversation from a standardized list of questions with an examiner during the 6MWT. Participants wore APDM Opal sensors during 6MWT. Gait speed, stride length, and step cadence were calculated. Paired samples t-test were utilized to analyze the effect of the cooling and control conditions on gait parameters.

Results: Stride length was significantly greater with cooling vest (Cooling: 1.02±.260m; Non-cooling: 1.00±.28m; p=.05). Gait speed was also greater while wearing a cooling vest with a trend towards significance (Cooling: .93±.35m/s; Non-cooling: .90±.37m/s; p=.072). Cadence was similar between the conditions (Cooling: 107.41±21.10 steps/min; Non-cooling: 105.89±20.90 steps/min; p=.083).

Conclusions: Preliminary results suggest that in PwMS, the acute effects of a cooling vest may improve gait speed and stride length, but not step cadence while dual-tasking. Further research with a larger sample size is needed to confirm these results.

Clinical Relevance: Heat sensitivity is a commonly reported symptom of multiple sclerosis that may lead to a pseudoexacerbation [1]. Heat stress may affect both walking and cognitive performance in PwMS [2,3]. Cooling modalities, including cooling vests, have long been used for ADLs, exercise and rehabilitation with PwMS. However, no current studies have investigated the effects of a cooling vest on dual task performance in PwMS. Being able to walk and perform a cognitive task is an integral part of daily living and rehabilitation. PwMS have demonstrated increased difficulty with dual-tasking, which has been reported to worsen gait impairments [4] and increase fall risk [5]. Previous research has also reported positive correlations between both dual-task cost stride length and dual-task cost gait speed with fall risk [5]. The results of the current study suggest that a cooling vest may acutely improve stride length and gait speed while dual-tasking. Given the current knowledge of heat sensitivity and increased difficulty with cognitive-motor dual-tasks, investigating the effects of a cooling vest on dual-task performance may provide more information on the benefits of using cooling technology to decrease fall risk and improve functional outcomes in rehabilitation.
Purpose/Hypothesis: Chronic headaches affect many adults in the United States, with a debilitating impact on quality of life. Self-efficacy, or the ability to manage and control headaches, in patients with chronic headaches is low. Defining the specific elements of self-efficacy in patients with chronic headaches has not previously been measured. A patient-reported measure entitled the Chronic Headache Self-Efficacy Scale (CHASE) has been developed, but measurement properties have not been examined. The purpose of this study is to evaluate the psychometric properties of CHASE.

Number of Subjects: Participants (n=22; 3 males, 45±14 years of age) diagnosed by a neurologist with chronic headache or chronic migraine were recruited from physical therapy and neurology headache clinics. Exclusion criteria include history of concussion, post-concussion syndrome, and inability to understand/read English.

Materials and Methods: Participants completed the CHASE, Headache Management Self-Efficacy Scale (HMSE), Headache Impact Test-6 (HIT-6), Global Rating of Change (GROC), and Patient Acceptable Symptom State (PASS) at three time points: initial encounter, post-24 to 72 hours, and post-12 weeks. The HIT6 measures the ability an individual affected by headaches has to function on the job, at school, at home, and in social situations. The HMSE measures self-efficacy of the psychosocial aspects of headache management. The CHASE is a 14-item patient-report scale assessing self-efficacy of headache management and belief in the ability to perform daily activities without causing or increasing a headache in individuals with chronic headaches. The 14 items are scored on a 5-point Likert scale (0=no confidence, 4=complete confidence; total score 0-100, 100=high positive self-efficacy). Reliability of the total score of the CHASE was measured using Interclass Correlation Coefficient (ICC3,1), which was then used to calculate the Standard Error of the Measurement (SEM) and Minimal Detectable Change at the 90% confidence interval (MDC90). Validity was assessed by measuring the relationship between the CHASE and two headache-specific questionnaires (HIT6 and HMSE) at T3. Further, the relationship between the change in CHASE score and the change in HIT6 and HMSE scores from T1 to T3 was calculated. Responsiveness of the CHASE was measured 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. A receiving operating curve was used to calculate the minimal clinically important difference (MCID) of the CHASE.

Results: The CHASE total score was T1: 42±11 points, T3: 59±20 points. The ICC3,1 =0.87(CI: 0.62,0.96); SEM=7.3 points; MDC90=16.9 points. At T3, there was a strong relationship between the CHASE and the HIT6 (r=0.68, p<0.01) as well as the CHASE and the HMSE (r=0.70, p<0.01). There was a moderate relationship between the change in CHASE score from T1 to T3 and the change in HIT6 score (r=-0.41, p=0.06) and HMSE score (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, 95%CI=-15.9, -6.3, p<0.01) and CHASE (MD=26.7, 95%CI=12.8, 40.6, p<0.01), but not on the HMSE (MD=16.9, 95%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 and acceptable validity, error, and responsiveness when compared to other reliable and valid headache-based outcome measures (HIT6, HMSE). Participant recruitment continues in order to fully assess reliability, validity, measurement error, and responsiveness of the CHASE.

Clinical Relevance: Low levels of self-efficacy are associated with higher levels of disability in people with chronic headache. Identifying specific areas of low self-efficacy in patients with chronic headaches will assist the ability to self-manage headache episodes and help provide directed interventions towards improving management of chronic headaches.
**TITLE:** The Contribution of Use-Dependent Plasticity to Locomotor Learning  
**CURRENT SECTION:** Neurology  
**CURRENT SUB-CATEGORY:** General  
**AUTHORS:** Jonathan Martin Wood, Hyosub E. Kim, Darcy Schwartz Reisman, Susanne M. Morton  

**ABSTRACT BODY:**

**Purpose/Hypothesis:** Teaching clients to learn or re-learn movements is an important aspect of rehabilitation. Neurologic diseases often impair one or more forms of motor learning, but less impaired forms may be leveraged to improve movement. However, there is a gap in our understanding of what forms of learning exist for locomotion. To date, locomotor learning has primarily been studied in the form of sensorimotor adaptation (SMA; learning from a sensory prediction error). Here, we sought to determine if individuals can learn and store a new walking pattern using a form of learning not previously investigated in locomotion: use-dependent plasticity (UDP; learning from repetition).  

**Number of Subjects:** Twenty young, healthy individuals, randomly assigned to a SMA+UDP or UDP learning group.  

**Materials and Methods:** Participants walked on a treadmill while watching real-time visual feedback of their step lengths on a monitor. Step lengths were represented as two vertical bars which increased in height as each foot advanced during swing phase. Subjects were instructed to ‘hit’ a horizontal target line with each step. The paradigm consisted of three phases: Baseline (6 minutes), where subjects were familiarized with the visual feedback, Learning (22 minutes), where subjects used the visual feedback to learn a new 11% step length asymmetry, and Washout (22 minutes), where subjects were instructed to walk normally with no visual feedback. The Washout phase was expected to generate aftereffects, or sustained walking asymmetry, indicating storage of the newly learned pattern. The SMA+UDP group received distorted feedback to induce a sensory prediction error in addition to stepping repetition. The UDP group was provided with true feedback of step lengths with asymmetric targets to drive repetition of stepping without a sensory prediction error. The primary outcome was step asymmetry index, measured as \((\text{long leg step length} - \text{short leg step length})/\text{stride length}\). To assess the contribution of UDP to learning, we compared step asymmetry indices between groups at late Baseline, late Learning and early Washout.  

**Results:** Both groups learned the new stepping asymmetry to a similar degree (UDP+SMA, 9.8% ± 1.4; UDP, 9.3% ± 1.9; \(p=0.50\)) and demonstrated significant aftereffects that exceeded baseline asymmetry (both, \(p<0.001\)), indicating storage of the newly learned pattern. However, there were no differences in aftereffect magnitudes between the SMA+UDP and the UDP groups (\(p=0.97\)).  

**Conclusions:** UDP can elicit storage of a new walking pattern. The fact that aftereffects were no different between SMA+UDP and UDP groups suggests that repetition, rather than visual sensory prediction error, is the critical element for storage of learning in this visually driven locomotor learning paradigm.  

**Clinical Relevance:** The study demonstrates a new way humans can learn new walking patterns and highlights the importance of repetition over sensory prediction errors in this form of motor learning. Further studies must test if people with neurological deficits can use this type of learning to affect gait asymmetry.
Purpose/Hypothesis: To describe clinical practice experiences with robotic gait training (RGT) during inpatient rehabilitation.

Number of Subjects: 10 Ekso trained physical therapists.

Materials and Methods: Therapists completed a survey and participated in a semi-structured focus group interview to discuss their experiences with patients using RGT. Interviews were recorded, transcribed, and analyzed for reoccurring themes using a theoretical analysis-driven thematic approach.

Results: Therapists averaged 7.6 years (range=2–18) of neurologic rehabilitation experience and 1.85 years (range=0.5–4.5 years) with RGT. The majority of therapists had completed ≥50 RGT sessions, at a frequency of 1 to 5 sessions per week, with patients with on-label (spinal cord injury, stroke) and off-label (e.g., traumatic brain injury, LVAD, Guillain-Barre syndrome) diagnosis. Three medical events occurred in 3 years that included 716 RGT sessions and 186 patients. Qualitative analysis indicated three major themes and corresponding subthemes: 1. Comparison with traditional gait training approaches (6 sub-themes), 2. Considerations requiring clinical judgment (3), and 3. Concerns with on-label and off-label utilization (4). Stated benefits of RGT included decreased physical burden on therapists, decreased human error, and increased patient motivation. Clinical concerns with RGT included tonicity, continence, and patient communication (e.g., aphasia, cognition), and goals. Therapists conducted off-label RGT to overcome barriers in contemporary gait therapy, achieve early mobility, and increase the scope of patients able to receive RGT.

Conclusions: Level of training and clinical knowledge of our therapists benefitted the implementation of RGT and the patient experience and allowed for safe utilization of RGT with on-label and off-label patients.

Clinical Relevance: Robotics in rehabilitation are becoming more common and technological advances are creating opportunities for earlier mobilization, perfect movement, and increased intensity. Sharing creative and innovated clinical practice for use of RGT will improve utilization.
TITLE: Effects of Dry Needling on Muscle Spasticity in Adults with Neurological Disorders: A Systematic Review

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: General
AUTHORS: Rebecca Oliveira, Alyssa Piranio, Conor Coughlan, Thomas J. MacDonald, Anthony Fiorindo Carusotto, Renee M. Hakim

ABSTRACT BODY:

Purpose/Hypothesis: The purpose of this study was to determine the effects of Dry Needling (DN) on muscle spasticity in adults with neurological disorders.

Number of Subjects: N/A

Materials and Methods: A literature search of Cochrane, CINAHL, Google Scholar, and ProQuest was conducted using the search terms: (dry needling) AND (spasticity OR hypertonia OR dystonia). Search limits: English, journals, human subjects, 2009-2019. Selection criteria: Adults 18+ with neurological disorders and interventions included dry needling as treatment for spasticity. Each study was independently assessed by two reviewers for methodological quality based on Oxford Levels of Evidence.

Results: A total of 610 articles were screened for eligibility. After detailed appraisal, 8 articles met our selection criteria which included 3 case reports, 1 case series, 1 pretest-posttest cohort study, and 3 RCTs. Levels of evidence ranged from 2-5. Sample sizes ranged from 1 to 34 subjects (118 total) with the mean age ranging from 48-62 years old with all participants having a diagnosis of stroke. Treatment parameters varied widely with durations ranging from a single session to 9 sessions of DN and follow-up ranging from one day to 30 days post intervention. No adverse events were reported. Primary outcome measures for spasticity included: Modified Modified Ashworth Scale (MMAS), Modified Ashworth Scale (MAS), H-reflex, Hmax/Mmax ratio, and tensiomyography. All studies reported reductions in spasticity with 4 studies finding statistically significant improvements. Secondary outcomes were reported with improvements at the impairment level which included muscle length, range of motion, pain, and motor performance (Fugl-Meyer motor subscale); and at the functional level which included hand dexterity (box and block test), balance (computerized dynamic posturography) and mobility (TUG).

Conclusions: There is low to moderate evidence in support of using dry needling to decrease spasticity in adults with neurological disorders, specifically in those with a history of stroke. Successful applications of dry needling targeted shoulder, arm, and wrist flexor spasticity to increase ROM, and the gastrocnemius to decrease plantarflexor spasticity and ultimately improve gait. Limitations included a lack of follow-up and small sample sizes. Further high level research is needed to determine long-term outcomes of dry needling in spastic muscles and its effectiveness in relation to functional outcomes, in conjunction with other PT interventions.

Clinical Relevance: Overall, there was a short-term decrease in spasticity of target muscles after DN. Evidence also included improvements at the impairment and functional levels after the use of DN. Based on the evidence, PTs should consider the use of DN in conjunction with standard PT interventions as a safe, feasible option to improve spasticity and impact other targeted outcomes in adults with stroke.
Purpose/Hypothesis: To date there are no self-reported measures that assess lower extremity amputees’ perceptions of function as it relates to walking, standing, participation in recreational and usual activities of daily living. The purpose of this study was to determine which physical performance factor(s) (lower extremity strength, power, cardiovascular endurance or dynamic balance in gait) is most related to perceived levels of function for individuals who are below knee amputees.

Number of Subjects: 25

Materials and Methods: Twenty-five participants (21 males / 4 females), with a mean age of 49.8 years who underwent a below knee amputation (BKA) and are ambulatory with a prosthesis performed the following tasks: two-minute walk test for endurance without the prosthesis using a rolling walker, manual muscle tests of the involved and uninvolved hip abductors, flexors, extensors and knee extensors, L-test for dynamic balance in gait and the two minute walk test with the prosthesis. A portable metabolic analyzer was worn during each two-minute walk tests to measure oxygen consumption (ml*kg^{-1}*min^{-1}) during both walking tests, and a handheld dynamometer was used to quantify each manual muscle test (ft*lbs.). Perception of lower extremity function was assessed using the Lower Extremity Functional Scale (LEFS). Means and standard deviations for each physical performance measure and LEFS score were calculated. Correlation coefficients were calculated to determine the strength of the relationship between each physical performance measure and the LEFS score. Backwards, hierarchical linear regression was performed using physical performance measures that had a significant correlation with LEFS scores.

Results: The two-minute walk test without the prosthesis, two-minute walk test with the prosthesis and L-test had significant correlations with LEFS scores ($p < .05$). Forty-one percent of the variance in LEFS test scores was explained by the L-test: (adjusted $R^2 = .413$; $F_{22,1} = 17.2$; $p = .0004$).

Conclusions: The L-test was the strongest predictor of perceived lower extremity function for individuals with a BKA.

Clinical Relevance: To enhance perceptions of lower extremity function for individuals with a BKA, clinicians need to emphasize dynamic activities that require change of direction, variations in gait speed, and navigation of environmental barriers.
ABSTRACT BODY:

Purpose/Hypothesis: Motor coordination, the ability to produce context-dependent organized movements in both spatial and temporal domains, is impaired after neurological injuries and compromises the performance of everyday activities. Clinical assessments of coordination mostly quantify endpoint performance variables (i.e., temporal qualities of whole arm movement) but not movement quality (i.e. displacements of trunk and arm joints). This distinction is necessary to identify motor compensations from true recovery. Kinematic analysis better captures movement quality, but it can be challenging to implement in clinical practice due to the cost and expertise required. Observational kinematics can help to address the gap in objectively assessing coordination.

The purpose of this study was to develop a comprehensive tool to measure unilateral and bilateral coordination of upper and lower limbs that can be quantified by observational kinematics at both endpoint performance and movement quality levels.

Number of Subjects: 6 experts (PT, OT, researchers) and 5 individuals with stroke.

Materials and Methods: The tool was constructed from valid and reliable tests used in clinical practice or research. The first version was sent to a group of six experts together with a questionnaire asking about the 1) relative importance and 2) level of comprehension of each item and their instructions as well as 3) feasibility of the whole scale for use in clinical practice. A focus group meeting using the Technique for Research of Information by Animation of a Group of Experts method (TRIAGE method) was held to identify potential gaps, suggest additional items and perform content validation. After the meeting, the final version was produced. The final version was used to assess coordination in five individuals with chronic stroke to standardize the application of the scale.

Results: The final version of the Comprehensive Coordination Scale (CCS) is composed of 6 coordination sub-tests: finger-to-nose test, arm-trunk gain test, lower extremity motor coordination test and interlimb coordination tests for the upper limbs and for all four limbs. Constructs include spatial and temporal variables totaling 69 points, with higher scores indicating better performance. The final form of the CCS is ready to have its measurement properties assessed.

Conclusions: A new tool for assessing movement quality and performance was developed. The content validity and applicability of the scale were tested and the standards for application were developed. CCS is an important, understandable and feasible tool for clinical practice.

Clinical Relevance: The CCS fills a gap in the assessment of motor coordination. The scale is able to assess both movement quality and performance by observational kinematics in individuals with neurological conditions.
TITLE: Actigraphy-Assessed Daytime Sleep, Nighttime Sleep and Functional Outcomes in Patients with Neurological Insult

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: General

AUTHORS: Kendell L. Erickson, Ellie Marion Ottman, Gina L. Sprint, Doug L. Weeks, Elena Crooks

ABSTRACT BODY:

Purpose/Hypothesis:
Daytime naps may lead to nighttime sleep disruptions, such as difficulty falling asleep or staying asleep during the nighttime. These nighttime sleep impairments may hinder functional recovery post-neurological insult. Relationships between daytime sleep, nighttime sleep, and functional outcomes in patients post-stroke or traumatic brain injury (TBI) warrant further study. The purpose of this study was to determine whether daytime sleep duration could predict nighttime sleep duration in patients admitted to an inpatient rehabilitation facility (IRF) for stroke or TBI. A secondary purpose was to assess whether daytime or nighttime sleep duration were predictive of functional outcomes.

Number of Subjects:
Thirty-five subjects (65.2±17.0 years, 22 male) completed the study. Subjects were admitted to an IRF for sub-acute rehabilitation after stroke (n=28) or TBI (n=7).

Materials and Methods:
Sleep was measured with wrist actigraphy, worn continuously on the unaffected arm. The first two full 24-hour periods after entrance into the study were analyzed to determine sleep duration during the daytime (06:00-20:59) and nighttime (21:00-05:59) periods. Functional Independence Measure (FIM) scores were collected at admission and discharge from the IRF, which were then used to calculate the Montebello Rehabilitation Factor Score (MRFS), a measure of relative gain in function. Descriptive statistics and simple linear regression analyses were conducted using SPSS version 24.

Results:
Regression analyses indicated that greater daytime sleep duration was predictive of greater nighttime sleep duration on both days (p<0.05). There was a trend toward significance in the ability of greater nighttime sleep duration to predict better motor MRFS on both days (p=0.08). Greater nighttime sleep duration predicted cognitive MRFS on day 2 (p=0.01) but not on day 3 (p=0.13). Daytime sleep duration did not predict either cognitive or motor MRFS (p>0.05).

Conclusions:
Findings indicate that subjects who slept more during the daytime hours also slept more during the nighttime hours. Greater nighttime sleep duration trended towards predicting better motor functional recovery, as assessed by motor MRFS. Of interest, daytime sleep duration was not predictive of functional recovery, though actigraphy’s ability to distinguish sleep from sedentary behavior is disputable.

Clinical Relevance:
Unlike previous research indicating daytime sleep may disrupt nighttime sleep in healthy adults, our findings suggest that greater daytime sleep is predictive of greater nighttime sleep in this sample population post-stroke or TBI. Increased sleep altogether may be associated with damage to brain nuclei and projections involved in wakefulness. Daytime sleep architecture may also differ in this patient population, and daytime sleep may not dissipate the homeostatic pressure for sleep adequately. Providers and therapists should consider the differing effects of daytime sleep on nighttime sleep, and the potential for nighttime sleep to improve motor outcomes in patients post-stroke or TBI.
Exercise Intensity across Usual Care Therapy Interventions on an Individual with C4 Motor Complete Tetraplegia

Background and Purpose:
High intensity exercise intensity improves cardiovascular function and promotes neuroplasticity and general health outcomes. For people with spinal cord injury (SCI), exercise also promotes skin health, digestion, bone density, weight control, emotional well-being and sleep quality. However, little is known about the intensity of usual care therapy interventions for those with tetraplegia during inpatient rehabilitation. The purpose of this case study was to describe the intensity of usual care therapy interventions when applied to a person with tetraplegia.

Case Description:
A 23-year old African American female (CC) with C4 AIS B tetraplegia from motor vehicle collision 1-year prior was admitted to inpatient rehabilitation for multidisciplinary intervention with goals of independence with eating and power wheelchair propulsion. During her 90 day length of stay, therapy interventions included usual care activities including functional electrical stimulation (FES) bike, standing frame, and functional tasks training (e.g., bed mobility, transfers) and strengthening. CC also participated in robotic exoskeleton gait training for increased aerobic activity.

Outcomes:
Heart rate (HR) and revised scale rate of perceived exertion (RPE) were measured to gauge intensity of each intervention. Heart rate was collected using a Polar A370 Fitness Tracker and RPE was measured prior to discharge. Average observed intensity across sessions for interventions was: FES bike, 58% HR max, RPE= 4 (n= 2 sessions); standing frame, 58% HR max, RPE= 8 (n= 2 sessions); functional tasks training 58% HR max, RPE= 10 (n= 5 sessions); and robotic exoskeleton gait training, 61% HR max, RPE= 5 (n= 6 sessions). CC demonstrated improved manual muscle test scores (admit = 2/5, discharge = 3/5) for left bicep (C5) and left wrist extensors (C6) with no strength gains on the right upper extremity. Discharge FIM scores improved for eating with assistive devices [1 (total assist) to 4 (minimal assist)], grooming [1 to 3 (moderate assist)], and power wheelchair propulsion with joystick [1 to 3]. All other FIM scores were unchanged after inpatient rehabilitation.

Discussion:
With potential benefits for patients with SCI, the therapist is challenged to find activities to promote aerobic intensity despite the presence of profound weakness and significant risk for overuse injuries. While usual care therapy interventions did elevate CC’s heart rate to a low intensity zone, the robotic exoskeleton gait training appeared to elicit the greatest physiologic intensity, approaching the moderate intensity zone for exercise intensity. Interestingly, patient perceived intensity differed from physiologic measures of intensity. This case study suggests that robotic exoskeleton gait training should be considered as an adjunct to usual care therapy interventions to promote aerobic intensity for those with tetraplegia.
TITLE: Movement System Diagnosis; Integration of Recent Developments to the System Developed By Scheets and Colleagues

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: General

AUTHORS: Hoda Farhadi, Sarah Westcott McCoy

ABSTRACT BODY:

Purpose:
To investigate the feasibility of integration of recent Movement System Diagnosis (MSD) developments to the extant movement system diagnosis developed by Scheets et al.¹

Description:
The current APTA vision for physical therapy emphasizes the necessity of diagnostic labels and classification systems development²,³. While APTA works to create the foundation of MSD, there is value to compare and incorporate new suggestions to an extant MSD framework, developed by Scheets et al. The recent presented developments fall under two major categories; (1) included core tasks and (2) framework for task analysis. The APTA adopted 6 core tasks introduced by Scheets, with two modifications: (a) Tasks became more structured; more clear descriptions and standardized tools involved. (b) Few tasks were suggested as alternatives to provide more-in-depth information such as squatting, forward bending and floor to stand⁴,⁵.

The proposed task analysis framework is comprised of 5 constructs; postural control, symmetry, duration or speed, amplitude, motor control and symptom provocation. These constructs were inserted into the task stages (preparation, initiation, execution and termination) and evaluated by binary, yes/no questions⁴,⁵.

Two patients with different medical diagnoses were evaluated first using the Scheets system followed by using the presented APTA framework.

Summary of Use:
We used MSD to evaluate 2 patients with different medical diagnoses. Patient 1, 16 year-old with Cerebral Palsy (CP) and patient 2, 47 with Traumatic Brain Injury (TBI). Based on Scheets system, they were diagnosed with Movement Pattern Coordination Deficit (MPCD) and Force Production Deficit (FPD), respectively. The core tasks standardization in APTA framework decreased ambiguity and improved test administration. All additional proposed tasks were helpful. floor-to-standing, in particular, was valuable to observe as a whole body task performance. In particular, patient 2 experienced a sharp tone increase following his endeavor to stand. This caused hypertonicity to become the primary issue and dominating the weakness. While not adequate for making a diagnosis by themselves, these additional tasks provided important input.

To make diagnoses, feedback was pivotal in Scheets system (correction of genu recuratum and foot placement when differentiating FPD from MPCD). In APTA checklist, task variations and feedback were recommended and not required. The APTA construct checklists were simple to use to decide if a dysfunction was present. Understanding the dysfunction source from binary variable, however, was challenging when differentiating diagnoses (finding the source for inability to maintain upright trunk during quiet standing, for differentiating FPD from MPCD).

Importance to Members:
The ongoing research by APTA builds a solid framework for MSD discussion by providing evidence and structured instructions required for making diagnosis. Parallel research to incorporate recent findings to available systems could generate valuable input in early stages.
Trunk Angle Modulates Long Latency Reflex Responses during a Novel Single Limb Squat Task.

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: General
AUTHORS: Kristin A. Johnson, Shojiro Nozu, Richard K. Shields

ABSTRACT BODY:

Purpose/Hypothesis: Anterior cruciate ligament injury is pervasive in young female athletes and attributable to non-contact mechanisms [1]. When an accelerating limb, is unexpectedly decelerated, the feedback control system, via the long latency reflex (LLR) is thought to control the limb. The LLR is likely influenced by biomechanical positioning [2] and feed forward control [3, 4]. However, a method to safely test an unexpected event during a weight bearing task has been elusive. Accordingly, we tested the influence of sagittal trunk position on the LLR using a novel single-limb squatting task (SLS). We expect that a more flexed trunk at the time of perturbation will yield more robust LLRs.

Number of Subjects: Eight people (7 female; age=23±0.58) without history of injury/surgery participated in the study.

Materials and Methods: Participants completed two, 9-condition SLS tasks on a custom-built device [4, 5]. Each condition included 5 squats at varied speed/resistance while the knee position was projected on a computer screen and the participant tracked a sinusoidal target. The resistance of the device was randomly released during knee flexion causing an unexpected perturbation. The participant performed the task with an upright trunk (<15 deg) and with a flexed trunk (>30 deg). We used Vicon markers to calculate sagittal plane ROM and to provide feedback of trunk position. We recorded EMG from the Vastus Medialis (VM), Vastus Lateralis (VL), Medial Hamstrings (MH), Lateral Hamstrings (LH), Gluteus Medius (GMed), and Soleus (Sol) muscles; and calculated the peak EMG activity during feed forward control (0-50 ms), feedback control (0-200 ms), and during volitional response (>200 ms). A One-way Repeated Measures ANOVA was used to test if the LLRs varied between trunk positions.

Results: The LLR was 135% and 153% greater for the flexed versus the upright trunk position for VM (p=0.01) and GMed (p=0.008), respectively; while the VL showed a 42%increase and 15% decrease for the upright and flexed trunk positions (p=0.03), respectively. The Sol LLR increased 159% for the upright trunk position only (p=0.006). Greater trunk (p<0.001), hip (p<0.001), and knee (p=0.03) flexion excursion after perturbation occurred with the trunk in the flexed position.

Conclusions: Manipulating the position of the trunk during SLS exercises preferentially augments the transcortical LLR of the VM, GMed, Sol, and VL and alters the kinematics of the hip and knee. Importantly, the feed forward control strategy (central set) interacts with the biomechanical positioning to modulate the LLR in people exposed to unexpected events.

Clinical Relevance: SLS is a commonly prescribed exercise to prevent and treat people with knee joint instability. Understanding how trunk position modulates transcortical LLRs will guide physical therapists as we strive to develop precision based interventions.
Can the Arat be Used to Measure Arm Function in People with Cerebellar Ataxia?

Purpose/Hypothesis: Ataxia, or movement incoordination, may negatively affect reaching tasks. People with ataxia participate in rehabilitation to address this deficit. During rehabilitation, clinicians utilize outcome measures (OMs). For ataxia, there are validated OMs to address body structure/function (BSF) impairments, such as the International Cooperation of Ataxia Rating Scale (ICARS) and the Scale for the Assessment and Rating of Ataxia (SARA), and one OM for participation, the Frederick’s Ataxia Inventory Scale (FAIS); however, no upper extremity (UE) activity level OM exists for this population. As rehabilitation focuses on restoration of function, this gap should be addressed. The Action Research Arm Test (ARAT), is a measure of UE function validated in other health conditions. Therefore, the ARAT may be a useful OM for capturing UE activity level impairments in ataxia. The study objective was to evaluate the use of the ARAT in ataxia through the assessment of construct validity and inter-rater reliability; with the hypothesis that the ARAT will be a valid and reliable OM for UE function in ataxia.

Number of Subjects: 21 participants (age 23-78 years, 18 males and 3 females) with ataxia were evaluated to assess construct validity of the ARAT. 18/21 participants were included in the inter-rater reliability assessment.

Materials and Methods: Participants underwent a neurologic examination and completed a battery of OMs: ICARS, SARA, and FAIS. They then completed the measure of interest, the ARAT. For 18/21 participants, ARAT performance was video-recorded. Videos were independently scored by 4 additional raters (3 physical therapists, 1 clinical researcher).

Results: Construct validity for the ARAT: Spearman’s rho showed a moderate relationship between ICARS UE and ARAT (-0.423), ARAT and SARA (-0.560), and ICARS UE and SARA (0.759 significant). A small relationship was noted for ICARS UE and FAIS (0.301) and ARAT and FAIS (0.292). Post hoc analysis showed a moderate relationship between ICARS UE and ARAT grip subscale (-0.514 significant). Inter-rater reliability for the ARAT: Spearman’s rho, showed a large, significant relationship among all raters for the ARAT (range of 0.850-0.931).

Conclusions: We show that the ARAT is moderately correlated with ataxia BSF OMs, but not with participation scores. Therefore, the ARAT is a measure of UE function, which is different from BSF and participation OMs. The ARAT was identified to have strong interrater reliability among raters with varying amounts of experience administering the ARAT. Thus, the ARAT may be useful for assessing UE activity level tasks in the ataxic patient population.

Clinical Relevance: A valid and reliable OM for UE function would allow therapists to evaluate and track patients during rehabilitation. The high inter-rater reliability of the ARAT would promote the use of the tool between clinicians.
Subjective Fatigue Is Correlated with Perceived Effort and Reach Performance

AUTHORS: Hui-Ting Goh, Kevin Becker, Cheng-Ju Hung, Garrett Beutel, Jill Campbell Stewart

ABSTRACT BODY:

Purpose/Hypothesis: Pathological fatigue, an intensified perceived effort during activity, is a common complication in patients with neurological disorders, such as, multiple sclerosis, Parkinson’s disease, and stroke. Pathological fatigue is different from muscular fatigue and negatively impacts quality of life, participation in rehabilitation and physical activity. However, little is known about how fatigue influences movement performance. This study aimed to 1) validate a reaching task to measure perceived effort during movement, and 2) examine relationships between self-reported fatigue, perceived effort, and reach performance.

Number of Subjects: 23

Materials and Methods: 23 right-handed healthy participants (15 females, mean age: 25.5 years) were recruited. Subjective fatigue was measured with Fatigue Severity Scale, Visual Analog Scale-Fatigue, and Fatigue Scale for Motor and Cognitive Functions (FMSC-Motor and FMSC-Cognitive). Participants performed reach actions towards 9 different circular targets on a digitized tablet with both arms while seated; targets were projected on a computer monitor in front of participants. Targets differed in location (left, middle, right of the workspace), distance (6cm, 12cm from the starting position), and size (2cm, 1cm in diameter). For each target, participants performed 10 reaches (2 blocks of 5 trials) and the goal of the task was to reach to the target as fast and as accurate as possible. Feedback on movement time and reaction time was given after each trial. Perceived effort of reaching was evaluated after the first 5 trials using Borg Rating of Perceived Effort and Mental Effort Rating Scale. After the 10 reaching trials, participants were asked to replicate the reach actions for 5 trials while the target was not displayed on the monitor. Perceived effort was reevaluated after participants finished reaching toward the non-visible target. Reach performance was assessed using reaction time, movement time and endpoint error.

Results: Participants reported significantly greater effort when reaching with their non-dominant arm, when the target was not visible, towards further targets, and towards smaller targets (all \( p < .05 \)). There were significant correlations between self-reported fatigue (FMSC-Motor and FMSC-Cognitive) and perceived effort when reaching with the dominant, right arm (\( r = 0.43 \) to 0.52) but not when reaching with the non-dominant left arm. Individuals with greater self-reported fatigue reported greater perceived effort during reaching. Individuals with greater fatigue also demonstrated longer reaction time (\( r = 0.47 \)) and greater reach endpoint error (\( r = 0.43 \) to 0.61).

Conclusions: A reaching paradigm that varied arm, target distance and target size was sensitive to capture variations in perceived effort during movement. Greater subjective fatigue was significantly correlated with greater reaching perceived effort and worse reach performance.

Clinical Relevance: Individuals with pathological fatigue might exhibit greater effort and worse performance when performing motor tasks. Therapists should consider the impact of fatigue when evaluating and treating neurologic clients with movement dysfunctions. Future studies could utilize this paradigm to investigate pathological fatigue in individuals with neurologic diagnoses.
ABSTRACT BODY:

Background and Purpose:
Evidence supports improved cognitive performance following regular aerobic exercise (delivered usually over a period of 9-12 months), but it is not clear if shorter interventions can influence cognitive performance in sedentary adults. Exercise-mediated cognitive improvements can be at least partly attributed to neuroplastic cortical changes. Transcranial magnetic stimulation (TMS) with intermittent theta-burst stimulation (iTBS) (TMS/iTBS) provides insights into neuroplasticity within intracortical circuits that may be useful in further elucidating the relationship between exercise and cognitive improvements in aging adults. The purpose of this case was to compare cognitive performance and TMS/iTBS neuroplasticity between 4-weeks of moderate (mod-ex) or high (high-ex) intensity aerobic exercise in sedentary healthy adults.

Case Description:
Ten sedentary adults (4 males, mean age=57.8 years) completed four 35-minute sessions of aerobic exercise per week for a total of 4-weeks. Participants were randomized into moderate (n=5, 55-64%) or high (n=5, 65-90%) intensity based on age-predicted maximal heart rate (Karvonen equation).

Outcomes:
For the TMS/iTBS neuroplasticity assessment, stimulation targeted the primary motor cortex and motor evoked potentials (MEPs) were recorded from the first dorsal interosseous muscle. The neuroplasticity assessment consisted of quantifying TMS/iTBS-induced modulation of MEPs 20 minutes post-iTBS (T20). The high-ex group showed a greater increase in response than the mod-ex group (highΔT20=32.22%, modΔT20=3.67%).

A neurocognitive test battery assessed attention, processing speed, and executive function utilizing the following tests: Stroop, Delis-Kaplan Executive Function System (DKEFS) verbal fluency, the Repeated Battery for the Assessment of Neuropsychological Status (RBANS) digit span and coding, and the NIH Toolbox® Flanker, Dimensional Card Sorting and Patterns assessments. Neurocognitive battery scores are presented as z-scores. Both groups showed increases from pre to post in DKEFS Phonemic fluency (highΔz=.73, modΔz=.60) and Flanker (highΔz=.52, modΔz=.24). Additionally, the high-ex group showed a positive change from pre to post in the Stroop (highΔz=0.18, modΔz=.04), DKEFS Switching Fluency (highΔz=.54, modΔz=-.34), DKEFS Switching Accuracy (highΔz=.33, modΔz=-.34), and Dimensional Card Sorting (highΔz=.86, modΔz=-.16) whereas the mod-ex group did not but showed a positive change from pre to post in the Patterns (highΔz=-.23, modΔz=.42), RBANS digit span (highΔz=-.46, modΔz=1.20), and RBANS coding (highΔz=.13, modΔz=.33).

Discussion:
Both groups had similar improvements in measures of attention and processing speed, but the high-ex group demonstrated greater improvements in executive functioning, specifically in the domains of response inhibition, phonemic fluency, and task switching. Additionally, the high-ex group had a greater increase in their T20 iTBS/TMS plasticity response, suggesting that the increased executive function performance paralleled increased neuroplasticity.
BACKGROUND AND PURPOSE: Graded Motor Imagery (GMI) is a top-down treatment for pain conditions. The approach involves a three-step process: implicit motor imagery (IMI), explicit motor imagery (EMI) and mirror therapy (MT). Preliminary evidence suggests GMI improves chronic pain by facilitating graded neuroplastic changes. However, few GMI studies have been conducted on Complex Regional Pain Syndrome Type 2 (CRPS2), and research outcomes have been inconsistent. The purpose of this case study is to demonstrate the efficacy of GMI in improving functional mobility in a patient with CRPS2.

CASE DESCRIPTION: The patient is a 50-year-old male who sustained a crush injury of his right lower extremity (RLE). Following the incident, he had a fasciotomy to address compartment syndrome and wore a CAM boot during gait due to pain and paresthesias with weight bearing. He presented to outpatient physical therapy (PT) 6.5 months post injury still ambulating with a CAM boot. Initial evaluation findings included hyper and hypoesthesia along the cutaneous distributions of the saphenous and superficial peroneal nerves as well as tropic changes in his RLE. During gait analysis, the patient ambulated without forefoot contact during stance phase on his RLE. He previously received PT at another facility without significant change in function.

GMI began with laterality recognition as part of the IMI phase. Right/left discrimination accuracy is reduced in patients with chronic pain due to altered body schema. FMRI data shows that laterality training activates the premotor cortex, improving precision in limb cortical representation. A phone app (Recognise) provided training games that the patient practiced until he reached accuracy levels comparable to healthy individuals. In the EMI phase, he was instructed to imagine movement of the involved limb. FMRI data shows that EMI activates the somatosensory, premotor and primary motor cortices to alleviate pain perception. Once in the MT phase, the patient began with active range of motion (ROM) and advanced to weight bearing activities. Research shows MT improves sensory perception and motor neuroprocessing. Following mirror therapy, the patient progressed to gait training, focusing on normalizing gait mechanics.

OUTCOMES: From initial evaluation to re-evaluation, the patient’s Lower Extremity Functional Scale score improved significantly from 24 to 40; his Timed Up and Go score improved from 25 seconds to 17 seconds without CAM boot; and his ankle DF ROM improved from 2 to 10 degrees. He was able to ambulate household distances wearing regular shoes, demonstrating RLE forefoot contact in mid stance and limited push off in terminal stance.

DISCUSSION: The patient responded well to GMI, successfully completing all stages of training with significant improvement in outcomes noted above. He was able to progress to gait training with improved mechanics and reduced pain levels following this program. GMI provides a way to promote neuroplastic changes to ultimately improve pain levels associated with functional use of the limb, even in those with CRPS2.
Purpose/Hypothesis: Accurate assessment of recovery following mild traumatic brain injury in adolescents can be difficult. Dual-task models that combine cognitive and motor demands may more accurately identify residual deficits that manifest during daily life and athletic play in adolescents with concussion. Previous studies have examined gait changes during a concurrent auditory task, or cognitive task. The purpose of this study was to generate preliminary values for gait (velocity, step length, and percent of the gait cycle (%GC) in double (DLS) or single limb support (SLS) in adolescents walking while performing a visuospatial memory task with altered visual attention. The investigators hypothesized that, during the dual-task efforts, all subjects would experience a significant dual-task cost (DTC). The investigators also hypothesized no significant differences in the DTC between males and females, but anticipated a smaller DTC to gait velocity than what is reported for adults.

Number of Subjects: Subjects comprised a total of 178 adolescent athletes (128 males; 50 females) ages 14-18 years old at six area high schools.

Materials and Methods: Subjects were instructed to walk “how you normally do” on the GAITRite® portable gait analysis walkway for three undivided and three divided attention trials performing a visuospatial memory task on a hand-held tablet.

Results: Significant differences (p<.0001) were present between males and females during typical gait in each of the measured parameters except step length (p>.0715). Female participants walked with a significantly faster gait velocity (by 0.21 m/s) than male participants (p<.0001). The females spent a significantly smaller (-2.27%) %GC in DLS (p<.0001) and a significantly greater (+1.10%) %GC in SLS (p<.0001) than did the males. Both groups experienced a similar, dual-task cost (DTC) during the divided attention trials (p<.0001) for each of the four gait parameters. Previous studies show that adults decrease their gait velocity by approximately 33%. The current study revealed that adolescents decreased their gait velocity by 8-9% by shortening their step length by 7.4 centimeters (p<.0001), increased the %GC spent in DLS (2.73%, p<.0001) and decreased the %GC spent in SLS (1.38%, p<.0001) during the dual-task.

Conclusions: These data provide preliminary reference values specific to the adolescent population for the DTC during a visuospatial memory task. More research is needed to determine the DTC during a visuospatial memory task for adolescents with concussion.

Clinical Relevance: Our study provides research evidence regarding the DTC associated with a task that closely mimics the everyday combination of motor, cognitive, and altered visual attention. Tasks include when adolescents walk while using a smart device or advancing down a court/field of play while manipulating a ball keeping their eyes on the nearest opponent. Our findings contrast with values reported in the literature for adults completing similar tasks, further emphasizing the need for reference values specific to the adolescent population. The data generated by this study can serve as a clinical comparison when assessing individuals with concussion.
TITLE: Screening Individuals with History of Concussion: Single Vs. Cluster Testing - Preliminary Data

CURRENT SECTION: Neurology  
CURRENT SUB-CATEGORY: General  
AUTHORS: Daniel Miner, Brent Alfred Harper, Carrie Case, Brooklynne McDermott, Ashley Gail Humphries, Ashley Dudding, Sam Lawrence

ABSTRACT BODY:

Purpose/Hypothesis:
Concussion is a complex phenomenon potentially affecting multiple domains of neurocognitive and physical functioning. Prevalence of concussion in adults is estimated to be 12-15%. No single test is comprehensive enough to adequately screen individuals with history of concussion. The purpose of this study is to compare individual tests to a cluster of tests to identify deficits in postural control and gaze stability for those with concussion history.

Number of Subjects: 30

Materials and Methods:
The short form of the Ohio State University-Traumatic Brain Injury Identification Method (OSU TBI-ID) was used to determine self-reported history of concussion. Thirty subjects participated in the study (11 males and 19 females, mean age 25.2 ± 3.7, history of concussion: n= 15, no concussion: n= 15). All participants performed the following assessments in randomized order: Sensory Organization Test (SOT) and Head Shake Sensory Organization Test (HS-SOT) on the NeuroCom Balance Master, the computerized Dynamic Visual Acuity Test (DVA) using InVision software, and the anterior reach section of the Y-Balance Test (YBT).

Results:
Sensitivity and specificity scores for each assessment were calculated separately based on concussion history as determined by the OSU TBI-ID. None of the individual assessments had a sensitivity >54%. The SOT and the DVA had the best specificity, 93.33% and 86.7% respectively. A cluster of ≥2 positive test results improved sensitivity to 73.3% with a specificity of 46.67%, positive predictive value= 0.58, negative predictive value= 0.64, positive likelihood ratio (LR+) = 1.37, and negative likelihood ratio (LR-) = 0.59.

Conclusions:
Tests with a high sensitivity and specificity are preferred indicators of clinical importance. Individual tests in this study had low sensitivity. Creating a cluster of tests which evaluates impairments across multiple domains of function may create a more useful and sensitive assessment tool for those with concussion history. A cluster of tests performed early in the evaluation process may identify those with history of concussion in need of further follow-up. Future studies should evaluate the diagnostic accuracy of individual assessments compared to clusters of tests to identify subtle impairments in individuals with a history of concussion.

Clinical Relevance:
Subclinical deficits in postural control and gaze stability may predispose individuals with a history of concussion to future injury. This study’s preliminary findings are consistent with current literature that history of concussion is not predictive of deficits in postural control. However, this study’s preliminary data indicates that a cluster of tests may be utilized to identify persistent subtle deficits in those with concussion history.
TITLE: Intra-Observer Reliability of Hand-Held Dynamometry for Assessing Muscle Strength in Children and Adults with Neurofibromatoses

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: General

AUTHORS: Nashwa S. Khalil, Srivandana Akshintala, MBBS, MPH, Alona Muzikansky, MA, Kaleb Yohay, MD, Jeffrey Allen, MD, Miriam Pudel, NP, Celia Engelson, NP, Carole Mitchell, MS, RN, Jaime Obletz, OTR/L, CIMI, David A. Stevenson, MD, Scott Plotkin, MD, Ph.D.

ABSTRACT BODY:

Purpose/Hypothesis: Generalized or focal muscle weakness secondary to tumor or non-tumor manifestations is a significant concern in patients with NF. Muscle weakness may be due to primary myopathy, central nervous system dysfunction, or abnormalities of peripheral nerves, and can be associated with hypotonia and postural/skeletal deformities. Additionally, weakness may negatively affect typical motor development of children, physical capacity at work and school, and quality of life. Reliable and sensitive measures are needed to measure muscle strength in this population. Hand held dynamometry (HHD) is a convenient technique that provides a quantitative measurement of strength, however, the reliability of this technique is unclear. The objective of this single-center study is to assess the reliability of HHD in measuring strength in NF and to evaluate its utility as an outcome measure in clinical trials.

Number of Subjects: Nineteen subjects aged five years and above with a clinically confirmed diagnosis of neurofibromatosis type 1 (NF1) or type 2 (NF2) were recruited from the Neurofibromatosis Clinic at NYU Langone Health. Eligible patients must have at least one weak muscle group weak by manual muscle testing (MMT).

Materials and Methods: Maximal isometric muscle strength of a weak muscle group and the biceps of the dominant arm was measured using the Ametek Chatillon® DFE2 HHD per a standardized protocol. Three sessions with a minimum of 15-minute rest period between each were performed on the same day by a single observer, and each session consisted of 3 trials. Intra-session and intersession intraclass correlation (ICC) were calculated to assess reliability. The average of 3 trials within one session was used as an observation for intersession ICC.

Results: Of the first 19 patients (12 male/7 female, 14 NF1 and 5 NF2) who underwent testing, median age was 13 years (range 6-45). Weak muscle groups tested included iliopsoas (n=3), quadriceps (n=5), gluteus medius (n=8), shoulder external rotators (n=2), and deltoid (n=1) and their strength ranged from 2-/5 to 4+/5 by MMT. For all the weak muscles combined (n=19), the first session intra-session ICC was 0.98 and intersession ICC was 0.99. For the subset of 14 NF1 patients, the intra-session and intersession ICC were 0.97 and 0.98 respectively. Biceps strength was measured in 18 patients: the first session intra-session ICC and intersession ICC were 0.97 and 0.98 respectively; the intra-session and intersession ICC were 0.97 in the subset of 13 patients with NF1.

Conclusions: Preliminary results of our ongoing study show that HHD appears to be a promising technique to measure muscle strength in patients with NF. The study is currently ongoing and additional analyses are planned to further assess the reliability and measurement error of this technique to help determine its utility as an outcome measure in clinical trials.

Clinical Relevance: Our HHD protocol was feasible over a wide age range and is a potentially useful tool to reliably measure strength in patients with NF.
ABSTRACT BODY: Incidence of functional neurological disorder (FND) is rising with as many as 70% of physiotherapists reporting treating this population. Despite the high incidence reported, surveyed physiotherapists indicated low confidence in treating this population. Research on treatment is sparse and consists of case studies or small randomized control trials limiting application in various treatment settings. Many patients with FND present with concurrent pain, activity, and participation limitations. According to consensus recommendations, education on diagnosis and prognosis is essential to maximize patient outcomes. Similar to FND, pain has multiple dimensions including physical, emotional, and cognitive experiences that must be addressed during education. Pain science education has been well studied and provides an evidence-based method of education, goal setting, and graded exposure for patients with pain. A pain science treatment approach of creating a "positive movement experience" may be applicable for treatment of FND. Incorporation of the principles of pain science education can serve as a valuable tool to educate patients and guide treatment interventions for patients with FND. A theoretical treatment model for incorporation of pain science principles into management of FND will be provided. Implementation of treatment model will be highlighted with case examples from clinical practice.
Purpose:
The purpose of this research is to investigate the relationship between athletic skill level and an athlete’s ability to suppress the vestibulo-ocular reflex (VOR).

Description:
Ten female gymnasts (mean age 15±2.2yo) were obtained via a sample of convenience. The sample included both competitive and recreational gymnasts. In a laboratory setting, subjects were asked to wear a measurement system that could track head and eye movements as they performed a series of visual tasks. Three experiments were performed:
(1) a saccadic experiment in which two horizontally fixed LEDs (±10° of visual angle) were alternately lit in a non-predictable pattern to provide visual cues,
(2) a VOR experiment where the subject was asked to perform yawl head movements (left/right rotation) to an audible metronome beat while visually fixating on a centrally-fixed LED target 1m away, and
(3) a vestibulo-ocular reflex suppression/cancellation (VORc) experiment where a laser pointer was fixed to the subject’s helmet close to the cyclopean eye (slaving the displayed target to the head movement). In this configuration, the subject was again asked to perform yawl head movements to a metronome while visually fixating on the target.

In both VOR experiments, the metronome frequency varied from 72 to 196 beats per minute resulting in head angular velocities of up to 100°/s. Eye and head position data were synchronously sampled at 250 and 100Hz respectively. Data were post-processed using MATLAB. Periodic calibrations were performed throughout the experiment to test the continued reliability of the data. Statistical analysis (ANOVA) was used to compare individual and grouped data (p≤0.05) where groups were based on gymnastics competitive level.

Summary of Use:
Saccadic peak velocities and onset latencies were calculated and showed no statistical difference across subjects or groups. In fact, their performance did not differ from published norms. VOR and VORc gains were also calculated and compared. Between subjects VORc gains were found to be statistically significant for left directed head velocities only. VORc grouped statistics (by gymnastic level) also showed significant difference. The higher level (competitive) gymnasts were better at suppressing their VOR. In addition, left/right VOR gain asymmetries correlated highly with twist direction in seven of the competitive gymnasts.

Importance to Members:
In many aerial sports, athletes perform twisting and flipping skills at high angular velocities. These athletes rely heavily on sensory information from the visual, proprioceptive, and vestibular systems. The VOR is responsible for stabilizing the visual field on the retina during head movement. To accomplish this, the eyes are reflexively moved in a direction opposite the head. In a twisting athlete, this actually reduces the ability of the individual to see the landing during airborne skills. Hence it becomes advantageous to cancel or suppress VOR in order to view the landing.

There is a correlation between VOR performance and gymnastic level. These results do not suggest that VOR differences develop as a result of practice. These differences may be innate and simply allow some individuals to become better performers. A longitudinal study on a larger population would be required to test the causal relationship between these variables.
Twelve Weeks of Overground Bionic Ambulation with Fes in Individuals with SCI: A Case Series

Background and Purpose: Spinal cord injury (SCI) is often associated with cardiovascular disease, pulmonary complications, osteopenia and obesity. Combining overground bionic ambulation (OBA) with functional electrical stimulation (FES) has the potential to combat these secondary impairments by enabling patients with SCI to weight-bear in assisted walking and stimulate the cardiorespiratory and musculoskeletal systems. The purpose of this case series was to explore the potential benefits of combining OBA with FES for patients with SCI. We hypothesized that OBA+FES would result in improved cardiorespiratory capacity ($VO_2_{\text{peak}}$), body composition and bone mineral density (BMD) in individuals with SCI.

Case Description: Two female participants (P1, P2) with spinal cord injury (P1: ASIA Impairment Scale (AIS) C, level of injury (LOI) C5, 26 years old, 4 years post injury; and P2: AIS B, LOI T2, 31 years old, 15 years post injury) trained for up to 1 hour, 2 days per week for 12 weeks in the Ekso GT integrated with FES. FES electrodes were placed over bilateral quadriceps, hamstrings, gastrocnemius, and gluteus maximus or tibialis anterior muscles. Stimulation intensity enabled antigravity contractions for each muscle group. Walk time, number of steps, rate of perceived exertion (RPE), blood pressure, and heart rate were recorded at each training session. VO$_2$ peak, cost of transport, body composition, and BMD (measured with dual energy x-ray absorptiometry (DXA)) were assessed pre- and post-training. Participants completed the Physical Activity Enjoyment Scale (PACES) after training to assess to what extent they enjoyed exercising with OBA+FES.

Outcomes: Mean walk time per session increased from 27:45 (min:s) in month 1 to 51:28 in month 2, and mean number of steps per session increased from 1046 in month 1 to 2363 in month 3. After training, AIS score was unchanged for both participants, but the LOI for Participant 1 improved from C5 to C6. %VO$_2$ peak decreased for Participant 1 (11.7%) and increased for Participant 2 (4.7%) after training. Cost of transport (mL/kg/m) decreased after training (mean=27.6%) during RAGT with FES. Initial DXA scores region specific T-scores indicated osteopenia for bilateral proximal femurs in P1 and P2, and the spine in P1 (range = [-1.3, -2.2]). BMD increased after training in L1-L4 region (mean=2.07%), R femur (1.44%), and L femur (.96%). Body fat decreased 3.8% in P1 and increased .7% in P2. The PACES scores after training were 99 and 117, indicating moderate to high enjoyment of the physical activity.

Discussion: Participants tolerated OBA+FES well, as demonstrated by increases in walk time and number of steps over the 12 week training period and no adverse events. Decreases in cost of transport after training indicated that participants became more efficient at walking. Previous studies have shown that a standard standing program slows the decline of BMD in people with SCI, but our results indicate that OBA+FES may increase BMD. As demonstrated by high PACES scores, subjects enjoyed the training.
TITLE: Connection between Residency and a “Culture of Excellence” in a Highly Specialized Area of Rehabilitation

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: SCI SIG

AUTHORS: Lauren C. Snowdon, Arielle Resnick, Erin Josephine Donnelly, Isa McClure

ABSTRACT BODY:

Purpose: There is incredible value in clinicians sharing best practice approaches to elevate the expertise of therapists committed to meeting the diverse needs of persons with spinal cord injury/dysfunction (SCI/D). Research reveals that experts’ knowledge is organized around four core concepts that guide their thinking: curriculum, instruction, assessment, and professional development. Implementation of a focused SCI/D curriculum incorporating these principles will not only engage the learner but enhance the skills of the mentor to elevate an entire staff for a successful professional development experience.

Description: Our center is one of only eight centers in the country to have both SCI Model Systems designation and an APTA credentialed neurologic Residency program consisting of varied components designed to advance clinical expertise. Multi-modal educational opportunities enhance the educational experience for all involved. Collaborative learning occurs through active participation in interdisciplinary specialty clinics, structured competency-based lab experiences, and exposure to advance technology, including robotics and functional electrical stimulation. Utilization of evidence-based training in ISNCSCI classification and education in wound care through the SkinStep further develops the expertise of both mentors and mentees. Clinical educators mentor Residents further through didactic lectures and skills-based labs addressing examination, evaluation, skilled interventions, goal setting, and prognosis for individuals with SCI/D. Advanced wheelchair seating and mobility is also a component, emphasizing prescription, posture, pressure relief, and alternative drive options for individuals with SCI/D. Together, this delivery model for both Residents and non-Residents creates a culture of excellence within this highly specialized team of therapists.

Summary of Use: Clinicians at our center are dedicated to fostering a culture of specialization. As of 2018, there were 78 Board Certified Specialists in Neurologic Physical Therapy in the state of New Jersey. Out of this 78, 26 (33%) are currently employed within the organization. Curriculum focused on advanced practice in the area of SCI/D is a core component that contributes to achievement of this elite designation and facilitates development of clinical expertise in Residents, non-Residents, and clinical mentors.

Importance to Members: A structured didactic and experiential SCI/D curriculum can improve functional outcomes, emphasize personal growth and development, and elevate the level of expertise of an organization. Since the inception of the Residency program in 2011, the number of Board-Certified Specialists in Neurologic Physical Therapy within this organization increased from 6 to a maximum of 30. Sharing this comprehensive framework with other centers can lead to enhanced specialization for all qualified clinicians.
**Purpose/Hypothesis:** Evaluate the influence of level of spinal cord injury (SCI) on caloric intake relative to total daily energy expenditure (TDEE) and body composition, and develop a SCI-specific correction factor for the TDEE estimation.

**Number of Subjects:** Individuals with paraplegia (PARA) n=28, and tetraplegia (TETRA) n=13.

**Materials and Methods:** Daily caloric intake, basal metabolic rate (BMR), and TDEE were obtained using dietary recall, indirect calorimetry, and prediction equations, respectively. Caloric intake and TDEE were adjusted to bodyweight. Body composition was assessed using dual energy x-ray absorptiometry.

**Results:** Total caloric (PARA 1516.4±548.4, TETRA 1619.1±564.3 kcal/d), fat (PARA 58.6±27.4, TETRA 65.8±29.7 g), and protein (PARA 62.7±23.2, TETRA 71.5±30.9 g) intake were significantly higher in TETRA versus PARA (P<0.05) when adjusted for bodyweight. Adjusted and unadjusted TDEE (unadjusted: PARA 1851.0±405.3, TETRA 1530.4±640.4 kcal/d) and BMR (unadjusted: PARA 1516.6±398.0, TETRA 1223.6±390.2 kcal/d) were significantly higher in PARA versus TETRA (P<0.05). Bone mineral content (PARA 3.17±0.6, TETRA 2.71±0.5 g), lean body mass (PARA 50.0±8.6, TETRA 40.96±8.8 kg), and percent regional body fat (PARA 36.45±8.0, TETRA 41.82±9.1) were different between groups (P<0.05). The SCI-specific correction factor was 1.15, and demonstrated a significantly lower TDEE in TETRA compared to PARA.

**Conclusions:** A dichotomy exists in caloric intake, TDEE, and body composition among TETRA and PARA. The SCI-specific correction factor of 1.15 is a promising tool to estimate TDEE in SCI.

**Clinical Relevance:** The estimation of TDEE was established in the able-bodied population, and when applied to those with SCI likely overestimates their caloric needs given the alterations in body composition which occur following the injury. The positive energy balance demonstrated in the present study, accompanied by reductions in LBM and TDEE, may help to explain the higher body fat in those with TETRA compared to PARA.
Purpose/Hypothesis: To determine whether a wheelchair back designed to support the natural spinal curves improves posture and function compared to an upholstery back.

Number of Subjects: 50 Participants with motor complete spinal cord injuries (SCI) from C6-T4, ages 18-60 were recruited from a convenience sample from two SCI Model System Hospitals.

Materials and Methods: Participants performed postural and functional outcomes (Table 1) as well as numeric pain rating and subjective satisfaction survey while using both an upholstery back and a solid back on their own wheelchair base and seat cushion. The order of back use was randomized.

Table 1:
<table>
<thead>
<tr>
<th>Postural Outcomes</th>
<th>Functional Outcomes</th>
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<tbody>
<tr>
<td>Pelvic angle</td>
<td>Vertical Forward Reach Test</td>
</tr>
<tr>
<td>Spinal angle of kyphosis</td>
<td>One Stroke Push Test</td>
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<tr>
<td></td>
<td>Timed Forward Wheeling</td>
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<td></td>
<td>Ramp Ascent</td>
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Results:
- The mean difference in pelvic angle was 9.16 (p < .0001), denoting that subjects demonstrated more upright posture with the solid back.
- Participants achieved a 2.03 inch higher vertical forward reach when using the solid back (double the minimal detectable change (MDC)).
- Participants pushed 10.2 inches farther during the one stroke push test with the solid back (2.4 times the MDC).
- Participants propelled 6.82 seconds faster up a 12 foot 12:1 ramp using the solid back.
- 80% of participants felt more stable in the solid back with 95% stating they would use it daily.

Conclusions: These results suggest a solid back promotes a more neutral pelvis, which improves functional mobility, comfort and overall satisfaction as compared with an upholstery back. This pilot study demonstrates that upward reach, forward propulsion, one stroke push and ramp ascent can be used to evaluate the effectiveness of a wheelchair back.

Clinical Relevance: Persons with SCI, especially those who are manual wheelchair users, are at increased risk for shoulder injuries, caused by repetitive use and overuse, which can potentially require surgery and increase burden of care and healthcare costs. Minimizing the number of push-strokes per day, demonstrated by increase in one-stroke push distance, is an important consideration in decreasing overuse injuries. Improved stability and biomechanics that lead to improved functional propulsion may also be the primary contributors to improved vertical forward reach. As pushing uphill causes more strain on upper extremity muscles and on energy expenditure, increasing the efficiency of this task is clinically important. Normally, in healthy adults, anticipatory postural reactions engage stabilizing muscles of the trunk when moving extremities or exerting a force. Without the ability to activate core muscles, as occurs with SCI, individuals must rely on external support surfaces such as the interaction of the back with the seat cushion. A back supporting the spinal curves enhances postural stability to increase vertical forward reach and wheelchair skills. This is important within the clinical setting to enhance function and decrease shoulder injuries.
TITLE: The Effects of Acute Estrogen Supplementation on Respiratory Function in Male Rats Two Weeks Post-SCI

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: SCI SIG
AUTHORS: Chase Allen Nier, Benjamin Andre, SPT, Ryan Biernath, SPT, Emily Madison Carstens, Lydia Stein, Rebecca Feczer, MS, Brendan J. Dougherty

ABSTRACT BODY:
Purpose/Hypothesis: Estrogen is a critical modulator of central nervous system function including the control of breathing. Yet, the impact of estrogen supplementation on respiratory function after SCI is not known. The purpose of this study was to determine if a single, acute, administration of estradiol-benzoate would improve breathing function in male rats 2 weeks post-cervical SCI.

Number of Subjects: 16 adult, male Sprague-Dawley rats

Materials and Methods: All rats received C2 hemisection spinal cord injuries (SCI). Two weeks post-SCI, rats were randomly assigned to an experimental group (n=8) receiving a single dose of estradiol benzoate, or a placebo drug control group (n=8). Breathing function was assessed with barometric plethysmography three hours post-injection during a stable room air (FiO2=0.21) baseline and subsequent graded respiratory challenges using hypoxia and hypoxia/hypercapnia. Data analyzers were blinded to treatment.

Results: Two-way RM ANOVA with Bonferroni Test for multiple comparisons indicated that spinal cord injured rats in both groups showed significant increases in ventilation during respiratory challenges (p<0.05) when compared to baseline. However, baseline respiratory frequency (p = 0.008) and minute ventilation (p = 0.039) were significantly reduced in rats receiving estradiol-benzoate compared to the control group.

Conclusions: Rats with cervical SCIs adopt a rapid, shallow breathing pattern consisting of higher respiratory frequency and reduced tidal volume production. Our results suggest that a single injection of estrogen may enable rats to adopt a more “normal” pattern of breathing, with lower baseline frequency and minute ventilation. Since estrogen-treated rats begin at a lower baseline minute ventilation, their capacity to respond to respiratory challenges may have increased.

Clinical Relevance: Estrogen signaling in the central nervous system is necessary for normal breathing, and estrogen supplementation has been shown to beneficially impact limb function following SCI. Understanding how estrogen enhances respiratory function may provide new drug targets to augment physical therapy interventions in patients with respiratory compromise following cervical SCI.
TITLE: Postprandial Thermogenesis in Persons with Spinal Cord Injuries

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: SCI SIG

AUTHORS: John P. Handrakis, Marin Leigh Graham, Patricia P. Leung, PT, DPT, Nina S. Kumar, BS, William A. Bauman, MD

ABSTRACT BODY:

Purpose/Hypothesis: Spinal cord injury (SCI) disrupts thermoregulation, the ability to maintain core body temperature (Tcore) within the range of normothermia, despite ambient temperature challenges. As a result, when in cool environments, persons with cervical SCI (tetraplegia) are vulnerable to hypothermia (Tcore≤35°C). The thermic effect of food (TEF) may help to temporarily reduce this vulnerability in persons with tetraplegia. We aimed to determine 1) whether TEF is different for two distinct, isocaloric meals, protein/fat/capsaicin (HP) versus predominantly carbohydrate (HC), in persons with tetraplegia and; 2) if TEF is altered in persons with tetraplegia compared to controls. Hypotheses: 1) TEF of HP will be greater than that of HC in persons with tetraplegia secondary to the prevalence of impaired carbohydrate metabolism after SCI. 2) TEF after HC will be lower in persons with tetraplegia than able-bodied (AB) controls secondary to decreased insulin sensitivity in persons with SCI.

Number of Subjects: 8

Materials and Methods: In a 27°C room, while in a fasted-state and in the seated position, 3 persons with chronic tetraplegia (C4–T1, American Spinal Injury Association Impairment Scale A-C) and 5 AB matched-controls ingested HP and HC on different days in random order. Outcomes included metabolic rate (VO\textsubscript{2}), Tcore (rectal thermocouple), and distal skin temperatures (Tsk). Data were collected 30-minutes prior and for 3-hours post each meal. A 2 (group: Tetra, AB) x 2 (meal: HP, HC) x 2 (time: pre, post-meal) mixed-model ANOVA was used to determine main or interaction effects followed by appropriate post-hoc analyses.

Results: Analyses of outcomes (pre to 3-hours) demonstrate 1) significant main effects of time for VO\textsubscript{2} (p=0.0003); 2) significant interactions of time*meal for VO\textsubscript{2} (p=0.01) and Tcore (p=0.02); and 3) significant interactions of time*group for distal lower extremity Tsk (p=0.0001). Within-group comparisons (pre to 3-hours) demonstrate 1) VO\textsubscript{2} increased in controls (p=0.01) after HP, but not in Tetra (p=0.08), and not after HC in either group; 2) Tcore did not significantly increase in either group after either meal; 3) lower extremity Tsk increased (p=0.02) in Tetra after HC and decreased in AB after both HP (p=0.02) and HC (p=0.03). Within-group comparisons (pre to 1-hour and pre to 2-hours) demonstrate VO\textsubscript{2} increased in Tetra at 1 and 2-hours only post HP and in AB at 1- and 2-hours post HC and at 2-hours post HP.

Conclusions: Postprandial changes in metabolic rate, although not affecting a significant increase in Tcore, suggest that the thermogenic response from HP was greater in Tetra and of longer duration in controls compared to HC in both groups. The increased postprandial distal lower extremity Tsk in Tetra compared to decreased Tsk in controls supports thermoregulatory dysfunction after SCI.

Clinical Relevance: Persons with tetraplegia may find a breakfast of spicy protein beneficial in increasing metabolic rate versus typical high-carbohydrate breakfast foods during cool seasonal weather.
 TITLE: Musculoskeletal Pain and Psychosocial Characteristics of Individuals with New SCI: Preliminary Data from Longitudinal Study

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: SCI SIG

AUTHORS: Margaret Anne Finley, Elizabeth Euiler, Thomas Trojan, Sara Kate Frye, Marni Lynn Kallins, Paula Richley Geigle

ABSTRACT BODY:

Purpose/Hypothesis: Individuals with a spinal cord injury (SCI) display a high prevalence of shoulder pain which is associated with loss of function and independence, participation restrictions in self-care, work, and leisure activities, and decreased quality of life (QoL).\(^1\)\(^2\)\(^3\) Higher pain catastrophizing has been demonstrated in individuals with SCI creating a relationship of reduced function and increased pain.\(^4\) Psychosocial determinants of shoulder pain have not been identified for individuals with acute SCI nor has the interdependence of determinants facilitating chronic pain and secondary disability. Our longitudinal study investigates the relationship and temporal characteristics of musculoskeletal pain, biopsychosocial factors, and QoL during the first year following SCI. Preliminary findings of musculoskeletal pain and psychosocial factors at baseline (n=27) and 6-months (n=15) are presented.

Number of Subjects: Individuals participating in inpatient SCI rehabilitation (n=27) and age and gender matched controls without SCI (n=23).

Materials and Methods: Demographics, Musculoskeletal Pain Survey upper extremity (MPS_UE) and shoulder (MPS_shdr) subscales,\(^5\) along with psychosocial measures [Tampa Kinesiophobia Scale-11 (TSK), Pain Catastrophizing Scale (PCS), Fear of Pain Questionnaire (FPQ), and Subjective Quality of Life Questionnaire (SQoL)].

Results: No baseline difference in age, ethnic identification, racial group, occupational status, marital status, education level, or annual income existed between the groups. Baseline MPS_UE (p=0.02), MPS_shdr (p=0.05), PCS (p<0.001), TSK (p<0.001), and FOP (p=0.01) scores were higher and SQoL was lower (p<0.001) in individuals with SCI compared to matched controls. At 6-months following discharge from inpatient rehabilitation, musculoskeletal pain remained elevated and maladaptive psychosocial characteristics were unchanged for people with SCI (n=15).

Conclusions: Preliminary data indicate individuals with new SCI demonstrate upper extremity musculoskeletal pain along with maladaptive psychosocial pain factors. These factors continued 6-months post inpatient rehabilitation during initial community reintegration.

Clinical Relevance: Shoulder pain management for people with SCI is currently reactive rather than proactive. Early identification of pain-related factors may ameliorate potential pain linked activity and participation decline. Our longitudinal study will identify shoulder pain determinants in the year after SCI.
Purpose/Hypothesis: Emerging research indicates the application of electrical stimulation applied directly to the spinal cord can result in active motor recruitment below the level of injury for individuals with complete spinal cord injury (SCI). Non-invasive electrical stimulation, transcutaneous spinal direct current stimulation (tsDCS), has the ability to alter spinal reflexes and modulate spinal cord excitability in healthy subjects and individuals with SCI. Therefore, tsDCS has the potential to modulate and induce spinal cord excitability and neuroplasticity which may lead to recovery after SCI. The purpose of the study was to investigate the potential neurophysiological changes and functional improvements in gait for individuals with SCI after application of tsDCS and exoskeleton assisted locomotor training. We hypothesized that all subjects would tolerate the use of tsDCS without adverse reactions and use of tsDCS would lead to measureable change in spinal excitability. We also hypothesized that when subjects received tsDCS in combination with exoskeleton assisted locomotor training they would demonstrate increased spinal excitability.

Number of Subjects: 4 subjects, 3 male and 1 female, with chronic motor incomplete SCI.

Materials and Methods: Subjects received two types of training A) 20 minutes of exoskeleton assisted locomotor training and B) 20 minutes of tsDCS (2.5 mA, anode or cathode) applied over the spinous processes of T10 followed by 20 minutes of exoskeleton assisted locomotor training. Two subjects received training in A-B-A sequence and 2 subjects in B-A-B sequence. Subjects a one week wash out period after 5 consecutive days of training under each condition. Spinal excitability (H-reflex) and gait speed were assessed on the first and fifth days of training for each type of training session.

Results: All subjects responded to treatment without any adverse reactions. The Hmax/Mmax ratio (H/M ratio) of the soleus muscle was utilized to measure spinal excitability. When subjects received tsDCS followed by exoskeleton assisted locomotor training, half demonstrated an increase and half had a decrease in H/M ratio. When subjects received exoskeleton assisted locomotor training only, 3 of 4 had a decrease in H/M ratio. 3 of 4 subjects showed a decrease in gait speed after exoskeleton assisted locomotor training and 3 of 4 had an increase in gait speed after tsDCS combined with exoskeleton assisted locomotor training.

Conclusions: Non-invasive spinal stimulation can be used safely with individuals with incomplete SCI. Further research is necessary on a larger scale to determine the efficacy of the stimulation on spinal excitability and recovery of gait in person with SCI.

Clinical Relevance: This non-invasive modality, which modulates spinal cord excitability, has the potential to promote neurological recovery after SCI.
A Relationship between Breathing and Balance in Persons with Spinal Cord Injury

Purpose/Hypothesis: Functional seated balance (FSB) is compromised after spinal cord injury (SCI) by suboptimal muscle activation and altered sensation. The diaphragm plays a key role in postural stability and balance for persons with an intact neuraxis. This study examined the relationship between diaphragm function and FSB in persons with SCI, hypothesizing that those with better inspiratory performance (IP) will have higher FSB scores on a modified version of the Function in Sitting Test (FIST-SCI).

Number of Subjects: Individuals with tetraplegia (Tetra; n=21, ASIA Impairment Scale (AIS) A = 8, B= 7, C = 6) and paraplegia (Para; n=16, AIS A= 9, B=4, C=3) for > 1 year were recruited. Subjects were non-smokers and had no acute/chronic cardiorespiratory illness or disease.

Materials and Methods: IP testing was performed in personal wheelchairs using a handheld device and nose clips. Individuals exhaled completely and then inhaled as fast and as long as possible. IP measures were: 1) maximal inspiratory pressure (MIP) measured from residual volume to peak pressure within two seconds (cm H\textsubscript{2}O), 2) sustained MIP (SMIP) measured from residual volume to total lung capacity in pressure time units (PTU), and 3) inspiratory duration (ID) in seconds. The FIST-SCI measured FSB. Descriptive characteristics (age, height, weight, level of injury (LOI), and the duration of injury (DOI) were recorded.

Results: When the entire sample was analyzed, UEMS, MIP, SMIP, and LOI had low-to-high correlations with FIST-SCI scores ($r_s$ = .72, .48, .47, .53, respectively, $p \leq .05$). Descriptive measures and ID were not significantly correlated with FSB. None of the factors were significantly correlated with FSB in the Para group. However, the UEMS and breathing factors showed equal or higher correlations with FSB in the Tetra group (UEMS $r_s$ = .86, MIP $r_s$ = .51, SMIP $r_s$ = .47, $p \leq .05$). MIP, SMIP, and FIST-SCI scores were higher for the Para group ($p \leq .05$). Further, SMIP and UEMS predicted FIST-SCI balance scores in the Tetra group, accounting for 55% of total variance ($p \leq .05$) ($\text{FIST-SCI} = 11.88 + .03(\text{SMIP}) + .425(\text{UEMS})$). No autocorrelation was present (Durbin-Watson= 2.09).

Conclusions: These data show that the relationship between breathing and balance in neurologically intact individuals is preserved after SCI. FSB can also be predicted, in part, by measuring UEMS and SMIP in individuals with cervical SCI. Future research should focus on the impact of breathing interventions on FSB after SCI.

Clinical Relevance: The relationship between IP and FSB across LOI and the predictive relationship of SMIP and FSB may warrant an increased focus on diaphragm strengthening in persons with cervical SCI.
Purpose/Hypothesis: Upper extremity (UE) functional impairments due to cervical spinal cord injury (cSCI) are attributable primarily to the disruption of ascending and descending spinal pathways, and secondarily to maladaptive cortical reorganization. Non-invasive brain stimulation approaches, such as transcranial direct current stimulation (tDCS), can induce neuroplastic changes in the primary motor cortex and improve hand function in individuals with cSCI. However, the literature indicates there is high inter- and intra-individual variability in response to tDCS, limiting its clinical value. Transcranial random noise stimulation (tRNS) induces more consistent cortical excitatory responses, can improve behavioral performance, and is imperceptible. Yet, tRNS application in persons with cSCI is still novel. We performed a sham-controlled study to assess the post-stimulation effects of a single application of tRNS on cortical excitability, force generation, and motor unit recruitment/derecruitment in individuals with cSCI.

Number of Subjects: Eleven individuals with cSCI (American Spinal Injury Association Impairment Scale grade B=1, C=4, and D=6; mean age 49 ± 12.6 years) participated in this crossover, sham-controlled study. All participants had been injured at least three months prior to enrollment and had a neurological level of injury at C7 or above.

Materials and Methods: Subjects completed 2 sessions - separated by at least 48 hours – of functional task practice (FTP) while receiving 20 min of tRNS or sham stimulation in the cortical representation area of the more impaired UE. FTP consisted of repetitive unimanual and bimanual tasks. Before and after each session, cortical excitability was assessed based on motor evoked potential amplitude (elicited via transcranial magnetic stimulation). Maximal motor unit recruitment was assessed based on key pinch force generation (measured via pinch dynamometer). Finally, a finger tapping task was utilized to test the ability to rapidly recruit/derecruit motor units. Paired t-tests were performed to assess the significance of pre/post differences. Effect sizes were also computed.

Results: TRNS was well tolerated by all participants, and no adverse events were reported. The application of tRNS increased cortical excitability and improved the ability to recruit/derecruit motor units in the targeted UE (moderate and weak effect size, respectively). No differences were observed in pinch force.

Conclusions: TRNS can modulate cortical excitability in persons with cSCI. Overall, tRNS may have the potential as an adjunct to traditional FTP in order to enhance corticospinal transmission for improved hand function in this population. The use of tRNS warrants further exploration in a multi-session study.

Clinical Relevance: TRNS is a noninvasive and easily administered stimulation approach. When combined with FTP, TRNS may augment the therapeutic effects of training and increase functional recovery in SCI. Improving UE function in individuals with cSCI may have significant implications for their daily lives.
TITLE: Does Walking Training Improve Glycemic Control and Psychological Status in Individuals with Spinal Cord Injury

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: SCI SIG

AUTHORS: Ramzi A. Alajam, Abdulfattah SAEED Alqahtani, Jason Frederick, Wen Liu

ABSTRACT BODY:

Purpose/Hypothesis: Abnormal glycemic homeostasis after spinal cord injury (SCI) is one of risk factors of cardiovascular disease. A study reported that 22% of individuals with SCI had diabetic mellitus (DM) compared to 6% in able-bodied individuals. The high incidence of DM after SCI can be attributed to lack of physical activity and alterations in body composition and muscle characteristics. Regular exercise is necessary to reduce or prevent secondary complications following SCI, including DM. A previous study, in individuals with motor incomplete SCI, reported a significant improvement in the concentration of blood glucose after walking training. However, this study did not include those with motor complete SCI. Furthermore, it is estimated that 20-30% of people with SCI are at risk of psychological distress after injury, and those with severe physical function impairments are at high risk. Thus, the primary purpose of this study was to investigate the effects of walking training on hemoglobin A1c (HbA1c), which is the averaged level of blood glucose over the previous two to three months, in individuals with chronic SCI, including those with motor complete injury. The secondary purpose was to examine the impacts of walking training on psychological status in individuals with chronic SCI.

Number of Subjects: Nine individuals (7 male, 7 motor complete SCI, 36±9 years-old, injury level T3-L1, injury onset 10±11 years) with chronic SCI enrolled in the study.

Materials and Methods: Subjects went through a walking training program using a treadmill, a body weight-supported system, and an assistive gait training device, three sessions per week for eight weeks, a total of 24 training sessions. HbA1c was assessed using the A1CNow® test kit before and after training. Psychological status was examined through the Depression Anxiety Stress Scale-21 before and after training.

Results: After training, HbA1c significantly decreased from 5.71±0.65% to 5.34±0.56%, p=0.0005. There were significant decreases in the mean score of depression (4.33±2.78 vs. 1.78±1.30, p=0.0003), anxiety (4.56±4.79 vs. 2.78±4.32, p=0.0045) and stress (4.56±2.87 vs. 2.11±1.16, p=0.002) after training.

Conclusions: The findings of this study suggest that eight weeks of walking training, in individuals with chronic SCI, could have a positive impact on glycemic control as shown by a reduction in the measured level of HbA1c. In addition, the walking training helped to improve psychological health as reflected by a decrease in the level of depression, anxiety, and stress. A future randomized controlled trial is needed to examine the effects of walking training on those outcome measures as compared to other exercise modalities.

Clinical Relevance: People with SCI are at high risk of developing DM due to a sedentary lifestyle and changes in body composition after injury. The finding of this study would help to guide clinical practice in rehabilitation for patients with SCI to prevent or reduce secondary complications following injury.
Abstract

Purpose/Hypothesis: After neurological injury, decreased motor control, autonomic dysregulation, and functional impairments such as spasticity are frequently present. Physical therapy plays an essential role in the management of spasticity through various interventions including stretching, positioning, dry needling, therapeutic exercises and electrical stimulation. Recently a technique known as transcutaneous spinal cord stimulation has been shown to reduce spasticity, improve motor control and improve orthostatic hypotension while standing. However, the mechanism of action by which transcutaneous spinal cord stimulation reduces spasticity remains unclear but may be related to changes in autonomic function and there may also be effective at increasing peripheral blood flow after injury. Therefore, the purpose of this study was to investigate whether transcutaneous spinal cord stimulation modulates autonomic activity in healthy, non-injured participants. We hypothesize that transcutaneous spinal cord stimulation increases sympathetic drive resulting in decreased heart rate variability and increased peripheral blood flow and elevated skin temperature.

Number of Subjects: 11

Materials and Methods: To test this hypothesis, we measured heart rate variability, peak arterial blood flow velocity, and skin temperature before, during, and after a bout of transcutaneous spinal cord stimulation in eleven participants with no history or neurological injury. Heart rate variability was calculated as the variability between heart beats (R-R interval) using an electrocardiogram and finger plethysmograph. Doppler ultrasound was used to assess peripheral blood flow through measurement of the dorsalis pedis artery and skin temperature was measured using a surface temperature probe placed inferior and posterior to the medial malleolus. Transcutaneous spinal cord stimulation was applied using a biphasic electrical stimulator with stimulating electrodes placed over the T11/T12 vertebrae and umbilicus. Stimulus frequency was set at 50 Hz and stimulus intensity was set to the max tolerable amplitude.

Results: Overall, we found no significant changes in peripheral blood flow velocity during or after stimulation. For skin temperature, we found no change across participants though some showed participants had changes in skin temperature. Similarly, we found no change in overall heart rate or heart rate variability during or after stimulation. Percent change from baseline for each measure was calculated and a repeated measures ANOVA was performed.

Conclusions: Our results suggest that a 20-minute bout of tonic transcutaneous spinal cord stimulation does not appear to alter sympathetic drive in non-injured participants. However, given the altered state of the spinal cord after injury, spinal stimulation may still alter sympathetic drive and needs to be investigated more thoroughly.

Clinical Relevance: Based on our results, transcutaneous spinal cord stimulation offers an intervention to diminish spasticity through it may not be as effective at reducing autonomic symptoms. Ultimately, this study helps to show that transcutaneous spinal cord stimulation is still poorly understood, and more studies are needed to elucidate the best practices.
TITLE: Acute Cardiometabolic and Muscular Responses to Exoskeleton Walking with Fes in SCI
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: SCI SIG
AUTHORS: Caitlin Segelke, Evan Lindsey Glasheen, Kimberly Tsuda, Jochen Kressler, Antoinette Domingo

ABSTRACT BODY:
Purpose/Hypothesis: Sedentary lifestyle due to spinal cord injury (SCI) can lead to serious secondary health complications. Robot-assisted gait training using the Ekso has potential to combat these complications by enabling people to walk overground in full weight bearing, but stimulation of the cardiorespiratory system is limited by an individual’s residual motor function. The addition of functional electrical stimulation (FES) to Ekso training can increase activation of leg musculature, producing additive benefits and improved health outcomes. The purpose of this study is to compare %VO$_2$peak, energy expenditure rate (EER), respiratory exchange ratio (RER), and muscle fatigue during Ekso walking with FES (Ekso-FES), Ekso without FES (Adaptive (Ekso-A) and Fixed (Ekso-F) assist) and lower-extremity cycling with FES (LEC-FES) in individuals with SCI. We hypothesized that Ekso-FES would result in greater %VO$_2$peak and muscle fatigue than Ekso without FES or LEC-FES in individuals with SCI.

Number of Subjects: 5

Materials and Methods: Participants with chronic SCI (ASIA A-D) exercised in 4 conditions: 1) Ekso-FES, 2) Ekso-A, 3) Ekso-F, 4) LEC-FES for 6 minutes each on separate days. Indirect calorimetry was used to measure %VO$_2$peak and RER. To estimate fatigue, pre- and post-exercise differences in stimulated muscle strength were measured using hand-held dynamometry, and spasticity using the Spinal Cord Assessment Tool for Spastic Reflexes (SCATS).

Results: Moderate-to-vigorous physical activity levels were achieved with Ekso-FES in 4 of 5 participants (52-88 %VO$_2$peak). %VO$_2$peak was significantly higher during Ekso-FES (mean=62%) compared to Ekso-F (56%) and LEC-FES (30%) (RMANOVA: p=.04, post-hoc LSD: p≤.033). RER was greater for both FES conditions than in non-FES conditions, and was significantly higher during LEC-FES (1.032) compared to Ekso-A (0.866) (RMANOVA: p=.01, LSD: p=.029). Decrease in quadriceps strength was significantly greater after Ekso-FES (8.09 lb) compared to Ekso-F (4.43 lb) and Ekso-A (3.36 lb) (RMANOVA: p=.019, LSD: p=.036). Knee flexor strength decreased after walking in all conditions except Ekso-A, with no significant differences between groups (p=.41). Clonus and extension spasticity decreased after walking, with no differences between groups (p>.371). Flexion spasticity increased for all Ekso conditions with no differences between groups (p=.477).

Conclusions: Ekso-FES can evoke greater physiological responses in people with SCI during exercise compared to LEC-FES, potentially leading to greater health benefits. RER results suggest that the FES conditions were more glycolytic. In general, electrically induced muscle strength was less after exercise, particularly in the quadriceps with Ekso-FES.

Clinical Relevance: This study is among the first to examine the effects of Ekso with FES in individuals with SCI. This study shows that cardiovascular demand and muscle engagement may be greater with Ekso-FES than Ekso without FES or LEC-FES. Further research should study the physiological effects of longer duration and repetitive exercise using Ekso with FES.
Purpose/Hypothesis:
To determine if the implementation of a Spinal Cord Injury (SCI) Specialized Care Initiative across a hospital continuum had an effect on functional outcomes at a hospital-based inpatient rehab facility (IRF).

Number of Subjects:
Participants included 419 patients with acute traumatic SCI admitted to the IRF from 2003 to 2018, and separated as eight years pre-implementation and eight years post-implementation of a hospital based SCI initiative in 2011.

Materials and Methods:
This study was a single center retrospective case control study. Five variables were collected per year: IRF LOS, time of admission to IRF after injury, Functional Independence Measures (FIM) scores on admission, FIM scores on discharge, and overall FIM change. Data was analyzed to look for significant differences pre-implementation and post-implementation of the initiative.

Results:
Statistically significant differences ($p \leq 0.05$) were found between pre-implementation and post-implementation for days to IRF admission post-injury (39.4 versus 18.7), IRF LOS (30.0 versus 24.5), FIM change (23.0 versus 28.9), and discharge FIM scores (80.9 versus 86.7). There was no significant change in admission FIM scores.

Conclusions:
Results showed that despite a shorter IRF LOS, less days from injury to IRF admission, and similar functional capabilities on admission, the implementation of an SCI Initiative led to greater functional changes and improved discharge functional outcomes. This retrospective study shows that standardization of SCI care across a hospital continuum may result in better functional outcomes and more effective and efficient LOS.

Clinical Relevance:
It is essential for persons who suffer an acute traumatic spinal cord injury (SCI) to have access to timely medical care, early interventions, and specialized care across the continuum to improve survival, wellness, and community reintegration. Research demonstrates that early specialized SCI care has the potential to shorten length of stay (LOS), lower costs of care, improve hospital and functional outcomes, lower mortality, decrease the number and severity of complications, and improve the likelihood of returning home. This study supports the importance of a SCI specialized care initiative to improve functional outcomes and LOS during an IRF visit.
Purpose/Hypothesis: Previous studies have validated the use of the Sitting Balance Scale (SBS), to assess the balance of older-adults who are primarily non-ambulatory. Research indicates that the SBS may be a useful tool for assessing a wide range of diagnoses (neuromuscular, musculoskeletal or cardiopulmonary). Currently, no research assessing the usefulness of the SBS in individuals with spinal cord injury (SCI) exists. The current 11 item Sitting Balance Scale (SBS-11) includes two tasks that require use of the lower extremities, Item 6 (alternating leg movements) and Item 10 (sit to stand). A 9-item version (SBS-9) removes these two items, allowing the scale to be used with individuals who have a SCI and cannot move their lower extremities. Objectives: To determine whether the SBS-9 is able to differentiate level of injury, assess the reliability of the SBS-9, and determine the association between the SBS-9 and SBS-11.

Number of Subjects: Fifty three (53) primarily non-ambulatory participants with a SCI (Cervical =22; Thoracic = 27; Lumbar = 3; Unknown =1) were recruited from the community.

Materials and Methods: Prior to testing, each participant completed a consent form and demographic survey including their background, level of injury, time since onset, and their functional abilities. All participants were assessed with Functional Independence Measure -Transfers, SBS and Modified Functional Reach Test (MFRT). Verbal instructions and visual demonstration were given for each assessment tool. Participants performed all seated components on a mat or at the edge of their wheelchair, feet supported on a firm surface, and no upper extremity support. The data analysis was completed using descriptive statistics and parametric testing, including independent t-test and Pearson’s product-moment correlation.

Results: The results revealed that items in both the SBS-9 and SBS-11 demonstrated high inter-item reliability (Cronbach’s alpha = 0.884 and 0.894, respectively). The average score on the SBS-9 was 26.43 ± 9.067; SBS-11 was 27.06 ± 9.516. Independent t-test results revealed that scores for participants with a cervical level injury (M = 21.64 ± 8.156) were significantly lower than for participants with a lower injury level (M = 29.84 ± 8.190), with a large effect size (Cohen's d = 1.003). Results revealed that higher scores on the SBS-9 were associated with higher scores on the SBS-11 (r = 0.928).

Conclusions: Both the SBS-9 and SBS-11 demonstrate high inter-item reliability. The SBS was able to discriminate between individuals with cervical injuries and those with below-cervical injuries and is an appropriate outcome measure to use for the SCI population, particularly in non-ambulatory individuals. Scores on the SBS-9 correlated highly with those on the SBS-11, indicating that the SBS-9 is appropriate to use in individuals who cannot move their lower extremities. Further analysis should be done to assess concurrent validity with other functional outcomes. Limitations of the study include a small sample size and possible selection bias as all participants were members of a local gym or clinic.

Clinical Relevance: Clinicians who treat individuals with SCI may use either the SBS-9 or SBS-11 to assess sitting balance in their patients.
TITLE: Triceps Brachii in Tetraplegia: A Feasibility Study of a Novel 6-Week Home-Exercise Program
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: SCI SIG
AUTHORS: Lisa Johanson, PT, DPT, Jeff Jaramillo, PT, MSPT, Elliot J. Gann

ABSTRACT BODY:

Purpose/Hypothesis: Injury to the cervical spine often results in the loss of voluntary elbow extension due to disrupted neural input to the triceps brachii, which can have a profound effect on upper extremity function. Exercise therapy is a primary component of rehabilitation following spinal cord injury; however, this population has limited access to directed, long-term exercise following formal rehabilitation. The purpose of this study was to assess the feasibility, safety and resources required to implement a novel home-exercise program designed to strengthen the triceps brachii for individuals with chronic cervical spinal cord injury (cSCI).

Number of Subjects: Four participants (2 females, mean [SD] age=46 [4.8]; mean [SD] years since injury=17.8 [4.1]) with clinical diagnosis of cSCI and weak elbow extension strength (manual muscle test grades 2 to 4) completed the study.

Materials and Methods: In this feasibility study, 3 participants completed a novel, home-exercise program designed to strengthen the triceps brachii. The intervention entailed a 6-week exercise program aimed to stimulate the triceps in various postures and under multiple conditions. Practicality of the intervention was determined based on participant’s verbal report of their ability to independently set-up and use the exercise stations in a home environment. Safety and treatment effect of the exercise dose were quantified through combined triceps brachii strength with use of a fixed force sensor and functional capacity tests. A hand-held dynamometer (HHD) was used to measure elbow extension strength in 3 positions to independently assess the different heads of the triceps brachii.

Results: Three participants independently set-up the home-exercise equipment and reported a positive physical benefit following training. There were no adverse events related to the intervention. Small increases (<5%) in combined triceps strength were measured by force sensor. Two participants increased the weight used during each functional capacity test. Within-participant measurements of strength of the individual heads of the triceps with HHD varied by up to 3kg with different testing postures.

Conclusions: Our findings indicate this is a feasible home-exercise program which may be deployed for individuals with tetraplegia with reduced triceps strength. Additional work is needed to determine the effectiveness of this type of exercise program with a larger cohort. Future studies may benefit from inclusion of a validated subjective questionnaire to quantify perceived change in function, and increased frequency of monitoring to optimize safety and adherence to the exercise program.

Clinical Relevance: Clinicians who prescribe a home-exercise program of this intensity to individuals with tetraplegia should closely monitor strength changes to prevent overuse injury. Our findings suggest that assessing elbow extensor strength in multiple positions may provide more detailed information regarding an individuals’ residual motor resources.
ABSTRACT BODY:

Background and Purpose: Rehabilitation of walking after incomplete spinal cord injury (ISCI) is limited by insufficient excitation and poor modulation of spinal locomotor circuitries. Transcutaneous spinal direct current stimulation (tsDCS) is a mild, non-invasive electrical stimulation approach that can alter the spinal circuits, potentially enhancing responsiveness to descending motor commands and ascending somatosensory inputs provided during training. The aim of this case series is to investigate the effects of tsDCS in combination with locomotor training on spinal excitability in two individuals with ISCI. We hypothesized that tsDCS combined with locomotor training (LT+stim) would increase spinal excitability and improve reflex modulation more than locomotor training with sham stimulation (LT+sham).

Case Description: Participant 1 is a 33-year-old male with a chronic ISCI (C1, AIS D, 27 months post-injury) who ambulates independently in the community. Participant 2 is a 61-year-old male (C1, AIS C ISCI, 21 months post-injury) who uses a power wheelchair for home and community mobility. Both individuals completed two random-ordered sessions, five days apart. Active tsDCS (2.5 mA for 30 minutes) or sham stimulation was delivered simultaneously with locomotor training, with the anode centered posteriorly between the T11 and T12 spinous processes and two cathodes placed on either side of the umbilicus. Spinal excitability was measured by eliciting Hoffman (H) reflexes before and after the locomotor training session. H-wave measurements were normalized to the maximal motor response (M-wave). Normalized H-wave amplitudes were plotted against stimulation intensity, and a sigmoid curve was fit to the ascending side of the curve. Changes in the area under the sigmoid curves (pre- to post-session) were taken to indicate a change in spinal excitability. Modulation of reflex responses to repeated stimuli (post-activation depression) was also assessed by quantifying the change in H-wave amplitude when repeated stimuli were delivered at 1 Hz.

Outcomes: Consistent with our hypothesis, participant 1 demonstrated greater spinal excitability after LT+stim (0.042 increase in the area under the curve) versus a slight reduction in excitability following LT+sham (-0.021). Similarly, participant 2 demonstrated a larger increase in spinal excitability after LT+stim (0.044) versus LT+sham (0.039). Greater improvements in reflex modulation were also evident following LT+stim with a 31% increase in post-activation depression versus a 15% increase after LT+sham in participant 1. Post-activation data were unobtainable in participant 2 due to spastic responses to repeated stimuli.

Discussion: These findings support the hypothesis that tsDCS combined with walking rehabilitation can increase the excitability of spinal circuitries and alter the modulation of reflex responses below the level of the injury. The observed changes with tsDCS may allow the spinal circuitries to be more responsive to rehabilitation, particularly when applied repeatedly as part of a training paradigm.
**Title:** Contribution of Strength and Force Control to Manual Dexterity in High-Functioning Stroke

**Current Section:** Neurology

**Current Sub-Category:** Stroke SIG

**Authors:** Prakruti J. Patel, Tasnuva Alam, Neha Lodha, PhD

**Abstract Body:**

**Purpose/Hypothesis:** Individuals with moderate-mild motor impairments after stroke experience a higher level of functional autonomy. Increased functional independence places greater demands on hand dexterity to complete tasks such as using a phone, typing, and driving. However, the motor deficits that influence manual dexterity in high-functioning stroke survivors are not known. Two prominent motor deficits that limit functional performance after stroke are decline in strength and force control. Therefore, the purpose of our study was 1) to quantify the deficits in manual dexterity, strength, and force control in high-functioning stroke survivors and 2) to identify the relative contribution of strength and force control to manual dexterity.

**Number of Subjects:** Twelve high-functioning chronic stroke survivors with Fugl-Meyer upper extremity score >43/66, independent community ambulation, and Montreal cognitive assessment score of ≥ 24/30 and 12 age-matched controls volunteered to participate in the study.

**Materials and Methods:** Participant’s manual dexterity was assessed with nine-hole pegboard task and car steering in simulated driving environment, and strength and force control were examined during isometric gripping and index finger flexion. Manual dexterity was quantified with a) time to complete the pegboard task that required transferring and removing nine pegs into the holes as fast as possible, and b) the extent of lane deviation during steering task that required maintaining the car in the center of a winding road in simulated driving environment. Strength was measured as maximum voluntary contraction force. Force control was measured as the variability (coefficient of variation) of force output on a visuomotor force tracking task that required dynamic isometric force. All tasks were performed with paretic hand in the stroke group and non-dominant hand in the control group.

**Results:** The high-functioning stroke group showed moderate to mild upper limb impairment with mean FMA score = 52.5/66, 67.59% paretic hand grip strength, and 66.09% paretic finger strength relative to the non-paretic hand. Compared with the control group, the stroke group required greater time to complete the pegboard task and had increased lane deviation on the steering task. Further, the high-functioning stroke group showed reduced strength and increased force variability compared with the controls. Multiple regression analysis in the stroke group revealed that finger force variability ($\beta = 0.77$, $R^2 = 0.59$, $p < 0.01$) rather than finger strength ($\beta = -0.19$, $p > 0.05$) predicted time to complete the pegboard task. Similarly, grip force variability ($\beta = 0.80$, $R^2 = 0.65$, $p < 0.05$) was a significant predictor of lane deviation, but not grip strength ($\beta = 0.17$, $p > 0.05$).

**Conclusions:** High-functioning stroke survivors with moderate to mild motor impairments show persistent deficits in manual dexterity. With reasonable recovery of paretic hand strength, steadiness of force is the primary contributor to manual dexterity in stroke survivors with higher functional status.

**Clinical Relevance:** Deficits in skilled manual performance could be a barrier in achieving a greater degree of functional independence after stroke. Yet, rehabilitation resources are often limited for high-functioning stroke survivors who show persistent deficits in manual dexterity. Our findings regarding the contribution of force variability to manual dexterity provides a compelling reason for evaluating and rehabilitating force control to improve upper limb function in high-functioning stroke survivors.
Purpose/Hypothesis: People in the chronic phase of stroke recovery use substantially more energy to walk than individuals without stroke. Impaired locomotor control contributes to the increased energy cost of walking. There is strong evidence that incorporating rhythmic auditory cues during gait training can influence and improve post-stroke walking. The purpose of this study was to evaluate the effects of a single session of music-based rhythmic gait training delivered from an automated training platform on the energy cost of post-stroke walking (i.e. walking economy). We hypothesized a training-induced improvement in walking economy, and that this improvement would be related to improvements in walking rhythm.

Number of Subjects: Ten individuals with chronic post-stroke hemiparesis.

Materials and Methods: This study was conducted as part of a larger feasibility study of a sensor-automated, music-based rhythmic locomotor training platform. The training platform was designed to (i) monitor a user’s cadence and (ii) progress them to faster cadences by systematically advancing the tempo of music played through headphones based on their ability to match their cadence to the rhythmic music stimuli (i.e., entrain). Thirty minutes of overground gait training with the platform were provided, with each user’s walking economy and gait biomechanics evaluated immediately before and after the training by way of a 3-min treadmill walk test. The treadmill speed was set to each participant’s pretraining overground comfortable walking speed (i.e., matched speeds). Pairwise analyses were used to identify pre- to post-training changes in walking economy. Regression analyses were used to evaluate contributing factors to these changes.

Results: As hypothesized, a 30-min training session resulted in a 7.7 ± 2.8 % improvement in walking economy (p=0.014), with 5 of 10 participants achieving at least a 12% reduction in their energy cost of walking. Pretraining walking economy explained 50% of the variance in improved walking economy (R²=0.499, p=0.022). Group-level changes in the spatiotemporal and biomechanical variables evaluated were not observed; however, a reduction in step time asymmetry explained 45% of the variance in improved walking economy (R²=0.445, p=0.049).

Conclusions: Thirty minutes of music-based rhythmic locomotor training provided from an automated training platform can facilitate substantial improvements in post-stroke walking economy, with these effects partially explained by changes in walking rhythm as measured by step time asymmetry. Moreover, larger improvements were observed in more impaired participants. Taken together, these findings support further study of how this promising rehabilitation technology can be used to facilitate more economical walking after stroke.

Clinical Relevance: A high energy cost of walking contributes to reduced physical activity and community participation after stroke. This study demonstrates that providing music-based rhythmic stimuli in an individualized and progressive manner can promote more economical walking in people post-stroke, and that this training approach can be provided by an automated training platform.
TITLE: Reliability and Validity of “Awareness of Functional Tasks with Arm and Hand in Stroke” Scale

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Stroke SIG

AUTHORS: Samantha Wicks, Shelby Marie Tarr, Spencer Castillo, Gregory Rasmussen, Christopher Warden, Ann Van de Winckel

ABSTRACT BODY:

Purpose/Hypothesis: About 70% of people with stroke have upper extremity impairments resulting from sensorimotor\(^1\)–\(^3\) and body awareness\(^4\) deficits. Body awareness is defined as conscious awareness of body position and movements in space.\(^5\) Body awareness is correlated with independent activity of daily living performance,\(^4\) suggesting the importance of assessing body awareness concurrently with quality of motor function post-stroke.\(^6\),\(^7\) Yet, current outcome measures only look at either quality of movement (in stroke)\(^1\) or body awareness (designed for healthy adults).\(^8\)–\(^10\) The purpose of this study is to assess the inter-rater reliability and convergent validity of the 13-item “Awareness of Functional Tasks with Arm and Hand in Stroke” (AFAS) comprised of a quality of movement or motor section and body awareness section in patients with stroke.

Number of Subjects: We recruited participants with stroke with arm/hand motor impairments due to stroke, age 18-99, and English speaking. Exclusion criteria were severe neglect, aphasia, or apraxia, or reduced cognitive function (Mini-Mental State Examination-Brief version<13/16).

Materials and Methods: Inter-rater reliability was tested with ICC and kappa. Convergent validity was tested with Spearman correlations.

Results: We evaluated 37 participants (mean age 55.70±12.84 years, range 25-81; 11 females; 4.04±2.82 years post-stroke, range 0.50-10.50 years post-stroke; 29 with ischemic brain lesions). AFAS inter-rater reliability was moderate to excellent (\(ICC=0.97-0.99, \kappa=0.50-1.00\)). AFAS motor section was strongly correlated with the Motor Evaluation Scale for Upper Extremity in Stroke Patients (MESUPES)\(^1\) (\(\rho=0.91, p<0.0001\)), and moderately correlated with the AFAS body awareness section (\(\rho=0.57, p=0.0006\)). There was a weak to no relationship between AFAS body awareness and the Multidimensional Assessment of Interoceptive Awareness scale\(^8\) (\(\rho=-0.02, p=0.90\)), Revised Body Awareness Rating Scale\(^9\) (\(\rho=-0.15, p=0.40\)), and Physical Body Awareness Questionnaire\(^10\) (\(\rho=-0.24, p=0.18\)).

Conclusions: AFAS motor and body awareness sections and total score have excellent inter-rater reliability. AFAS motor section demonstrates high convergent validity with MESUPES, indicating similar constructs of evaluating quality of movement. AFAS body awareness only showed weak to no correlation with other existing body awareness scales, which might indicate that they are measuring different constructs of body awareness.

Clinical Relevance: AFAS is the first scale measuring both quality of movement and body awareness in stroke. This is a promising scale for clinical use. The moderate correlation between AFAS motor and body awareness sections lead us to assume that there is at least some association between body awareness ability and quality of movement after stroke. Thus, further research on the impact of body awareness ability on motor recovery post-stroke is warranted.
Purpose/Hypothesis: Stroke is a leading cause of the loss of independent mobility status among older adults. Although survivors of stroke may recover some ability to complete functional mobility, successful mobility in the community often remains limited. The aim of this study is to explore how perceptions of community mobility align between older adults recovering from stroke and their physical therapists after discharge from therapy.

Number of Subjects: Six pairs of older adult patients who have experienced stroke and their physical therapists.

Materials and Methods: A mixed methods approach was utilized including individual semi-structured qualitative interviews with patients and physical therapists in addition to administration of the Environmental Analysis of Mobility Questionnaire 2.0 with patient participants. Qualitative and quantitative data were triangulated to determine overarching themes related to patient perspectives on community mobility encounters and avoidances as well as the alignment of the perspectives to those of the treating physical therapist.

Results: Overarching themes from patients included: factors that promoted community engagement, frustrations with the rehab process including malalignment with their physical therapist’s plan of care, and barriers to community mobility which included decreased upper extremity function, inability to drive, and fall risk. Themes from the physical therapists included: incorporation of evidence based practice for outcome measures and interventions, development of a therapeutic alliance with the patient, and barriers to community reintegration post stroke including third party restrictions and negative public perceptions. Barrier themes of upper extremity function, fall risk, and inability to drive supported avoidances of the distance, terrain, physical load, postural transition and attention dimensions when triangulated to the EAMQ 2.0.

Conclusions: Despite all older adults achieving the designation of community ambulator, significant avoidance of dimensions related to community mobility existed. Notably, the reported residual upper extremity impairments seem to be a larger contributor to avoidance behaviors versus the influence of achieving a designation of community ambulatoras per gait speed had on reported encounters across the dimensions of community mobility.

Clinical Relevance: Increased awareness by physical therapists of the variety of dimensions of community mobility as perceived by stroke survivors may allow for meaningful tailoring of post stroke rehabilitation approaches. Specifically, these insights can inform considerations related to episodes of care, therapeutic alliances, and performance across the dimensions of community mobility which may lead to enhanced patient outcomes.

Keywords: stroke, survivor perception of community mobility, therapist perception of community mobility, mixed methods
Neuromechanical Differences between Paretic and Nonparetic Hip Joints during a Step-up Task: A Pilot Study

Purpose/Hypothesis: Stroke is a leading cause of disability and fifth leading cause of death for American adults. Common abnormal co-contraction patterns post-stroke include hip extension, adduction, and knee extension; or hip flexion, abduction, and knee flexion. These co-contraction patterns make it challenging for individuals post-stroke to perform functional activities, such as a step-up task. Stepping is essential in locomotion, navigating terrain, and negotiating stairs. The purpose of this study was to examine the kinematics and kinetics of the leading hip of individuals post stroke during a step-up task. We hypothesized that individuals post-stroke would display mechanistic differences in their leading hip kinetics and kinematics when compared to controls.

Number of Subjects: N=10; 5 of these were individuals post-stroke that were recruited from the Clinical Neuroscience Research Registry. They were community ambulators, able to step up and down a 4” step, and diagnosed with a unilateral brain lesion (>1 year). Five age matched controls were also recruited. All participants were secured in an overhead safety harness and instructed to stand in a comfortable position. Participants’ self-perception of their balance was assessed by the Activity Balance Confidence (ABC) Scale (x=84%). Lower Extremity (LE) functional movement was determined by the LE Fugl-Meyer (x=20.4). The data presented here was part of a larger study.

Materials and Methods: Participants performed 24 randomized forward step-up trials; 12 leading with paretic (P) limb and 12 leading with non-paretic (NP). Hip kinetics and kinematics were collected and processed for both leading and trailing limbs. This study only reports the leading hip during a forward step-up task. Statistical significance was determined by paired t-test.

Results: Kinetic data revealed a significant difference between paretic and non-paretic limbs in the frontal plane when compared to age-matched controls (p=0.0095*), and a trend in kinetics on the sagittal plane (p=0.06). Kinematic data revealed a significant difference between paretic and non-paretic limbs in sagittal-plane hip joint excursion during a step-up task when compared to age-matched controls (p=0.05*). There were no differences in the frontal plane.

Conclusions: Data suggests that larger joint excursion in the paretic hip combined with increased generated torques in multiple planes affect hip joint control during a step-up task. This may ultimately contribute to mechanical inefficiency.

Clinical Relevance: Clinicians may consider prioritizing interventions in multiple planes when targeting stepping up tasks and negotiating stairs.
Purpose: Improving ambulation is a critical goal of stroke rehabilitation, and evidence supports intense, high repetition, task-specific gait training to improve ambulation. The purpose of this quality improvement study was to determine if a knowledge translation effort, aimed at physical therapists working with individuals with stroke in an inpatient rehab setting, can increase locomotor training intensity, defined by high cardiovascular intensity, high frequency and duration of training.

Description: The Knowledge to Action Cycle was used as the primary method for improving physical therapist adoption of the principles of High Intensity Gait Training (HIGT) over a year-long period. Specifically, an integrated knowledge translation approach was used with 10 participating clinicians integrally involved in assessing the barriers and facilitators to implementation as well as developing the various interventions consistent with the Theoretical Domains Framework (TDF). This iterative process resulted in the development of clinician work groups in the areas of knowledge, equipment, and hands-on skills. Clinicians developed intervention strategies that included education sessions, practice of psychomotor tasks, and development of handouts and clinical tools for improving implementation, adherence and sustainability of HIGT. Medical record audits and clinician feedback were used to report on progress toward self-established goals throughout the implementation process.

Summary of Use: Outcomes of interest regarding clinician adoption of HIGT included self-efficacy of implementation, impact of barriers to implementation, efficacy of interventions directed toward improving implementation, and duration of walking and number of steps taken per day for patients. Clinicians demonstrated a 18% improvement in self-efficacy with HIGT and a 71% reduction in impact of barriers to implementation. Intervention efficacy was rated on average at 77%. Duration of walking and number of steps taken per day by patients with stroke was assessed before and after implementation of HIGT. The knowledge translation process resulted in a statistically significant increase in time spent walking from 14.6 minutes to 25.6 minutes per day and number of steps improved from 892 steps/day to 1494 steps/day (p<0.05).

Importance to Members: The results of this quality improvement project indicate that significant practice change can be accomplished through the use of a knowledge translation process. The involvement of the clinicians in all phases of the Knowledge to Action cycle resulted in adoption of HIGT intervention and qualitative sense of collective ownership of the practice improvement. This collaborative approach resulted in a significant reduction in barriers to implementation and a significant increase in use of HIGT with individuals following stroke.
ABSTRACT BODY:
Purpose/Hypothesis: It is well accepted that survivors of stroke present with reduced cardiopulmonary function compared to age- and sex-matched peers. Although previous research has shown potential for cardiopulmonary improvement post-stroke, it is unknown which variables lead to improvement. The aim of this project was to determine demographic and physiologic factors that predict improvement in aerobic capacity among individuals with chronic stroke participating in aerobic exercise (AE) cycling interventions.

Number of Subjects: 44

Materials and Methods: All participants underwent cardiopulmonary exercise testing at baseline and post-intervention. Participants were randomized to one of the following interventions: forced-rate AE and upper extremity repetitive task practice (FE+RTP, n=16), voluntary-rate AE and upper extremity repetitive task practice (VE+RTP, n=15), or a non-aerobic control group (control, n=13). All interventions were time-matched and occurred three times per week for eight weeks.

Results: Significant improvements in VO$_2$ peak were observed from baseline to post-intervention in the VE+RTP group (p<0.001). Considerable variability was observed among participants relating to post-intervention change in VO$_2$ peak. Exercise variables including aerobic intensity and exercise duration were similar across groups except cadence, which was significantly faster for the FE+RTP group (p=0.01). Among AE participants, a multivariate regression analysis revealed that higher cycling cadence and lower baseline VO$_2$ peak were significant predictors of change in VO$_2$ peak.

Conclusions: High exercise rate appears to be an important variable in improving aerobic capacity and should be considered when prescribing AE for individuals with chronic stroke. Those with low VO$_2$ peak at baseline may benefit the most from aerobic interventions as it relates to cardiorespiratory fitness. Further investigation is warranted to understand the precise role of other exercise and demographic variables in the prescription of AE for this population, and their effects on secondary stroke prevention and mortality.

Clinical Relevance: Our findings suggest that to maximize the cardiopulmonary benefits of AE post-stroke, exercise prescriptions should include a cycling cadence greater than 60 revolutions per minute at 60-80% HRR. Individuals with low baseline aerobic capacity may benefit most from AE interventions as they demonstrate greater improvement in VO$_2$ peak compared to those with higher baseline aerobic capacity.
Purpose/Hypothesis: National trends in stroke rehabilitation to improve rates of community discharge necessitate an understanding of factors affecting discharge destination. The purpose of this retrospective study was to develop and the test sensitivity and specificity of a home discharge destination prediction model identifying the most predictive factors for patients with stroke on admission to inpatient rehabilitation. We hypothesized that the model developed for one cohort of patients with stroke would apply to a second cohort.

Number of Subjects: Electronic medical records were reviewed for all patients with first stroke admitted for inpatient rehabilitation from January 1, 2016 - December 31, 2018. The subjects were divided into two cohorts, a Model Cohort (MC) (n=634) consisting of patients from January 1, 2016 - December 31, 2017, and an Applied Cohort (AC) (n=329) consisting of patients from January 1, 2018 - December 31, 2018.

Materials and Methods: Predictive variables for home discharge were identified in the MC through logistic regression. The binary outcome variable was community (home) vs. subacute rehabilitation discharge destination. Patients who were transferred to an acute care hospital during their inpatient rehabilitation stay were excluded from the analysis. This prediction model was applied to the AC to test the sensitivity and specificity of the model.

Results: Logistic regression analysis identified admission motor Functional Independence Measure (FIM), Fugl-Meyer balance test, and cognitive FIM as the respective predictive variables for discharge destination (p <0.05). The prediction model showed an 81.1% correct prediction rate for home discharge and an 82.2% correct prediction rate for subacute rehabilitation for the AC.

Conclusions: A successful model, including cognitive and motor FIM and Fugl-Meyer balance scores at admission to inpatient rehabilitation, adequately predicted community vs. subacute rehabilitation destinations. Results were comparable to prior research whereby admission motor and functional status, and cognitive status were important predictors of discharge destination. The importance of balance in this prediction was unique to this study. Patient age and home situation did not arise as major factors when compared to prior studies.

Clinical Relevance: This model would be useful for the healthcare team to best plan patients’ discharge soon after admission for inpatient rehabilitation following stroke.
Purpose/Hypothesis: Stroke affects greater than 700,000 individuals in the U.S. each year. Two-thirds of stroke victims survive the initial insult and require rehabilitation to improve quality of life. While rehabilitation has been shown to improve motor outcomes, there is a paucity of literature describing the neurobiological basis for improvement. We sought to use resting state functional magnetic resonance imaging (rsfMRI) to investigate this question. Training in the virtual environment in post-stroke rehab has been established as an approach for neurorehabilitation; a robot-assisted program is based on the understanding that numerous repetitions of functionally oriented movements can stimulate cortical reorganization. Comparing Task Related Training (TRT) to robotic arm therapy (REO), this randomized controlled study measured sensorimotor recovery, neuroplasticity and changes in kinematic impairments. Exploratory MRI data was expected to yield information on neuroplastic changes of the cortical connectivity. Based on prior work in this area it was expected that greater changes would be apparent post training for the TRT group that was engaged in greater problem solving.

Number of Subjects: Eighteen post stroke subjects participated in this randomized controlled trial. Individuals all scored between 18 and 53 on the Upper-Arm subsection of the Fugl-Meyer Assessment of Motor Recovery after stroke (FMA) and demonstrated some trunk movement during the pretest reaching performance measures.

Materials and Methods: Nine subjects were randomized to perform TRT at varied locations across the workspace using the paretic upper limb for approximately 200 reaching and grasping tasks. The other nine subjects were randomized to the robotic arm training that involved the paretic arm supported in a trough while reaching in various planes and directions as guided by a corresponding tracking task on the video monitor in front of the subjects. Auditory sensory feedback that encouraged maintenance of the trunk against the chair back was systematically and equally faded throughout the training for all subjects. Rehabilitative sessions lasted between 50 and 65 minutes, 2-3 times a week for 4-6 weeks. The TRT group performed TRT activities at varied locations across the workspace using the paretic upper limb, while the REO group protocol involved mostly active (80%), but some active assistive (15%) and occasional passive movements (5%) as per the training paradigm. Both groups performed the same number of repetitions. Auditory sensor feedback that encouraged maintenance of the trunk against the chair back was systematically and equally faded throughout the training for both groups. Scans were taken in a 3T Siemens MR scanner, including rsfMRI (TR=2000ms, TE=30ms, flip angle=90o, spatial resolution=3.6×3.6×5.0mm). Images were preprocessed for correction of spatial and temporal artifacts. Regions of interest (ROIs) were defined using the Harvard-Oxford atlas. Resting state functional connectivity (RSFC) was calculated using the MatLab-based CONN toolbox. Significant RSFC differences among post-stroke patients both before and after rehabilitation were evaluated with an ROI-to-voxel analysis (FDR-corrected p<0.05). Rehabilitative effects were further determined using scales at each level of the ICF model.

Results: There were no significant differences between the TRT and REO groups at baseline. ROI-to-ROI analysis showed that the TRT group had significantly increased connectivity within the cerebellum (p=0.003), between the putamen and parahippocampal cortex (p=0.0004), between the planum temporale and temporal pole (p=0.0004), between the PT and temporal fusiform cortex (p=0.0002), and between the cerebellar vermis and frontoparietal network (p=0.0004). The major kinematic difference post training was observed with less deceleration time during reaching toward the ipsilateral targets post TRT. Main effects of training included increases in peak velocity reaching toward the center and toward the unimpared side targets. The other main training effects included: an overall increase in elbow extension, FMA, Motor activity log, reaching far and close on the Reaching Performance measure, and lastly on the Wolf Motor Function Test.

Conclusions: Our results demonstrate that rehabilitation improves connectivity between the cerebellum and cortical structures responsible for motor output, translating into clinical improvement. These results show promise in the ability of rsfMRI to serve as an objective correlate for motor function improvement post-stroke. More specifically, the increased cerebellar connections after TRT are related to the increased proprioceptive input necessary with greater visual guidance for TRT compared to robotic arm training, where the subject is only focused on the video screen throughout the training sessions. More significant changes post TRT is supportive of our hypothesis of greater connectivity with greater problem-solving activity, as is necessary with TRT. Trunk support in some capacity has been shown to be necessary to control in order to improve arm function post stroke, but the poor carryover of constant strapping of the trunk is what we question. Our results indicate the positive effect of the augmented, faded, sensory feedback device to control the trunk; with extrinsic feedback for implicit motor learning while improving upper limb motor recovery.

Clinical Relevance: Rehabilitation improves connectivity among cortical structures responsible for motor function, providing the neurobiological basis for clinical improvement. Training in the natural environment, such as at the tabletop reaching and performing appropriate tasks, is necessary to alleviate impairment changes of individuals post stroke. However, there is some vital training indications for the use of robotic therapy for the upper extremity of individuals post stroke, specifically increasing repetitions and training reaching distance. Lastly, external auditory feedback should be utilized in rehabilitation to reduce compensatory strategies.
**Background and Purpose:** Gait deviations are common post stroke and can limit independence with ambulation and quality of life. The plantar flexors have an essential role in the stance phase of gait by controlling the tibia over a stable foot as the body progresses forward. However, many stroke survivors have difficulty controlling tibial progression. While research has shown that strengthening the plantar flexors can improve gait mechanics, there is little research on training the plantar flexors for their specific role needed in gait for tibial progression. Therefore, the purpose of this case report is to describe an eccentric plantar flexor strengthening protocol in order to improve tibial progression in the terminal stance phase post stroke to optimize gait quality.

**Case Description:** The patient was a 69 year old female admitted to a skilled nursing facility after sustaining a right ischemic stroke. The patient presented with weakness throughout her left lower extremity, but decreased tibial progression in stance due to weak plantar flexors was identified as the primary impairment affecting her gait pattern. Due to the patient’s gait presentation and difficulty with tibial progression with the affected leg in stance phase, she was unable to achieve the appropriate trailing limb posture to maximize mechanics in preparation for swing. She participated in an eccentric plantar flexion strengthening protocol including stair training, power lunges, and backwards walking for a total of 26 sessions (45-75 minutes) over 6 weeks. Outcome measures included the 10 meter walk test (10MWT), 3 meter backwards walking test (3MBW), plantar flexion strength assessed by a heel rise test, and observational gait analysis through the Hudl Technique application.

**Outcomes:** The patient’s 10MWT showed clinically significant improvement from 0.54 m/sec to 0.68 m/sec, exceeding the standard error of measurement and just shy of the minimal clinically important difference. Her 3MBW test time improved from 0.27 m/sec to 0.39 m/sec. Plantar flexion strength increased from 2-/5 to 2+/5. The patient’s tibial progression in terminal stance also improved through observational gait analysis.

**Discussion:** This case report describes improvements in tibial progression in the stance phase of the gait cycle following eccentric plantar flexion strengthening, which can position the limb with improved biomechanics for the next phase of gait. Addressing tibial progression in stance phase may be beneficial in improving gait quality and independence in individuals post stroke. Clinicians should consider use of task specific eccentric plantar flexion strengthening exercises to maximize gait mechanics. Future research is needed with larger sample sizes and for optimal dosage of the strengthening protocol.
Distinct Trends in Walking Recovery Following Repeated Bouts of Intensive Locomotor Training in Chronic Stroke

Purpose/Hypothesis:
To describe trends in walking recovery for individuals greater than 6 months post stroke who completed 4 repeated bouts of intensive, task-oriented locomotor training (LT) for 30 sessions. Under this paradigm, we hypothesized that individuals with chronic stroke would continue to make real and meaningful improvements in functional walking capacity, following repeated bouts of LT.

Number of Subjects:
5 subjects with chronic stroke were recruited from stroke support groups at medical centers in the **** metropolitan area. Baseline characteristics included: 4M/1F, mean age 62.6 years (range 56-70 years), mean time since stroke: 56 months (range 16-92 months), mean self-selected gait speed: 0.49 m/s (range 0.12 – 0.78 m/s) and mean Fugl-Meyer lower extremity score range of 15-27.

Materials and Methods:
All study methods and procedures were approved by the Institutional Review Board at ***. Study design: Repeated measures design. Intervention
All participants completed 4 bouts of LT (T1, T2, T3, and T4) consisting of at least 30 sessions each, 3x/week over a 12-week duration. A delay period of 4-12 weeks was used between each of the 4 bouts of LT. Training sessions lasted 60-75 minutes, with the goal of accruing an aggregate of 20-30 minutes of overground or treadmill LT combined with functional electrical stimulation applied to the gastroc/soleus muscle group on the paretic limb to assist in limb propulsion. In addition to LT, participants performed strength, range of motion, and forced use training of the paretic limb, which included manual stretching of muscle groups in the paretic upper and lower extremity, sit-to-stand transitions from variable height surfaces, and floor-to-mat transitions.

Clinical outcome measures
Functional walking capacity was evaluated using the following: a) Ten meter-walk test was used to assess short distance walking pace at a self-selected and fastest gait speed, b) 6-minute walk test was used to assess walking endurance, and c) Timed up and go (TUG) test was used to evaluate functional mobility. All participants completed outcome measures before and after each bout of LT. Achieving the minimal detectable change for clinical outcome measures was reported as a real change, while a change exceeding the minimal clinically important difference was reported as a meaningful change.

Results:
No adverse events were found with exposure to repeated bouts of the LT program. One participant elected to terminate participation in the study at the initiation of the forth bout of training (T4) due to complications of a potential rheumatologic condition. The following values represent the average change in clinical outcome measure values following each bout of LT: Self-selected gait speed (0.09 m/s; 0.06 m/s; 0.04 m/s; 0.06 m/s), fastest gait speed (0.12 m/s; 0.05 m/s; 0.07 m/s; -0.01 m/s), TUG (-7.1 sec; -3.1 sec; -0.8 sec; -3.0 sec), Walking endurance (53.5 m; 23.4 m; 23.1 m; 4.0 m).

For each of the clinical outcome measures, the percentage of participants achieving real and meaningful changes following LT are reported. 60% of participants achieved a 2nd real change in self-selected gait speed, while 20% of participants achieved a 2nd meaningful change in self-selected gait speed following completion of all 4 bouts of LT. 80% of participants achieved a real change in TUG following the 1st bout of LT (T1), while 40% of participants achieved a 3rd real change following completion of all 4 bouts of LT. All participants achieved a meaningful change in walking endurance following the 1st bout of LT (T1), while only 1 participant achieved a 2nd meaningful change in walking endurance following the completion of all 4 bouts of LT.

Conclusions:
Similar to previous investigations of motor learning, diminishing returns in response to repeated bouts of LT were found across all clinical outcome measures of functional walking capacity. Still, when considering real and meaningful changes in walking capacity, all participants were found to be a “responder” to the LT program as each participant was found to achieve a meaningful change in at least one walking domain over the course of the LT program. Three distinct trends in walking recovery for individuals with chronic stroke are reported: a) individuals who achieve a real or meaningful change within the 1st or 2nd exposure to LT (T1 or T2), followed by a diminished response to additional bouts of LT, b) individuals who experience a real or meaningful change in only a single walking domain, with no real or meaningful change experienced across other walking domains during any point of the 4 bouts of LT, c) individuals who demonstrate consistent improvement over time, achieving multiple real and meaningful changes across several walking domains with successive exposures to LT.

Clinical Relevance:
To the authors’ knowledge, this is the first study to examine trends in walking recovery of individuals with chronic stroke following repeated bouts of LT. For some individuals with chronic stroke, a single bout of intensive LT lasting 30 sessions may not be sufficient to lead to a real or meaningful change in walking recovery. For example, for self-selected gait speed, 3 participants did not make a 1st meaningful change until the completion of the second (T2) or third (T3) bout of LT. Conversely, after achieving a meaningful change in walking endurance following the 1st bout of LT (T1), 4 participants made no successive real or meaningful change in walking endurance following the second (T2), third (T3), or forth (T4) bout of LT. Therefore, it is important that future research focus on identification of variables that can predict what trend in walking recovery an individual can expect in chronic stroke. Establishing variables that accurately predict response to behavioral training paradigms can better inform therapists with regards to the appropriate amount of therapy, at the appropriate time, for an appropriate duration to maximize function with the most time- and cost-effective approach for walking recovery following stroke.
ABSTRACT BODY:

**Purpose/Hypothesis:** The purpose of this study was to assess the feasibility of using a sensor-automated, progressive, and music-based rhythmic locomotor training platform to train faster walking post-stroke. Unique to this technology is the ability to maintain high sound quality while modulating, in real-time, the tempo of rhythmic music stimuli based on a user’s ability to (i) match their cadence to the musical tempo (i.e., entrain) and (ii) progress to faster cadences in-sync with the systematic progression of the tempo. We hypothesized that training with the platform would facilitate within- and across-session increases in gait speed and that users would be interested in using the platform to practice walking at home.

**Number of Subjects:** Eleven participants with chronic hemiparesis completed one training visit. A subset of seven participants completed four training visits.

**Materials and Methods:** Comfortable walking speed (CWS) and fast walking speed (FWS) were assessed before and after each 30-min training visit using the 10MWT. A smart phone application was used to deliver the rhythmic music stimulus to wireless headphones. In brief, the platform uses an inertial sensor clipped to the paretic shoe to identify a user’s baseline cadence and a closed-loop controller automatically modulates the rhythm of music from a standardized playlist to match this baseline. Consistent entrainment for 5 minutes leads to an automatic 5% advancement in the tempo. Difficulty entraining elicits a metronome overlay. Continued difficulty results in the tempo modulating down by 5% towards baseline. These processes repeat throughout the 30-min training to ensure a consistent cadence challenge.

**Results:** A single training visit resulted in an average increase in posttraining CWS of 0.085±0.027 m/s (p=0.011), with 8 of 11 users surpassing the 0.06 m/s small meaningful change score and 5 of 11 users increasing CWS by more than 0.10 m/s. FWS similarly increased by 0.093±0.032 m/s (p=0.016). After three training visits, participants presented with a pretraining CWS that was, on average, 0.12±0.03 m/s faster than the pretraining CWS measured during the first training visit (p=0.012), with 5 of 7 users increasing their speed by more than 0.10 m/s. Of the 7 users who completed 4 training visits, all reported that the platform helped them walk faster than normal and 5 said they would use the platform most or all of the time at home.

**Conclusions:** An automated, progressive, and music-based rhythmic locomotor training program did not adversely affect participants, nor result in any falls. All participants were able to entrain to the rhythmic music stimuli and modulate their cadence in-sync with changes to the tempo. The vast majority of users presented with meaningful increases in speed within- and across visits. These findings, taken together, motivate further study of this promising training platform.

**Clinical Relevance:** This automated training platform is simple to use, feasible to implement with minimal supervision, readily accepted by end-users, and has potential to facilitate community-based rehabilitation.
TITLE: Effects of Practicing Yoga on Non-Motor Symptoms and Balance in Individuals with Stroke: Pilot Study
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Pradip Kumar Ghosh, Alaina Gribler, Amanda Gross, Emily Kothe, Rachel Durchholz, Sarah Gerdes
ABSTRACT BODY:
Purpose/Hypothesis: Yoga has been found to be as beneficial as traditional exercise in both healthy and unhealthy individuals in improving several health-related symptoms including fatigue, pain, and sleep. Throughout the literature, there has been insufficient research regarding the influence of practicing yoga postures and breathing techniques on non-motor symptoms (NMS) such as fatigue, sleep quality, and quality of life in the chronic stroke population. Therefore the purpose of this study was to determine the effects of yoga breathing and postures on NMS and balance in individuals with chronic stroke. Our hypothesis was that practicing yoga breathing and postures would reduce NMS and improve balance in individuals with chronic stroke.

Number of Subjects: Eight individuals, who experienced a stroke at least 6 months ago, ages 25-80, were recruited from local stroke support groups in the greater St. Louis area.

Materials and Methods: All participants were asked to attend a 1-hour weekly supervised group yoga session and instructed to practice the same exercises at home, 2 times/day, 5 days/week for 10 weeks. Each yoga practice schedule consisted of 7 yoga breathing techniques and 3 yoga postures with a 1 minute rest break between each activity. Participants were assessed 2 different days at baseline and after 5 and 10 weeks of practice. The outcome measures used included: Mini Balance Evaluation Systems Test (Mini-BESTest), Fatigue Assessment Scale (FAS), Pittsburgh Sleep Quality Index (PSQI), and Stroke Impact Scale (SIS). Friedman test was performed to determine the overall significance between groups followed by post-hoc analysis using Wilcoxon signed rank test. The level of significance was set at p<0.017 after Bonferroni correction. Change scores for each participant were calculated from baseline to Week 5 and baseline to Week 10 and compared to the MCID value of each outcome measure to determine clinical relevance.

Results: The median score of each outcome measure was calculated and statistical significance was found for Mini-BESTest (p=0.013), FAS (p=0.007), PSQI (p=0.013), SIS-strength (p=0.013), SIS-ADL (p=0.013), SIS-mobility (p=0.014), SIS-communication (p=0.014), SIS-emotion (p=0.011), SIS-memory (p=0.014), and SIS-social participation (p=0.013) after 10 weeks of practice when compared to the respective baseline values. After 5 weeks of practice, significant changes were found for Mini-BEST (p=0.013), FAS (p=0.013), PSQI (p=0.014), SIS-ADL (p=0.014) and SIS-social participation (p=0.014) when compared to the respective baseline values. After calculating change scores for each outcome measure, the results on MCID were as follows: Mini-BESTest: 8 participants met MCID at Week 10 while 6 participants met MCID at Week 5; FAS: 8 participants met MCID at Week 10 while 2 participants met MCID at Week 5; PSQI: 6 participants met MCID at Week 5 while 2 participants met MCID at Week 5. Most participants met MCID on SIS subscales after 10 weeks except SIS-hand function.

Conclusions: The results of this study suggested that practicing yoga breathing and postures decreased NMS and improved balance in individuals with chronic stroke. Further research utilizing a larger sample size and control group is required to establish these effects.

Clinical Relevance: Activities utilizing yoga breathing and postures may provide a cost-effective and accessible adjunct to current interventions for individuals who are expected to experience repetitive balance deficits and present with several NMS resulting from stroke.
ABSTRACT BODY:
Purpose: There is a growing body of evidence supporting the use of non-invasive brain stimulation (NIBS) as an adjunctive treatment to excite or inhibit brain areas affected by stroke (Rabadi et al 2017, Kang et al 2016). Transcranial direct current stimulation is a form of NIBS that is affordable (under $500) and has been shown to be safe for use in individuals post-stroke (Brunoni et al 2012). Recent systematic reviews have explored this topic in sub-acute and chronic stroke populations, but did not target an acute stroke population in inpatient rehabilitation. The purpose of this critical appraisal was to investigate the latest findings in transcranial direct current stimulation (tDCS) as an adjunct to traditional rehabilitation in adults post-stroke in an inpatient rehabilitation setting.

Description: PubMed, PEDro, MEDLINE, and CINAHL were searched. The key words were selected based on the PIO format, using AND and OR Boolean operators. Inclusion criteria included Level 1b or 2b evidence, adults post-stroke in inpatient rehabilitation, tDCS intervention (either anodal, cathodal, or bi-hemispheric), outcome measures of motor recovery, and published between 2013 and 10/2018. Exclusion criteria included age < 18, outpatient setting, and no sham control. Seven articles met criteria and were included in this appraisal.

Summary of Use: The use of tDCS was shown to augment traditional methods of both upper and lower extremity rehabilitation. Statistically significant changes were demonstrated at mostly the body structure and function level according to the ICF model, but improvements at the activity level were also shown. The intensity of stimulation varied from 1.0 to 2.0 mA, which falls within safety guidelines. The duration of treatment ranged from 20 to 60 minutes, which also falls within safety guidelines. This review found there is no consensus on whether it is best to use tDCS as a priming technique (before therapy), or as a concurrent technique (during intervention). Transcranial direct current stimulation is a safe and efficacious adjunct to traditional inpatient rehabilitation for enhancing motor outcomes in adults post-stroke.

Importance to Members: For adults post-stroke in inpatient rehabilitation, the use of tDCS as an adjunct to traditional rehabilitation led to significant improvements in static and dynamic balance, endurance, strength, balance perception, fall risk reduction, motor control, gait speed, dexterity, coordination, and ADL performance.
TITLE: Effects of Two Different Types of Afos on Gait Outcomes in Patients with Subacute Stroke
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Priya Sibi Karakkattil, Elaine Trudelle-Jackson, Ann Medley, Chad Swank
ABSTRACT BODY:

Purpose/Hypothesis: Ankle foot orthoses (AFOs) are commonly prescribed in patients with stroke to restore safe walking. Though AFOs have been shown to be effective interventions in chronic stage of stroke recovery, the effect of different designs of AFOs during the subacute stage when maximum recovery is expected have not evaluated. The purpose of this study was to identify whether patients in the subacute stage of stroke, with foot drop, would have better gait outcomes when using a custom double adjustable AFO (DA AFO), or an over the shelf posterior leaf spring AFO (PLS AFO). A secondary purpose was to determine whether one week of practice would significantly change gait outcomes with either of the AFO conditions when compared to baseline.

Number of Subjects: 20 participants diagnosed with first time unilateral stroke resulting in hemiparesis with foot drop.

Materials and Methods: This experimental study used a within subject repeated measures design. The manipulated independent variables in the study were 1) type of AFO with two levels: (a) DA AFO, and (b) PLS AFO; and 2) practice time with 2 levels: (a) baseline (eg.no practice), and (b) after 1 week of practice. The dependent variables in this study were: gait endurance measured by 6MWT, gait symmetry and, gait velocity measured using GAITRite gait analysis system for self-selected velocity walk and fast-paced velocity walk, and patient report of which AFO they preferred to walk with.

Results: Paired t-tests used to compare the differences in gait endurance, gait symmetry and gait velocity were not significant at baseline between the two AFO conditions. The 2 x 2 repeated measures ANOVA used to test the significance of difference in gait endurance between the two types of AFOs from baseline to after one week of practice revealed no significant interaction between the type of AFO and practice time. However, there was a significant difference for the main effect of AFO (p = .046, ηp² = .194) and for the main effect of practice (p < 0.001, ηp² = .698). The repeated measures MANOVA used to analyze differences in gait symmetry and gait velocity within the group did not show statistically significant interaction between the type of AFO and practice. However, there was a significant main effect of practice for both self-select velocity walk (p = .001, ηp² = .431) and fast paced velocity walk (p < .001 ηp² = .555). 16 participants preferred DA AFO and 4 participants preferred PLS AFO for their walking.

Conclusions: In conclusion, with practice, significant improvement in gait endurance and gait velocity were found regardless of the type of AFO. DA AFO showed more improvement than PLS AFO with gait endurance and gait velocity but did not reach statistical significance.

Clinical Relevance: Average Cost of a DA AFO is $1400 whereas the average cost of a PLS AFO is $40. Clinicians should try the PLS AFO first and a custom DA AFO should be used, only when an off the shelf AFO proves to be unsuccessful. Regardless of the design of AFO, patients need to practice with the AFO to improve gait velocity and endurance.
**Purpose/Hypothesis:** Risk factors for stroke are well-established, and many are modifiable medical conditions and lifestyle behaviors. The potential impact of stroke, along with the possibility to reduce risk through medication, education, and behavior change, all suggest stroke prevention as a high priority to improve public health. Physical activity (PA) may mitigate many stroke risk factors, and aerobic exercise is recommended as an important element of stroke prevention. As part of a larger study which surveyed physical therapists (PTs) and occupational therapists on stroke prevention education, we hypothesized that objective PA measures and self-monitoring recommendations would be commonly used by PTs. The purpose of the present study was to determine PA testing and self-monitoring recommendations employed by PTs for people at risk for stroke, including individuals with risk factors, transient ischemic attack, and stroke.

**Number of Subjects:** 261 PTs from four subgroups of APTA who were currently engaged in clinical practice and belonged to: the Academy of Geriatric Physical Therapy (AGPT), Home Health Section (HHS), or to listservs of the Academies of Neurologic (ANPT), and Acute Care Physical Therapy (AACPT).

**Materials and Methods:** A link to a web-based survey was posted in the AGPT and HHS electronic newsletters and posted to the ANPT and AACPT listservs. The survey was validated via feedback from 5 PTs who are contemporary experts in stroke rehabilitation (content) and 5 PTs who were treating people with stroke in their clinical practice at that time (utility and clarity). The survey queried respondents on whether they provide a variety of stroke prevention interventions, including testing, recommendations, and self-monitoring strategies regarding PA, at least 75% of the time.

**Results:** A precise response rate cannot be determined. 91% of respondents provide PA/exercise recommendations to people at risk for stroke; 62% of these report performing an objective exercise or performance-based measure prior to making such recommendations. The most commonly cited objective measures were the 2, 3, or 6-minute walk test, and the Timed Up and Go. Subjective observations (93%) and patient-reported symptoms (90%) were used as the basis for exercise recommendations more frequently than parameters such as heart rate (84%) and rating of perceived exertion (RPE) (83%). The most common parameters on which patients were taught to self-monitor while exercising at home were subjective symptoms (87%) and RPE (80%).

**Conclusions:** The use of objective measures for PA/exercise testing and self-monitoring recommendations by PTs for individuals at risk for stroke is suboptimal. PTs should undertake training and implement behavior change strategies to widely adopt the use of such changes.
Purpose/Hypothesis:
Current motor control scales tend to be extremity or joint-specific and insensitive to small changes. Unlike the Fugl-Meyer, Trost, and SCALE, the Boyd and Graham scale has a four-point scoring system allowing it to potentially be more sensitive to changes in motor control. This scale was only developed for application to ankle dorsiflexion. The Modified Boyd and Graham (mBG) scale was designed to be applicable to any joint and to capture small changes in motor control by using an expanded scoring system. The purpose of this study was to determine the inter-rater and intra-rater reliability of the mBG scale.

Number of Subjects:
Twenty-one raters participated in this study, including two licensed physical therapists with experience in pediatrics, and nineteen third-year physical therapy students. On average, the licensed physical therapists had 18.5 years of experience.

Materials and Methods:
Therapists reviewed the mBG scale then shown a video of a patient attempting isolated elbow flexion or isolated knee extension. Six videos of either elbow flexion or knee extension from four different patients were used for this study. Each video was shown for a total of 3 times consecutively. After watching each video, the therapists scored the patient’s motor control using the mBG scale. Raters viewed each video again one week after the initial scoring to test intra-rater reliability.

Results:
The intraclass correlation coefficient (ICC) was calculated using SPSS version 25. The ICC was 0.5 for the inter-rater reliability of the initial scores and 0.6 for the week scores. For intra-rater reliability, the ICC was 0.98.

Conclusions:
The mBG exhibited fair to good inter-rater reliability and excellent intra-rater reliability. Clinical Relevance:
Because the modified Boyd and Graham scale exhibited excellent intra-rater reliability, it is possible that one clinician could use the scale to consistently monitor motor control. However, further research is needed to explore other components of the scale, such as validity.
TITLE: Factors Associated with Distinct Trajectories of Arm Motor Impairment Recovery after Ischemic Stroke
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Danielle Kristine Kline, David J. Lin, Alison Cloutier, Kelly Sloane, Kristin Marie Parlman, Jessica Ranford, Matthew Picard-Fraser, Annie B. Fox, Leigh R. Hochberg, Teresa Jacobson Kimberley
ABSTRACT BODY:

Purpose/Hypothesis: Motor recovery prediction after stroke remains a critical topic to optimize rehabilitation interventions and guide discharge planning. Current models predict motor recovery outcomes at a specific time point, but do not address the trajectory of recovery. We analyzed a longitudinal natural history dataset of people with arm impairment after stroke and identified three distinct categories of arm impairment recovery trajectories across 6mos. We explored which baseline factors differentiated participants into each recovery category.

Number of Subjects: A cohort of 34 participants (n=19 females, average age 62.2 y±13.1 SD) with baseline (4±3 days post-stroke) Fugl-Meyer Upper Extremity (FMA-UE) <50 and completed follow-ups at 6wks, 3mos, and 6mos from the Stroke Motor Recovery and Rehabilitation Study at Massachusetts General Hospital were included in this retrospective analysis.

Materials and Methods: 3 categories of arm motor impairment recovery trajectories (fast, extended and limited) were developed using the minimal clinically important difference (MCID) of a 7-point improvement on the FMA-UE. 1) Fast Recovery: demonstrated rapid improvement of at least the FMA-UE MCID between the acute and 6wk follow-up, but did not improve at or beyond the MCID after 6wks. 2) Extended Recovery: achieved any FMA-UE change between acute and 6wks, but showed improvement of MCID or greater after 6wks. 3) Limited Recovery: achieved <FMA-UE MCID at all follow-ups. 26 baseline factors were analyzed in a two-step approach. First, all factors were assessed with separate logistic regression models to determine which factors were associated with group membership. Next, the 7 remaining factors were considered using multinomial logistic regression analyses to determine the combination of baseline factors that most accurately categorized individuals. To reduce the risk of overfitting the model, no more than 3 factors were used and parameter estimates and standard errors were carefully considered to ensure reasonable estimates.

Results: The considered variables included: FMA-UE, NIH Stroke Scale, smoking history, Charlson Comorbidity Index, Barthel Index, body mass index (BMI) and Fazekas periventricular score. After examining multiple combinations of the considered variables, the combination of FMA-UE, Fazekas periventricular score and BMI best explained category assignment. This model of baseline factors was significantly associated with recovery group classification, $X^2(12)=52.4$, p<0.001; McFadden $R^2=0.73$, and correctly classified 82.35% of the total sample, 91.7% of the fast, 86.7% of the extended and 71% of the limited categories.

Conclusions: Preliminary results suggest that baseline arm impairment, periventricular white matter damage and BMI are associated with distinct categories of arm motor impairment recovery trajectories. These factors determine not only the recovery potential, but also the rate at which recovery will be achieved.

Clinical Relevance: Understanding the trajectory of recovery post-stroke can help inform rehabilitation service use and discharge planning.
Purpose/Hypothesis: Improvement of walking ability is a primary goal for individuals with hemiparesis after stroke. Current evidence stresses the need for high doses of stepping practice during rehabilitation, but early practice may be limited by weakness and instability of the paretic lower extremity (LE). Use of a training stance-control knee-ankle-foot orthosis (SCKAFO) may provide support necessary for increased walking practice in the early post-stroke period, while discouraging compensatory movements. The purposes of this study were to obtain: 1) preliminary evidence regarding immediate effects on spatiotemporal gait characteristics of walking with a training SCKAFO, and 2) user perspectives about the SCKAFO.

Number of Subjects: 13

Materials and Methods: Participants were 9 men and 4 women with a mean age of 63.6 ± 12.2 years. Key eligibility criteria were: ≤4 weeks post unilateral non-cerebellar stroke, receiving inpatient stroke rehabilitation, significant LE weakness as indicated by a Fugl-Meyer LE motor scale score ≤24, and able to walk 18 steps with no more than moderate assistance of 1 person. Gait speed, step length, stance time, and spatial and temporal asymmetry were measured using a GAITRite instrumented walkway under 3 walking conditions: 1) without SCKAFO, 2) with non-functioning SCKAFO (mechanism disengaged), and 3) with SCKAFO functioning as intended, tested in random order. A questionnaire was administered to elicit participants’ perspectives on the SCKAFO. Descriptive statistics were calculated for gait variables and questionnaire responses. Because the data were not normally distributed, the non-parametric Friedman test was used to detect differences between walking conditions.

Results: Paretic LE step length differed significantly under the 3 walking conditions, χ²(2) = 6.500, p = 0.039. Mean values were 31.72 ± 11.66 cm, 34.79 ± 13.67 cm, and 40.80 ± 14.35 cm for walking without a SCKAFO, with a non-functioning SCKAFO, and with a functioning SCKAFO, respectively. Post hoc analysis with Wilcoxon signed-rank tests revealed that paretic LE step length was significantly longer during walking with a functioning as compared to a non-functioning SCKAFO, Z = -2.197, p = 0.028. In addition, there was a borderline significant difference in gait speed under the 3 conditions, χ²(2) = 5.922, p = 0.052. Mean gait speeds were 14.79 ± 16.17 cm/sec, 18.09 ± 14.72 cm/sec, and 20.83 ± 13.87 cm/sec for walking without a SCKAFO, with a non-functioning SCKAFO, and with a functioning SCKAFO, respectively. Participants reported an average of 9.0 ± 1.4 on a 10-point scale of overall satisfaction with walking training with the SCKAFO.

Conclusions: Individuals in the early stages of stroke recovery walked with significantly improved paretic step lengths and a trend toward increased gait speed when using a SCKAFO. Participants reported high satisfaction with using the SCKAFO for short walking bouts.

Clinical Relevance: Early gait training with a SCKAFO may be beneficial for improving gait for a subgroup of individuals with paretic LE instability following stroke.
Comparison of Corticospinal Tract Fractional Anisotropy Extracted from Native Versus Standard Space in Chronic Stroke

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Allison Foster Lewis, Jill Campbell Stewart

ABSTRACT BODY:

Purpose/Hypothesis: Corticospinal tract (CST) fractional anisotropy (FA) is commonly used to represent integrity of the motor system after stroke. Some research studies extract FA from native space, while others extract FA from standard space since the best approach is unknown. Differences in approaches may be problematic for comparison of results across studies. The purpose of this study was to compare CST FA extracted from native space to CST FA extracted from standard space in individuals with chronic stroke.

Number of Subjects: Twenty-six individuals in the chronic phase of stroke (mean age 60.1 ± 9.8, months post-stroke 36.2 ± 36.2, Upper Extremity Fugl-Meyer (UE FM) score 39.5 ± 14.9).

Materials and Methods: Participants underwent diffusion weighted imaging. CST FA was extracted in FSL using two approaches: Cerebral Peduncle and Tract Template. For the Cerebral Peduncle approach, FA was extracted from a region of interest (ROI) in the cerebral peduncle. For the Tract Template approach, FA was extracted from a published template of the CST. Each approach was repeated in native (FA\text{native}) and standard space (FA\text{std}). Paired differences between FA\text{native} and FA\text{std} were examined. Relationships between FA and upper extremity motor impairment (UE FM) and motor function (Action Research Arm Test (ARAT)) were also examined.

Results: CST FA was lower on the lesioned side for both approaches, regardless of extraction space (p<0.01). FA\text{native} was different from FA\text{std} for the Tract Template (p<0.01) but not for the Cerebral Peduncle approach. For the Cerebral Peduncle approach, FA\text{native} was higher than FA\text{std} for about half of the participants (12/26). For the Tract Template approach, FA\text{native} was higher than FA\text{std} for most participants (25/26). However, the magnitude of the difference between FA\text{native} and FA\text{std} was relatively small for both approaches. The absolute difference between FA\text{native} and FA\text{std} for the lesioned side CST was 0.019 ± 0.018 and 0.014 ± 0.010 for the Cerebral Peduncle and Tract Template approach, respectively. The difference between FA\text{native} and FA\text{std} for the nonlesioned side CST was 0.018 ± 0.013 and 0.012 ± 0.007 for the Cerebral Peduncle and Tract Template approach, respectively. The relationships between FA\text{native} and UE FM and ARAT (r=0.41-0.69; p<0.05) were similar to relationships between FA\text{std} and UE FM and ARAT (r=0.44-0.60; p<0.05).

Conclusions: FA values extracted from native versus diffusion space differ, though by a relatively small magnitude. The relationship between motor function/impairment and FA\text{native} was comparable to the relationship between motor function/impairment and FA\text{std}.

Clinical Relevance: Our results have implications for how FA can be interpreted and compared across studies that extract FA from different spaces, as directional differences were not consistent depending on approach. Since the magnitude of differences were relatively small and relationships with behavior were minimally impacted, extracting FA from standard space may be advantageous in large data sets examining the integrity of multiple tracts or ROIs.
**Purpose/Hypothesis:** Previous studies have shown that transcranial magnetic stimulation (TMS) measures obtained from the upper limb muscles are important predictors for upper limb motor function after stroke. However, little is known about the usefulness of TMS measures acquired from the lower limb muscles in determining the gait performance after stroke. We performed a secondary analysis to explore the relationship between lower limb TMS measures and gait among chronic stroke.

**Materials and Methods:** 16 participants (5 females, mean age = 58 years) with prior left hemispheric chronic stroke (> 6 months) participated in a primary study to examine the efficacy of repetitive TMS on gait performance. TMS measures were acquired from the ipsilesional primary motor cortex. We recorded resting motor threshold, peak-to-peak motor evoked potential (MEP) amplitude, MEP latency and MEP areas from the right affected tibialis anterior muscle. Gait parameters, including gait speed, cadence, stance time symmetry, and step length symmetry, were recorded with GaitRite walkway.

**Results:** 9 out of 16 participants presented a resting MEP on the ipsilesional hemisphere. Individuals with resting MEP presented demonstrated a tendency greater gait cadence (p = .09) and more symmetric stance time (p = .09) than those without a resting MEP. Exploratory correlation analysis was performed for participants with resting MEP (N = 9). None of the TMS measures significantly correlated with gait parameters. The correlations between TMS measures and gait speed were fair to moderate (r = 0.36 to 0.50) and the correlations between TMS measures and cadence were fair (r = 0.38 to 0.43).

**Conclusions:** Presence of resting MEP over the ipsilesional hemisphere appeared to be an important determinant for gait performance after stroke. There was fair to moderate relationship between TMS measures and gait performance but the correlation was not significantly largely due to small sample size.

**Clinical Relevance:** Ipsilesional hemisphere excitability as indexed by TMS measures might be an important prognostic factor to determine gait recovery after stroke.
ABSTRACT BODY:

Purpose/Hypothesis: Recent studies suggest strategies to help survivors find acceptance after stroke. As the most common ongoing formal health care provider, the physical therapist may play an important role in this journey, although no studies have investigated this. The purpose of this project was to examine stroke survivors’ perspective on acceptance after stroke including the physical therapist role.

Number of Subjects: 6 stroke survivors recruited through purposeful sampling: 3 female, 3 male, age range 43-76 years, average 9.7 years post stroke.

Materials and Methods: Semi-structured interviews were completed, transcribed and coded for analysis. Interview questions sought details of each survivor’s journey of acceptance after stroke including struggles, strategies that have helped and the role of their physical therapist(s). Acceptance was defined as: “The capability to redefine a meaningful life and to adjust to changes in ability.”

Results: Four major themes emerged. 1) The acceptance journey is a process where survivors grieve their former selves and redefine themselves. 2) The physical therapist role in the journey is multi-faceted: to serve as a listener, a guide to promote independent problem solving, a family educator to maximize an autonomous home environment, an advocate, to provide resources, and set survivor-driven achievable goals. At the center of the role is to push the survivor to maximize their potential so they “never give up.” 3) Each journey after a stroke is personal and recovery is not linear. The impact of having a stroke was noted across survivor social circles, primary caregivers, and families. 4) The keys to success provided a framework to the path of acceptance. Resoundingly, all survivors stated that support and purpose were critical. Strong secondary themes that emerged included redefining future goals and image of future self while not comparing self to others or trying to meet others’ expectations. Reflection, caregiver respite care, sense of humor and spirituality can play lesser but still significant roles.

Conclusions: Consistent with recent articles, these results emphasize the concept that redefining oneself and finding a “new” purpose is important in finding acceptance after a stroke. Survivors felt that their physical therapist played a role in the journey of finding acceptance and shared stories as examples.

Clinical Relevance: Acceptance does not mean “giving up.” In fact, these data suggest that the role of the physical therapist is to push survivors to not give up. Physical therapists may facilitate the journey of acceptance by focusing on what a survivor can do and by directing goals towards a “new purpose” to help them redefine themselves in a specific role. Educating physical therapists to connect with stroke survivor experiences may facilitate better understanding and improve therapeutic interactions. Future research should assess how much physical therapists know about acceptance after stroke in order to identify knowledge gaps and a focus for future PT education.
Purpose/Hypothesis:
Almost 800,000 people have a stroke per year, with half of stroke survivors 65 and older experiencing reduced mobility\(^1\). There is strong evidence to support that external focus (EF, attention on the outcome) is superior to internal focus (IF, attention on one’s body and movement) in the sports and healthy adult populations\(^2\), but there is conflicting evidence in the stroke population. In a recent study, people post acute stroke were found to have better seated lateral excursion performance with an external focus of attention\(^3\). However, task retention, weight shifting technique, and movement to the affected side were not examined. The purpose of this study was to extend this work by looking at bilateral performance, retention, and form analysis in seated trunk lateral excursion post acute stroke.

Number of Subjects:
23 adults (mean age 66.96 ± 10.6 years), 3 days to 6 months post-stroke, with impaired balance (BERG Balance Scale mean score 30.35 ±14.79 out of 56), and Functional Ambulation Category (FAC) 1-3 were randomly assigned to receive IF or EF instructions during seated balance training. Exclusion criteria: severe hemineglect (<44/54 on star cancellation test) or inability to follow multi-step commands.

Materials and Methods:
Participants performed lateral weight shifting on a pressure mat 3 times to each side during baseline (BASE), short-term (5 min later), and long-term (one week later) trials, and 9 times to each side during acquisition trials. After baseline, participants were given a demonstration, consistent with their focus group, on correct form during weight shifting and asked to use this for all remaining trials. During acquisition, the IF group was instructed to lean over as far as they were able to-and to keep their shoulders high. The EF group had targets at shoulder height and were told to bring the targets as close together as possible. The mean lateral excursion of center of pressure was measured using a pressure mat (BodiTrak). Quality of movement was measured using Body Align Pro with sensors on the acromions.

Results:
No group differences (P>.05) emerged for demographics, BERG, FAC, and BASE phase measures per side. Independent samples t-tests using change scores from baseline to acquisition and baseline to short-term showed that individuals in the EF group shifted their body weight significantly further than those in the IF group during performance trials both to the affected side (p<.01) and unaffected side (p=.04). There were no other significant findings in excursion and form data.

Conclusions:
These findings suggest that external focus of attention can lead to improved performance but the findings don’t support carry-over at this time. This ongoing study aims to find the effects of focus of attention with a larger sample size for short-term and long-term retention as well as the relationship functional level has with focus of attention.

Clinical Relevance:
Using external focus of attention may lead to better performance in individuals post stroke but the effect on true motor learning has yet to be uncovered.
ABSTRACT BODY:

Purpose/Hypothesis: Safe patient handling and mobility (SPHM) equipment helps caregivers and physical therapists (PTs) mobilize difficult to move patients to promote recovery and active muscle engagement during the rehabilitation process while reducing risk of injury to both patient and therapist. There is limited research comparing muscle activity during rehabilitation when SPHM equipment is used relative to manual assist from a therapist. The purpose of this case study was to compare muscle activity in the lower extremities (LE) during a repeated sit to stand activity in a stroke patient with severe left hemiplegia: manual lift by a PT (ML), powered sit to stand lift with PT manual assist (PL), and mechanical assist by an overhead lift (OL).

Number of Subjects: 1

Materials and Methods:
During five sets of repeated sit-to-stand activities for each of the 3 types of assistance (ML, PL, OL), surface EMG electrodes recorded LE muscle activity in the patient’s bilateral quadriceps and bilateral erector spinae in the assisting PT. The patient was instructed to provide maximal effort when performing each sit to stand lift. The PT was instructed to facilitate the sit to stand as she felt would best assist the subject in the sit to stand. Raw EMG time-series data from the patient and PT was converted to power spectra for analysis.

Results: EMG power spectra from the patient suggested that of the three conditions, the OL assist yielded the greatest total muscle activation for both left and right LE’s. However, the ML assist yielded more activation in the affected LE than unaffected when comparing to the OL and the next highest total activation of the LE’s. The PL condition showed minimal activation of both LE’s. EMG power spectra from the PT showed greatest muscle activation of the lumbar spine in the ML condition, followed by the PL condition, and the lowest during the OL condition.

Conclusions: Use of the OL promoted the second greatest muscular engagement of the subject’s LE’s as compared to ML and PL, while creating the lowest muscle activation in the PT lower back through the 5 lifts. Using the OL may offer greater opportunity for neuromuscular re-education of LE as compared to ML or PL, with lower strain and less risk for injury for both the patient and the PT. The OL may allow an improved ability to perform increased repetitions of sit to stand while still promoting increased LE muscle activation in people with stroke.

Clinical Relevance: Therapists should consider SPHM equipment to improve muscular engagement for their patients, while at the same time reducing risk of injury for themselves during rehabilitation of neurologic conditions.
Walking Characteristics in Individuals with Stroke Differ Based on Walking Speed, Endurance and Daily Steps

Purpose/Hypothesis: Walking is an ideal means of obtaining physical activity after stroke, yet many survivors take few daily steps. Understanding the discrepancies in daily steps among people with stroke can guide interventions aimed at increasing walking. The purpose of this study was to examine how the walking characteristics of bouts per day, median steps per bout, maximum steps per bout and time spent walking differ between individuals with various walking speeds, walking endurance and daily steps. Additionally, we aimed to identify cutoff values for differentiating active and inactive ambulators (i.e. those who do and do not achieve physical activity guidelines through walking).

Number of Subjects: 252 individuals with chronic stroke (>6 months). Mean age of 63 (13) years, self-selected walking speed of 0.66 (range = 0.07 – 1.29) meters per second, Six-Minute Walk Test of 211 (range = 0 – 468) meters and step count of 4,277 (3,064) steps per day.

Materials and Methods: Cross-sectional analysis of data from the Locomotor Experience Applied Post-Stroke (LEAPS) trial. Individuals were placed into previously established levels of ambulation (i.e. household ambulators, limited community and unlimited community ambulators), based on walking speed, walking endurance (via the Six-Minute Walk Test) and daily steps (via two days of StepWatch activity monitoring). Differences in walking characteristics were assessed between ambulation levels (e.g. household vs. community ambulators). Linear regression determined which characteristics best predicted daily step counts. Receiver Operating Characteristic (ROC) curves and area under the curve (AUC) determined which variable was most accurate in classifying active (>5,500 steps) and inactive (<5,500 steps) individuals.

Results: Regardless of categorization by walking speed, walking endurance or daily steps, household ambulators had significantly fewer bouts per day, steps per bout, maximum steps per bout and time spent walking compared to both limited and unlimited community ambulators (p = <0.001). 81 (32%) participants obtained >5,500 steps per day. The two highest AUC values were 0.91 (95% CI 0.88, 0.95) for maximum steps per bout and 0.83 (95% CI 0.78, 0.88) for bouts per day. Cutoff values of 648 maximum steps per bout or 53 bouts were used to differentiate active and inactive ambulators.

Conclusions: Walking characteristics differed based on an individual’s walking speed, walking endurance and daily step count. Differences in daily steps between household and community ambulators are largely due to shorter and fewer walking bouts. In conclusion, interventions aimed at improving walking after stroke should target both longer and more frequent walking bouts.

Clinical Relevance: Promoting life-long physical activity, including walking, is an ideal way for the physical therapist to address the health and wellness needs of people with stroke. While there is sparse evidence of effective interventions that increase free-living walking after stroke, clinicians should consider promoting increased walking bouts of any length to increase daily steps after stroke.
Background and Purpose:
Lower extremity spasticity following stroke can contribute to significant pain, muscle weakness, contracture, and decreased functional mobility status requiring equipment or caregiver assistance for safety. Rehabilitative progress can be effected as more conservative spasticity management, including thermal strategies, electrical stimulation, or even chemoneurolytics, has minimal benefit or the effect is transient. Selective tibial neurotomy (STN), a permanent resection of the tibial a1 motor nerve fibers innervating the triceps surae, posterior tibialis, and flexor hallucis longus, is an emerging option for patients presenting with significant lower extremity spasticity following stroke. Physical therapists play a vital role in facilitating the referral of appropriate patients and collaboration with neurosurgery to enhance patient outcomes. The purpose of this case series is to introduce the STN procedure and present a case series of patients follow the selective tibial neurotomy procedure describing pre and post-procedure functional outcomes.

Case Description:
Five patients presenting with significant equinovarus foot due to spasticity were evaluated to gather baseline functional outcome measures, including the 6 minute walk test and gait speed (assessed at self-selected pace over 10 meters), were obtained. Patients were at least 6 months post stroke with an average age of 58.9 years, Modified Ashworth Scale score of 2-3, and chemoneurolytic (injected botulinum toxin A and/or phenol to triceps surae complex and posterior tibialis) with minimal benefit. The patients voluntarily underwent an STN to their respective hemiparetic leg. Reassessment of functional outcomes was performed 3-14 days following procedure and secondary outcome measures, including discontinued use of any durable medical equipment or chemoneurolytic spasticity management options, were noted.

Outcomes:
The results of this case series showed improvements on the 6 minute walk test (6MWT) and the 10 meter walk test, with an average distance increase of 34 m and gait speed increased an average of .09 m/s. Physical therapy participation following STN enhanced these findings with additional improvements of 35 m on the 6MWT and 0.07m/s gait speed. All patients discontinued use of their respective ankle foot orthotics, assistive devices, or had improved capacity to use lower profile braces. Patients no longer required chemoneurolytic management with neurotomy benefit longevity.

Discussion:
Lower extremity spasticity can be a primary limitation for independent, safe mobility and is difficult for physical therapists to conservatively manage. Although this case study includes only 5 patients, all patients demonstrated improvement in functional outcome measure scores. The participant with the least benefit may have been effected by absent sensation and proprioception in his left hemisphere. Future research will need to be performed to determine patient candidacy for an STN procedure. It is essential for physical therapists to have knowledge about emerging, successful techniques to manage spasticity to ensure appropriate referrals to the neurosurgical department and to manage patients following the procedure for the best functional outcomes and recovery.
TITLE: Psychological and Social Influences on Elder Care Partners of Stroke
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Heather Anne Hayes, Kendall Christine Sauter, Trevor Staples, Alexandra Liisa Terrill

ABSTRACT BODY:
Purpose/Hypothesis: Caring for an individual with a disability presents a physical and psychological burden on the caregiver. Stroke is the leading cause of long-term disability in the United States, requiring a large number of individuals to take on this caregiver role. Elder caregivers must learn to cope with their own processes of aging while caring for a loved one. Little is known about the perceived emotional responses of elder caregivers of stroke survivors over the long-term (greater than 6 months). Describe the psychological and social characteristics of elder caregivers who have been caring for a stroke survivor for more than 6 months.

Number of Subjects: 35

Materials and Methods: Elder Caregivers: 1) > 55 years of age; 2) new to caregiving; and 3) caring at home. Individuals were contacted by mail to complete general demographic data about themselves and the stroke survivor. Psychosocial measures included the Patient Reported Outcomes Measurement Information System (PROMIS®) for social roles, cognition, physical function, psychosocial illness, depression, fatigue, and social isolation. These are reported in T-scores with a score of 50 representing the general population and 10 is the standard deviation. Additional measures included: 1) Caregiving Self-Efficacy; 2) Caregiver Strain Index; and 3) Connor-Davidson Resilience Scale.

Results: Thirty-five individuals, average age 67.9 years, primarily caring for spouses completed the study. The majority were well-educated, income of 50-75K or above, and had good social support. The majority of the stroke survivors had difficulty walking. However, they had no trouble using their arm, speaking, dressing, or bathing. On the PROMIS measures, T-scores were 50 or better for social roles, cognition, physical function, psychosocial illness, depression, and fatigue, indicating normal values. They scored less than 50 on social isolation. They scored above normal for self-efficacy, strain, and resiliency scales, indicating no concerns.

Conclusions: The majority of individuals in this cohort of caregivers presented with good adaptability to caregiving. The stroke survivors were not physically debilitated. Quality of life of caregivers has been shown to improve as physical function of stroke survivors improve. Perceived burden decreases over time from the post-acute to the chronic phases of stroke if there was a sense of coherence between the caregiver and survivor dyad and the amount of time caregiving is reduced. Recruitment for this study was difficult (25 individuals withdrew from the study, with a primary reason of no time to complete questionnaires) and thus this data may not fully represent the psychological and social burdens of elder caregivers of chronic stroke survivors.

Clinical Relevance: These data seem to represent a resilient, non-burdened set of elder caregivers of a stroke survivor who is not severely impaired. The question remains whether caregivers are burdened chronically after stroke and what characteristics may influence increased long-term burden.
ABSTRACT BODY:

Purpose/Hypothesis: To describe the clinical characteristics associated with robotic gait training (RGT) and examine the outcomes of people with spinal cord injury (SCI) and stroke who completed usual rehabilitation care (UC) with or without RGT.

Number of Subjects: 155 patients were included in the medical record review and comprised 59 people with SCI (n=31 RGT; n=28 UC) and 96 people post-stroke (n=44 RGT; n=52 UC).

Materials and Methods: A retrospective review of medical records over a period of 36 months in an inpatient rehabilitation setting. Patients with a primary diagnosis of SCI or stroke and a minimum of one RGT session were included. Once a complete list of RGT participants was obtained, medical records were reviewed for comparable matches as determined by gait FIM score <4, age 18-100 years, meeting exoskeleton manufacturer eligibility criteria, and participating in UC only. Functional Independence Measure (FIM) was collected on all patients. For patients with SCI, we also collected the Walking Index for Spinal Cord Injury – II (WISCI II) and Spinal Cord Independence Measure (SCIM). For patients post-stroke, we collected the Stroke Rehabilitation Assessment of Movement Measure (STREAM).

Results: 58% of patients with SCI and 56% of patients post-stroke completed 5+ RGT sessions and were included in between group analyses. To compare outcomes between patients receiving RGT and patients receiving usual care only, patients who completed a minimum of 5 RGT sessions were included (SCI, n = 18; stroke, n = 24) and demographic data was re-analyzed. For patients with SCI, a statistically significant difference in FIM Total change score was observed between groups (RGT 40.3±15.0 vs. UC 29.8±14.9; p = 0.03) and non-significant differences for remaining demographic, injury, and functional outcomes (Table 3). While not significant at the 0.05 alpha-level, the change score in FIM Motor for the RGT group was higher than the UC group (RGT 33.7±14 vs. UC 25.5±13.9; p = 0.06).

For patients with stroke, differences were observed between those who completed at least 5 RGT sessions and those receiving usual care on age (54.7 years old vs. 54.0 years, p = 0.011), length of stay (40.1 days vs. 30.9, p = 0.004), and baseline STREAM scores (RGT 3.0±4.4 vs. UC 6.4±6.5; p = 0.011) (Table 4). However, no between group differences were observed in FIM or change scores of the STREAM in upper extremity function (p = 0.903), lower extremity function (p = 0.759), basic mobility (p = 0.494), and total scores (p = 0.918). FIM Total scores improved in the RGT group compared to UC for SCI patients (40.3±15.0 vs. 29.8±14.9, p=0.03) but not stroke (25.8±10.7 vs. 27.6±11.8, p=0.53).

Conclusions: RGT utilization during inpatient rehabilitation requires consideration of unique patient characteristics (e.g., age, diagnosis, medical severity) impacting functional outcomes. Our patients with SCI appeared to respond positively to RGT sessions during inpatient rehabilitation compared to our patients post-stroke.

Clinical Relevance: More clinical research should be conducted to look at recommended dosages as related to outcome measures and usual standard of care.
Purpose/Hypothesis: Caring for an individual with a chronic condition presents a physical and psychological burden to care partners. Nearly all care partners of individuals with chronic conditions experience some adverse emotional effects within one year of diagnosis. Authors have demonstrated that the emotional well-being of the care partner has a direct effect on functional and psychosocial outcomes of stroke survivors. Engagement in physical activity can decrease stress, improve well-being, quality of life, and improve sleep for care partners. However, current physical activity for care partners of stroke survivors is not known. This study investigates the physical activity patterns in elder care partners of stroke survivors. Specifically, we assessed physical activity using accelerometry in elder care partners of stroke survivors, and compared these activity levels with healthy elders.

Number of Subjects: 22 elder care partners (>55 years of age) of individuals who were greater than 6-months post-stroke were recruited for the study.

Materials and Methods: Care partners wore a StepWatch™ Activity Monitor for 7 days and completed a 7-day activity log. Mean steps per day, percent time in no, low (1-15 steps/minute), medium (16-39 steps/minute), high (> 40 steps/minute) activity was recorded.

Results: Twenty-two participants (10 male, ages 68.6 ± 8.0 yrs) wore the monitors for 6.82 ± 1.56 days. Mean steps per day was 3881 ± 1748. Time (%) spent performing no activity was 78.2 ± 7.1%; low activity, 15.4 ± 5.2%; and medium to high activity, 6.4 ± 3.3% respectively. Number of steps/day was similar to those reported for healthy elders (3302-5269 steps/day). Compared to healthy elders, greater time was spent in sedentary activity (78% vs 65%), more time was spent in low activity (15% vs 33%) and less time was spent in medium to high activity (6.4% vs 2%).

Conclusions: Although total step volume for these care partners was similar to healthy elders, they had more time in sedentary activity. Increasing physical activity for care partners may result in improved well-being and quality of life, and may have a direct impact on the stroke patient's function. Future studies should identify the benefit of increased physical activity and well-being of care partners of individuals post-stroke.

Clinical Relevance: Elder care partners of individuals post-stroke may be experiencing reduced physical activity, which could influence the well-being of both the care partner and stroke survivor.
Purpose/Hypothesis: Regaining functional use of the UE is challenging for people with stroke. Identifying prognostic factors that predict UE function can be useful when developing a plan of care. The purpose of this study was to determine what factors at 5-30 days post stroke predict UE function 6 months later.

Number of Subjects: Data from 380 participants at 5-30 days post stroke and 6 months post stroke were analyzed.

Materials and Methods: Longitudinal, secondary data analyses from a large stroke rehabilitation trial. Independent variables collected at 5-30 days post stroke were single items on the Fugl Meyer UE (FMUE) motor subscale which previously have been shown to be able to classify people with stroke with mild, moderate, or severe impairment. The dependent variable of UE function at 6 months post stroke was defined using the Stroke Impact Scale Hand Function (SIS-HF) subscale. Individuals with SIS-HF scores >=80 were classified as good, 79-60 were classified as moderate, and <=60 classified as poor recovery. Multivariate analysis using Bootstrap method combined with all subset method and Bayesian information criterion were performed to select the most stable model to identify FMUE items at 5-30 days post stroke for predicting good versus moderate/poor and moderate versus poor UE recovery. Based on the selected model, the 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 good versus moderate/poor UE function, a linear combination of FMUE items lateral prehension and wrist flexion/extension with elbow at 0 degrees was suggested as the best subset of independent variables. The AUC for these two variables combined was 0.82. A cut off score of 1 for the sum of lateral prehension and wrist flexion/extension with elbow at 0 degrees resulted in a sensitivity of 0.87 and specificity of 0.69 for predicting good UE functional recovery. In the multivariate analysis for predicting moderate versus poor UE function the FMUE item wrist flexion/extension with elbow at 90 degrees was ranked at the top most frequently, which was suggested as the best independent variable. The AUC was 0.70. A cut off score of 1 for wrist flexion/extension with elbow at 90 degrees resulted in a sensitivity of 0.69 and specificity of 0.80 for predicting moderate versus poor UE functional recovery.

Conclusions: Three items on the FMUE (lateral prehension, wrist flexion/extension with elbow at 0 degrees, and wrist flexion/extension with elbow at 90 degrees) early after stroke can accurately predict good, moderate, or poor UE function 6 months post stroke.

Clinical Relevance: These findings can assist physical therapists in developing a prognosis and a tailored plan of care early after stroke for the recovery of UE function.
Abstract

Purpose/Hypothesis: Seven hundred and ninety-five thousand people experience a stroke in the United States each year and 50-60% of survivors demonstrate residual hemiplegia. These symptoms often negatively impact gait performance and overall functional capacity. Physical therapists work to ameliorate these impairments through a myriad of intervention strategies, which primarily focus on walking recovery. Functional electrical stimulation (FES) may be implemented to elicit muscle contractions during the appropriate phases of gait, thereby enhancing walking performance. However, clear guidelines do not yet exist for the use of FES during the rehabilitation of walking. The aim of this systematic literature review was to assess the available research on the optimal application of FES during gait training that aims to maximize gait speed and gait quality in the population of chronic stroke survivors.

Number of Subjects: Seven original research articles.

Materials and Methods: A systematic literature search was performed using the databases PubMed, CINAHL, and Scopus. The inclusion criteria were: original peer-reviewed research, FES with gait training, >3 months post-stroke, and gait speed as an outcome measure. Exclusion criteria: publication date >15 years ago, non-English translatable articles, single session interventions or those exclusively performed as home exercise programs. Initial screening yielded 52 articles and after full text review 7 met all of the above criteria. Study quality was evaluated using the Downs and Black grading scale.

Results: There was no significant difference in the Downs and Black scores across the 7 articles. All seven studies elicited statistically significant improvements in gait speed. Three studies applied FES to the dorsiflexors (DF) and plantar flexors (PF) and used a treadmill at fast speeds. These three studies not only demonstrated statistically significant improvements, but these improvements also exceeded the MCID value, potentially making them more clinically meaningful. In contrast, four studies applied FES to DF only during self-selected speed overground walking. In these studies, speed improvements were statistically significant but < MCID.

Conclusions: The combination of FES and gait training has a positive effect on gait speed in the population of chronic stroke survivors. FES to multiple muscle groups in combination with treadmill training appears to yield a greater benefit than FES to a single muscle group during less intense, overground training. However, we are unable to conclude whether it was the FES utilization, or the intensity of stepping that caused this effect.

Clinical Relevance: Clinicians should consider applying FES to multiple muscle groups during highly intensive and repetitive gait training to improve over-ground walking speed, as this combination likely optimizes gait mechanics while simultaneously exploiting the principles of neuroplasticity in order to influence maximal positive change.
Purpose/Hypothesis: Stroke survivors (SS) are at risk for falls, particularly towards the paretic side. A lateral step is the most effective response to prevent such a fall, however SS tend to have difficulty executing reactive lateral steps with the paretic limb (PL). Reducing PL weight bearing has been used to increase frequency of PL reactive stepping in the anterior direction. The primary purpose of this study was to investigate PL reactive lateral stepping behavior in individuals with chronic stroke under two weight bearing conditions. We hypothesized that unweighting the PL would increase PL lateral step frequency and decrease step onset time when pulled towards that side. A secondary purpose was to compare voluntary and reactive lateral stepping. We hypothesized that both PL and non-paretic (NPL) reactive step onset would be faster than voluntary step onset.

Number of Subjects: 5 community-dwelling stroke survivors (>6 months) ages 47-60 and 3-13 years post onset.

Materials and Methods: Starting with each foot on a separate forceplate, subjects performed 10 voluntary and 20 reactive stepping trials. In condition 1, subjects stood in their natural stance and, when prompted, took two voluntary lateral steps towards the NPL and PL sides. In conditions 2 & 3, subjects were given a lateral waist pull of 8% body weight toward the NPL & PL. In condition 2, subjects stood in their natural stance (NS) and in condition 3, they stood with only 25% of their body weight on the limb closest to the pull (unweighted – UW). Number of lateral steps and kinematic and force plate data were collected.

Results: Lateral steps with PL occurred in 17/25 trials in the NS condition and 11/25 in the UW condition. Lateral steps with NPL occurred in 13/25 trials in NS condition and 14/25 in UW condition. There was no difference in PL mean step onset times between NS (0.48 sec) and UW (0.524 sec) conditions or for NPL in the NS (0.54 sec) and UW (0.56 sec) conditions. In the NS condition PL lateral step onset times were faster for reactive steps (0.45-0.50 sec) than for voluntary steps (0.55-0.70 sec) with no difference noted between NPL voluntary (0.51-0.61 sec) and reactive (0.52-0.57 sec) step onset.

Conclusions: Limited reactive lateral stepping was seen with PL and NPL and unweighting the limbs did not facilitate additional lateral stepping. The 75-25% weight distribution may be too extreme of a change from natural stance thus disrupting SSs’ postural movement strategy to execute a lateral reactive step. Unweighting may have had a greater effect in SS who have a low frequency of PL lateral reactive steps in the natural stance condition. In the natural stance, lateral perturbations allowed PL steps to occur faster than voluntary step but had no effect on NPL lateral steps.

Clinical Relevance: More gradual unweighting of the PL in SS may be needed to facilitate reactive lateral stepping during training. The faster step onset time for PL reactive vs. voluntary steps supports using reactive training to drive the PL limb to move faster.
TITLE: Anodal Tdcs EnhancesRetention of Visually-GuideStepping in Healthy Adults
CURRENT SECTION:Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Shih-Chiao Tseng, Shuo-Hsiu Chang, PhD, Kristine Mae Hoerth, Anh-Tu Alexander Nguyen, Daniel Perales
ABSTRACT BODY:
Purpose/Hypothesis: Acquisition of motor skills is essential for our everyday life. Strategies to enhance motor skill learning are of great general and clinical interests as elderly and individuals with neurological disorders exhibit difficulties learning or re-learning motor skills, leading to functional limitations and restrictions of participation in all areas of life. Recent evidence shows transcranial direct current stimulation (tDCS) paired with exercise training can enhance skill learning and retention. The purpose of this study is to investigate whether tDCS paired with visually-guided stepping training can promote skill learning and retention. We hypothesize this visually-guided stepping training paired with anodal tDCS will promote a better skill learning and retention indicated by decreasing stepping reaction time immediately (as online skill gains) and 30 min after training (as offline skill gains).
Number of Subjects: 20
Materials and Methods: Twenty healthy adults, mean age 27 years old (± 4.1 SD) participated in the study. Participants were randomly assigned to one of two groups: anodal or sham tDCS (i.e. real or placebo brain stimulation) groups. The study consisted of two sessions on the same day: “stepping training” session followed by “skill retention” session, 30 min apart. 20-min sham or anodal tDCS (2 mA) was delivered over the leg area of primary cortex after participants completed the first 50 stepping trials in the training session. Step reaction times (RTs) were first calculated across three time points: (1) before brain stimulation (Baseline, BS), (2) immediately after brain stimulation (P0), and (3) 30 min after brain stimulation (P3). Two-way (group × time) mixed model ANOVA with repeated measures was used to compare RTs across three time points between groups.
Results: Anodal tDCS group showed a significant decrease in RT only at P3 compared to its BS value (post hoc, \( P = 0.003 \)); whereas sham group showed no improvements of RT at P0 and P3 (post hoc, \( P = 1.0 \) and \( P = 0.4 \), respectively).
Conclusions: Findings do not support our hypothesis that anodal tDCS enhance online learning as RT was not decreased significantly immediately after stimulation. Interestingly, anodal tDCS enhance offline learning as RT was significantly decreased 30 min after stimulation, likely attributed to tDCS-induced neural modulations deriving from multiple sources including changes in cortical and subcortical excitability, synaptic efficacy, and spinal neuronal activities.
Clinical Relevance: Prolonged stepping RT time is linked to increased risks of falling in elderly and people with neurological disorders. This study has provided a promising intervention strategy to decrease RT when pairing stepping exercise with anodal tDCS. Future studies will determine the long-term effects of anodal tDCS paired with visuomotor stepping training on cortical and spinal excitability to develop therapeutic strategies to enhance the health of people with neurological disorders.
Purpose/Hypothesis: To describe a 3 year knowledge translation effort to see extra functional electrical stimulation (FES) cycling realized during inpatient rehabilitation

Number of Subjects: 5 Inpatient Physical Therapists and 1 Physical Therapist Assistant

Materials and Methods: A feasibility study was conducted from January 2016 to August 2016 that examined Physical Therapist’s (PT) and Physical Therapist Assistant (PTA) perceptions of barriers and facilitators to extra FES cycling during inpatient rehabilitation. An 8 month trial period of extra FES cycling was conducted and both users and non-users of the program completed an on-line survey. Survey results on identified barriers and facilitators were utilized to create a 1 year quasi-experimental study from September 2016 to September 2017 to determine if extra FES cycling with bandwidth feedback (BWF) (n=20) led to decreased fall risk and decreased hospital length of stay (LOS) compared extra FES cycling without feedback (n=22) for persons with acute/sub-acute stroke. The results from this study were then utilized to see extra FES cycling realized during inpatient rehabilitation using the Knowledge to Action (KTA) cycle from May 2018 to present day.

Results: The feasibility study revealed time and insufficient staffing as primary perceived barriers for clinicians who did not utilize the extra FES cycling program. However, perceptions of insufficient staffing was less of a barrier for users of the program. Both users and non-users of the extra FES cycle program revealed that improved patient outcomes with discharge to home was a facilitator for program use. Quasi-experimental study findings revealed a 4 day decrease in hospital LOS for persons with stroke receiving extra FES cycling with BWF. Both groups had significant intra-group differences in the 10 Meter Walk Test, Timed Up & Go Test, and Berg Balance Scale, but no significant inter-group differences were seen at discharge or at 1 month follow-up. Immediately after the study’s end, the extra FES cycling program was not utilized by any full time clinician other than the primary researcher. Since implementing the KTA cycle in May 2018, extra practice has been performed with 42 patients. The program has been utilized by every full time PT and PTA in our clinic, with extra practice occurring 58% of the time during regular work days.

Conclusions: Extra FES cycling practice is now utilized greater than 50% of the time for patients in this busy inpatient rehabilitation setting. The use of the KTA cycle has facilitated the application of clinician led research into clinical practice.

Clinical Relevance: Translation of research into clinical practice is said to take 17 years. Extra FES cycling is being used 58% of the time in clinical practice after only 3 years of knowledge translation efforts. The application of the KTA cycle in our clinic may provide useful for other clinicians attempting to translate evidence into best practice.
ABSTRACT BODY:

Background and Purpose: Intravascular lymphoma (IVL) is a rare disease characterized by the proliferation of lymphoma cells in the lumen of the small blood vessels. IVL can have varying presentations, including neurologic manifestations, making diagnosis difficult. Currently, there is little to no research discussing physical therapy management of patients with IVL. The purpose of this case study report is to review the physical therapy (PT) management for a patient with IVL presenting as recurrent strokes.

Case Description: This case study reviews a 53-year-old male who was admitted to the hospital for treatment of multifocal infarcts in bilateral hemispheres and multiple watershed areas. The patient presented with impaired cognition, left inattention, and poor safety awareness which affected mobility-related activities of daily living. Therapy recommendations were made for outpatient PT and consistent supervision due to safety concerns. Following discharge home, the patient suffered additional strokes, resulting in left hemiparesis and impaired functional mobility, leading to readmission seven days later. Physical therapy interventions focused on functional activities, gait training, and neuromuscular re-education. Outcome measures included the Activity Measure for Post Acute Care (AM-PAC) “6-Clicks” Basic Mobility Inpatient Short Form and Berg Balance Scale (BBS). Following extensive testing and severe functional decline, the patient’s medical team diagnosed him with IVL.

Outcomes: The patient initially required standby assistance for all functional mobility with an AM-PAC score of 24/24 and BBS score of 46/56. The patient was discharged home and upon readmission, PT was re-consulted. Despite PT interventions, the patient continued to experience a rapid functional decline, as evidenced by a decrease in AM-PAC score to 7/24 with a minimal detectable change (MDC) of 4.28 and BBS score to 6/56 with an MDC of 6.3, indicating true change.

Discussion: The patient did not show progress as would be expected with his initial diagnosis and instead declined further despite intervention. In conclusion, the use of appropriate outcome measures and thorough documentation facilitated improved therapist and physician communication. This ultimately served as a tool for better patient advocacy and further medical testing for the proper diagnosis.
TITLE: The Impact of Sleep Disorders on Recovery Post Stroke: A Systematic Review
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Makenzie Hauger, Raktim Ghosh, Samantha Lauren Romano, Jonathan E. Thomas, Amy Slutzky, Karen Klingman, George David Fulk

ABSTRACT BODY:
Purpose/Hypothesis: Sleep disorders are a risk factor for stroke and may negatively impact recovery. The purpose of this systematic review was to determine the impact of sleep disorders on recovery of activity and participation in people with stroke.

Number of Subjects: Data from 31 articles were included.

Materials and Methods: Four databases; PubMed, CINAHL, Scopus, and PsycINFO; were searched for potentially relevant articles. Key concepts (sleep disorders and stroke) were broadly defined, using combinations of controlled vocabulary and keywords, to maximize the probability of finding all relevant articles. The PubMed search included MeSH terms of “Sleep”, “Sleep Wake Disorders”, and “Cerebrovascular Disorders”. All searches were run on November 30, 2018, with no restrictions on publication date. Search results were limited to English-language articles. The study selection criteria included diagnosis of stroke, diagnosis of sleep disorder defined by the AASM diagnostic criteria, and outcome measured at the mobility, self-care, domestic life, major life areas; and community, social and civic life aspects of the ICF levels of activity or participation.

Results:
2313 studies were identified and 23 duplicates were removed; 2290 studies were screened for title and abstract; 73 full-text articles were read; of which 31 met eligibility criteria and were included. Overall, 21 studies included participants with a diagnosis of sleep disordered breathing (SDB) and 10 studies included participants with other sleep disorder diagnoses, such as insomnia, RLS/PLMS and EDS. The Barthel Index and Modified Rankin Scale were the most commonly used activity and participation outcome measures. Within the diagnosis of SDB, 71% of the studies found that SDB early after stroke had a negative impact on recovery at the level of activity while 43% found that there was no impact. Additionally, 50% found that SDB early after stroke had a negative impact on recovery at the level of participation while 58% found that there was no impact. For other sleep disorder diagnoses, 50% found that other sleep disorder diagnoses had a negative impact on recovery at the level of activity while 67% found there was no impact. Furthermore, 67% found that other sleep disorder diagnoses had a negative impact on recovery at the level of participation while 33% found that there was no impact.

Conclusions: There is mixed evidence regarding the impact of sleep disorders on activity and participation following a stroke. It was not possible to combine data from studies secondary to a wide variety of methods in diagnosing sleep disorders. These results indicate a need for further research with consistent methods of diagnosing sleep disorders and the use of other activity/participation level outcomes.

Clinical Relevance: Sleep is vital for health and motor learning. It may negatively impact post-stroke recovery as well. PTs should consider screening all patients with stroke for sleep disorders and referring to the appropriate health care provider when indicated.
Purpose/Hypothesis:
Post-stroke gait rehabilitation emphasizes the recovery of forward walking and assessment of forward walking speed is recognized as a key standard outcome. However, gait adaptations such as backward walking (BW) are also critical for safe navigation in the home and community. Recent evidence suggests BW speed may be a useful predictor of fall risk, and rehabilitation that incorporates BW may lead to improvements in forward walking. However, current assessments of BW speed use costly instrumented walkways or motion capture systems not readily available in most clinics. A standardized, valid, reliable and clinically-accessible measurement of BW speed for adults post-stroke is needed. The purpose of this study is to establish preliminary data on the inter- and intra-rater reliability, as well as the construct validity of the 3-Meter Backward Walk Test (3MBWT) in individuals post-stroke.

Number of Subjects:
Twenty-one ambulatory individuals with first-time stroke (15 male; 13 left hemispheric stroke; 57.8 ± 12.9 years old; 3.1 ± 0.8 months post-stroke) and lower extremity (LE) paresis (mean LE Fugl-Meyer Motor Score 21.0 ± 6.0) participated.

Materials and Methods:
Comfortable BW speed was measured with an instrumented walkway (GAITRite®, CIR Systems, Inc. Franklin, NJ) and the 3MBWT. Assistive and orthotic devices were used only if necessary. Participants were instructed to walk backwards at their comfortable pace for a total of 5 meters. Walking speed was calculated for the middle 3 meters using a stop watch and floor markings. Inter-rater reliability was determined by comparing the averages of two trials, by two physical therapists who recorded the time simultaneously. Intra-rater reliability was assessed by comparing the two trials from one physical therapist. Construct validity was determined based on the average of two additional trials where the 3MBWT time was measured by a physical therapist as participants simultaneously performed BW over an instrumented walkway. Validity, intra- and inter-rater reliability were examined with Pearson’s correlation coefficients.

Results:
The average backward walking speeds calculated from the instrumented walkway and the 3MBWT were 0.26 ± 0.13 m/s and 0.26 ± 0.12 m/s, respectively. Strong, positive correlations were found for intra-rater (r=0.96; p<0.001) and inter-rater reliability (r=0.99; p<0.001) as well as construct validity (r = 0.99; p < 0.001).

Conclusions:
Excellent intra- and inter-rater reliability was demonstrated by the strong positive correlations between the gait speeds measured by one and by both raters, respectively. The 3MBWT has excellent construct validity as determined by the strong positive correlation between this new clinical assessment and the instrumented walkway.

Clinical Relevance:
By utilizing a clinical outcome measure to capture backward walking speed, clinicians may improve their ability to identify individuals post-stroke who may be a fall risk. This simple, inexpensive clinical assessment to measure backward walking speed is an important addition to the assessment toolbox in the rehabilitation of individuals post-stroke.
TITLE: Comparison of Gluteus Maximus Muscle Activation during a Chair-Rise in Individuals with Chronic Stroke

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Michelle Mounif Sawtelle, Shih-Chiao Tseng

ABSTRACT BODY:
Purpose/Hypothesis: The chair-rise is an important indicator of lower extremity strength, and functional independence in adults. The proximal lower extremity muscles provide the greatest magnitude contribution to a successful chair-rise. Minimal research has been conducted on the hip extensors during the transition. The purpose of this study was to investigate gluteus maximus (GM) muscle activation characteristics during a normal chair-rise in healthy adults (HA) and in the paretic and non-paretic lower extremities of individuals with chronic stroke (CS). The hypotheses tested were: (1.) that there would be a significant difference in GM onset and magnitude of activation within the CS group, and (2.) that those variables would be significantly different when comparing the paretic lower extremity of the CS group to the ipsilateral lower extremity of the HA group.

Number of Subjects: 16

Materials and Methods: A preliminary sample of eight adults with lower extremity weakness following chronic stroke and eight age and gender matched neurologically healthy adults participated in this study. Surface EMG electrodes were positioned on bilateral GM muscles to capture muscle activation variables. Kinetic and kinematic measurements were taken to ascertain relative phases of the chair-rise. Participants were instructed to stand independently with arms crossed at a self-selected natural speed from an armless, backless surface. Average root mean square (RMS) values of GM muscles were calculated throughout the task within each subject, with group averages calculated across all subjects.

Results: When comparing the paretic and non-paretic extremities within the CS group, there was no significant difference in average GM magnitude ($t(7)= 1.569, p=0.161$), or GM onset of activation ($t(7) = 1.849, p = .107$). When comparing the paretic extremity in the CS group to the ipsilateral extremity in the HA group, there was a significant difference in average GM magnitude ($t(14) = -3.660, p = .003$), but no significant difference in GM onset of activation ($t(14) = 0.818, p=0.427$). When comparing the non-paretic extremity in the CS group to the contralateral extremity in the HA group, there was also a significant difference in GM magnitude ($t(14)= -4.062, p = .001$), but no significant difference in GM onset of activation ($t(14) = -0.692, p=.50$).

Conclusions: This study contributes evidence of deficits in bilateral GM muscles during a chair-rise in individuals with chronic stroke. Emphasis should be placed on training to improve the magnitude of GM activation in synergy with the other lower extremity prime mover muscles.

Clinical Relevance: Task specific training has contributed to increased motor learning in healthy and stroke populations. To achieve such specificity, a comprehensive muscle activation profile of the prime movers involved is needed. This study provides missing evidence of the GM contributions during a chair-rise in individuals with chronic stroke.
TITLE: The Effects of Unilateral Recumbent Stepping in Patients with Chronic Stroke

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Stroke SIG

AUTHORS: Vicky Martina Pardo, Kathryn Kelley, Jared Thomas Kurdunowicz, Gunnar Vagn Littrup, Eric Mocher

ABSTRACT BODY:

Purpose/Hypothesis: The NuStep recumbent stepper is readily available and commonly used by clinicians as a warm up and/or cool down device. However, there is limited research on its use as a targeted intervention. There is currently no evidence on the specific effects of unilateral stepping training on the hemiplegic leg. The purpose of this study was to investigate the effects of a 4 week training protocol on the NuStep utilizing a unilateral stepping condition in individuals with chronic stroke.

Number of Subjects: Eleven participants (7 female, 8 right hemiparesis, mean age 56.7 ± 14.1 years) with chronic unilateral stroke (>6 months) were recruited.

Materials and Methods: Eleven participants (7 female, 8 right hemiparesis, mean age 56.7 ± 14.1 years) with chronic unilateral stroke (>6 months) were recruited. Participants completed pre- and post-evaluations (visits 1 and 10) which included gait on the GAITRite (normal and fast speeds), Maximum Voluntary Contractions (MVC) for knee and ankle in the sagittal plane, rhythmic weight-shifting on the BalanceMaster, the Five Times Sit to Stand (5xSTS), and the lower extremity motor and sensory Fugl-Meyer assessment. Visits 2-9 consisted of 45 minutes of training on the NuStep twice a week. Between the 5 minute warm-up and cool-down, participants stepped with the unilateral hemiparetic leg or with both legs for a total of 35 minutes with rest breaks and manual assistance provided as needed. A descriptive analysis was performed followed by nonparametric Wilcoxon paired samples testing to compare pre and post values for each participant.

Results: There were no significant changes in performance on BalanceMaster and Fugl-Meyer. There was a significant change in 5xSTS from 15.7 to 13.6 seconds (p=0.019). Fast gait showed significant changes in gait speed (p=0.01) from 1.27 to 1.37 m/sec. Normal gait showed significant changes for stride length on the hemi side (p=0.005) and the non-hemi side (p=0.009), and a change in gait speed from 0.92 to 1.04 m/sec (p=0.002). There was a nearly-significant change in dorsiflexion MVC on the hemi side from 30.9 to 34.2 lbs (p=0.051).

Conclusions: The improvements in 5xSTS from above to below 15 seconds is clinically significant because this is a cutoff for higher fall risk in community dwelling older adults. Changes in stride length and gait speed indicate clinically relevant improvements in functional mobility. Gait speed greater than 1.0 m/s has been suggested as a strong predictor of reduced fall risk, adverse health events, hospitalization, and dependence for ADLs. The nearly significant change in dorsiflexion strength on the hemi leg (which could be due to the active pulling up against the footstrap) is of great relevance to neurological PT since dorsiflexion is difficult to regain post-stroke.

Clinical Relevance: This intervention study has demonstrated that a targeted intervention of unilateral recumbent stepping has significant and clinically relevant effects on the strength and functional mobility of individuals with chronic stroke.
ABSTRACT BODY:
Purpose/Hypothesis: Robotic exoskeletons show promise as a rehabilitation method for improving recovery of walking in people poststroke. The lightweight exoskeleton studied here, is worn like a belt, and uses hip angle information to deliver up to 4 Newton-meters of force to the thighs in time with the gait cycle, it’s direct effect is thought to be at the hip. The effect this exoskeleton has at the knee and ankle is unknown. The purpose of this study was to determine the effect of the exoskeleton on the affected limb of individuals with poststroke hemiparesis for these kinematic variables 1) toe clearance during mid-swing 2) knee flexion angle during initial swing 3) ankle plantar flexion angle at terminal stance and dorsiflexion at mid-swing.

Number of Subjects: 9

Materials and Methods: Nine adults (5 female) who were within 12 months of ischemic stroke participated in this within-subject design study. Participants mean age was 69.4 years (55 – 83), 7 had left hemiparesis, 2 had right. Demographic information, daily step-counts, Fugl-Meyer and ABC balance were used to characterize the participants. Spatiotemporal and kinematic gait variables were collected during a single session for each of three conditions: comfortable walking (C1), exoskeleton walking (C2), after-effect walking (immediately after exoskeleton was turned off)(C3). Repeated measures ANOVA were used to compare the effect of condition on the kinematic variables. Tukey’s HSD was used to evaluate pair-wise comparisons.

Results: On average, study participants walked 2953 steps/day (1965-6817). Their mean gait speed was 0.89 (± 0.22) m/s, their LE Fugl-Meyer mean score was 30.7/34 (29-33). Their ABC balance confidence averaged 73.7% (± 21.1). Differences in toe clearance at mid-swing were found to be statistically significant among the conditions: F (2, 24) = 10.7, p < 0.001, C1 vs. C2 p = 0.11, C2 vs. C3 p <0.001, C1 vs. C3 p = 0.046. Knee flexion angle at initial swing was not statistically different between groups F (2, 24) = 0.18, p = 0.83. Ankle plantar flexion angle at terminal stance was not statistically different between groups F (2, 24) = 0.05, p = 0.95. Ankle dorsiflexion angle at mid-swing was not statistically different between groups F (2, 24) = 0.07, p = 0.93.

Conclusions: In this sample of individuals with mild poststroke hemiparesis toe clearance of the affected limb increased in the exoskeleton condition compared to the control condition, though differences were not statistically significant. Immediately after the exoskeleton was turned off toe clearance was less than in either the control or the exoskeleton condition suggesting an aftereffect of exoskeleton use.

Clinical Relevance: An improved understanding of the effect of exoskeletons on spatiotemporal and kinematic variables at critical phases of gait for people with stroke will contribute to improved exoskeleton design and function.
TITLE: Predicting Cognitive and Motor Functional Outcomes Using Admission Cognition in Patients Post-Acute Stroke

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Hannah J. X. Carey-Brown, Elena Crooks, Kimberly A. Honn, Doug L. Weeks

ABSTRACT BODY:
Purpose/Hypothesis: Stroke is the leading cause of long-term disability in the United States. Stroke can lead to cognitive impairments that compromise functional independence, such as memory loss and impaired attention. The purpose of this study was to determine whether a cognitive assessment could prospectively predict functional outcomes in patients post-stroke attending an inpatient rehabilitation facility (IRF). We hypothesized that a cognitive assessment would predict cognitive but not motor functional outcomes.

Number of Subjects: Thirty subjects (68.1±15.7 years, 15 female) post-acute stroke admitted to an IRF completed the study.

Materials and Methods: Cognition was assessed with the Trail Making Test Version A (TMT-A) and Version B (TMT-B), and functional independence was assessed with the cognitive and motor aspects of the Functional Independence Measure (FIM), administered near admission and discharge from the IRF. Admission and discharge FIM scores were used to calculate a cognitive and motor Montebello Rehabilitation Factor Score (MRFS), a well-established measure of relative gain in function during an IRF stay. Descriptive statistics and linear regression analyses were calculated using SPSS v24.

Results: The overall regression model was statistically significant for the ability of admission TMT-A scores or TMT-B scores to independently predict cognitive and motor functional outcomes, as assessed by the MRFS (p<0.05). Specifically, poorer cognition at admission, as assessed by the TMT-A or TMT-B, predicted lower cognitive and motor MRFS. In contrast, change in TMT-A or TMT-B scores from admission to discharge from the IRF did not predict cognitive or motor MRFS (p>0.05).

Conclusions: Results from this study indicate that a cognitive assessment near admission to an IRF, such as the TMT, can prospectively predict changes in functional outcomes in patients post-acute stroke. Of interest, the cognitive assessment predicted motor functional outcomes in addition to cognitive functional outcomes. The TMT-A and TMT-B assess perceptual speed and fluid intelligence, suggesting the importance of intact executive functioning at admission to an IRF in functional recovery post-stroke. Conversely, change in cognition from admission to discharge from an IRF did not predict cognitive or motor functional outcomes. The inability of changes in TMT scores to predict even the cognitive MRFS may be attributed to the communication and social cognitive aspects heavily assessed by the cognitive FIM, which may be unaffected by improvements in cognitive speed and fluid intelligence assessed by the TMT.

Clinical Relevance: Poorer performance on a cognitive assessment near admission to an IRF was predictive of less improvement in cognitive and motor functional recovery, suggesting that patients with better cognition at admission have greater opportunities for improvement, despite the common contradictory assumption. Physical therapists should consider performance on cognitive assessments, such as the TMT-A or TMT-B, when determining a patient’s prognosis and establishing the plan of care.
According to the Referent Configuration (RC) theory of motor control, the nervous system activates muscle by shifting the angular thresholds (or set point) at which muscle activation begins, called the tonic stretch-reflex threshold (TSRT). Stroke impairs the ability to shift the TSRT, which contributes to sensorimotor impairments such as spasticity, weakness and abnormal muscle activation. We hypothesized that if the primary motor cortex (M1) is involved in TSRT shifts, the corticospinal (CS) tract facilitates elbow flexor motoneurons to produce elbow flexion and de-facilitates elbow flexor motoneurons to produce elbow extension. After stroke, due to limitation in the ability to shift TSRT, this pattern may be absent or modified, which may be related to clinical movement deficits. The aim of the study was to examine whether and to what extent CS modulation is related to motor impairment and to TSRT regulation, to better understand sensorimotor deficits after stroke.

Number of Subjects:
17 healthy adults (59.8 ± 12.2 yr) and 12 subjects with chronic stroke (56.3 ± 9.8 yr) were recruited.

Materials and Methods:
In this cross-sectional study, transcranial magnetic stimulation (TMS) was delivered over the M1 flexor representation to elicit motor-evoked potentials (MEPs) in elbow flexor muscles in different angular positions (i.e. elbow in flexion and extension). MEP amplitude was considered as a measure of CS excitability. In subjects with stroke, the range of regulation of TSRTs for flexor muscles was determined based on muscle responses to passive stretches and active movements. TSRT modulation (Δ-TSRTs) was computed as the difference between the location of TSRTs in passive and active movements. Fugl-Meyer Upper Limb Assessment (FMA) and Composite Spasticity Index (CSI) assessed sensorimotor deficits and spasticity of the upper limb, respectively.

Results:
Position-related patterns of MEP modulation between elbow flexors and extensors were similar in healthy subjects and in individuals with mild stroke (p<0.05). Less consistent modulation was detected in more severe post-stroke subjects (p>0.05). MEP modulation was related to FMA, CSI and the ability to modulate TSRTs between passive and active conditions (p<0.05).

Conclusions:
Results confirm the close relationship between TSRT modulation and CS excitability. Impairments in the regulation of TSRTs may underlie motor deficits in moderate-to-severe post-stroke individuals. Future clinical research should aim to translate these neurophysiological findings to physical therapy practice to develop new treatment strategies based on strong motor control theories.

Clinical Relevance:
Findings suggest that efforts to improve TSRT modulation may result in better sensorimotor clinical outcomes in post-stroke subjects.
Purpose/Hypothesis: Sleep has been shown to be an important component of learning, cognitive functioning, and recovery following stroke. However, it remains unknown how sleep duration during inpatient rehabilitation impacts functional disability. Therefore, the aim of this study is to determine if sleep duration during acute inpatient rehabilitation is associated with functional disability for individuals following stroke.

Number of Subjects: This is an ongoing longitudinal observational study. To date, 29 individuals have enrolled. Six individuals dropped out of the study (two due to transfer to ICU; one due to transfer to acute care; one due to death; one due to unknown reasons; one due to complaints of discomfort with the actigraph wristband). Therefore, 23 individuals were included in the current data analysis (11 female, 12 male; average age 63.35 years, SD 12.35).

Materials and Methods: Participants are asked to wear an actigraph on their less-affected wrist for the duration of inpatient rehabilitation to assess sleep. The Functional Independence Measure (FIM) was collected at baseline and discharge. Sleep during the first three nights were averaged for a “baseline sleep” score and the last three nights were averaged for a “discharge sleep” score. Percent change for total sleep time (TST) and FIM was also calculated. Pearson correlations were used to explore associations between total sleep time (TST), and FIM at baseline and discharge and percent change in TST and FIM.

Results: Sixteen participants had an increase in TST from baseline to discharge with an average increase of 97.87 min, and seven participants had a decrease in TST with an average decrease of 88.19 min. There was a significant positive association between TST at baseline and FIM at admission ($r=.443$, $p = .034$) and a significant negative association between TST at discharge and percent change in FIM ($r= -.456$, $p= .029$).

Conclusions: The preliminary results of this ongoing study suggest that greater sleep quantity at baseline may be associated with better functional ability at admission to inpatient rehabilitation. Furthermore, preliminary results suggest that greater sleep quantity at discharge may be associated with less change in functional ability from admission to discharge from inpatient rehabilitation.

Clinical Relevance: Sleep should be assessed during inpatient rehabilitation following a stroke and may be associated with functional disability. It is currently unclear if greater sleep duration at admission promotes recovery and normalization of sleep duration by discharge (i.e., return to typical sleep duration) contributes to better functional ability over the course of inpatient rehabilitation. It is also not clear if other factors (i.e., stroke location, medication, age, physical activity) mediate the relationship between sleep and functional recovery. Further investigation is warranted.
Purpose/Hypothesis: Fatigue and sleep disturbances are reported in the majority of individuals following stroke and traumatic brain injury (TBI). Between these populations, abnormal sleep is associated with impaired cognitive and psychomotor functioning. Sleep characteristics have been described in these populations at both acute-hospital and chronic stages, however not during acute rehabilitation. Therefore, the purpose of this study was to describe and compare sleep characteristics in individuals with acute stroke versus acute TBI in an inpatient rehabilitation facility (IRF).

Number of Subjects: Thirteen subjects (67.5±5.7 years) with acute stroke (n=10) or TBI (n=3) at an IRF completed the study.

Materials and Methods: Subjects wore actigraph monitors, a valid alternative to polysomnography, to measure sleep characteristics over 10 days. Minutes of sleep during two time periods—lights-on (06:00-20:59) and nighttime (19:00-05:59)—and number of sleep/wake transitions were calculated for Days 1 and 10. Cognitive and motor Functional Independence Measure (FIM) scores were recorded to reflect functional severity of neurological injury. Non-parametric tests were used to compare differences in sleep characteristics between persons with acute stroke and TBI.

Results: There were no significant differences in sleep measures from Day 1 to Day 10 for either group. Total mean sleep durations were 14.9h for the TBI group and 8.0h for the stroke group. Despite observed differences, increased daytime sleep was exhibited by both groups. The stroke group displayed appropriate sleep duration, however, with a mean of only 68.5% of sleep occurring during nighttime hours. Compared to the stroke group, the TBI group demonstrated an additional 3h 13min of nighttime sleep, 3h 20min more of lights-on sleep, and 14.2 more sleep/wake transitions (p<0.05). On Day 1, the TBI group exhibited significantly lower cognitive FIM scores, however this difference was not maintained on Day 10. Motor FIM scores were not significantly different between groups.

Conclusions: Individuals with acute TBI demonstrated hypersomnia relative to those with acute stroke and compared to national recommended sleep durations (7-9h). Overall, there were no observed improvements in sleep characteristics following TBI or stroke during 10 days of inpatient rehabilitation.

Clinical Relevance: Greater sleep impairments in individuals with acute TBI may be attributed to affected functional brain regions more involved in sleep/wake circuitry. Previous work identifies hypothalamic changes as a potential mechanism for abnormal sleep following TBI. Increased fatigue, demonstrated by hypersomnia and/or daytime sleepiness in persons with acute stroke or TBI, can interfere with participation in rehabilitation. Clinicians should consider sleep characteristics following stroke and TBI, given that previous work suggests functional and cognitive impairments associated with abnormal sleep in these populations. At present, there are no evidence-based protocols addressing sleep/wake disturbances in individuals with acute stroke or TBI.
**TITLE:** High-Level Mobility Training in Ambulatory Patients with Acquired Non-Progressive Central Neurological Injury: A Feasibility Study

**CURRENT SECTION:** Neurology

**CURRENT SUB-CATEGORY:** Stroke SIG

**AUTHORS:** Estelle Christine Gallo, Iwona M. Kedzierska, Katie Ann Connors, Jaime P. Cepeda, Smita Rao

**ABSTRACT BODY:**

**Purpose/Hypothesis:**
The purpose of this study is to test the feasibility and safety of the implementation of a conceptual framework developed by William and Schache (W&S) for retraining High Level Mobility (HLM) on adults with Acquired Non-Progressive Central Neurological Injuries (ANPCNI). Our hypothesis is that its implementation would be both feasible and safe.

**Number of Subjects:**
Twenty-six

**Materials and Methods:**
Twenty-six participants who were 18 years-old or older, ambulatory (able to walk 20 m without an assistive device and physical assistance with a gait speed of 0.6 m/s or greater), and diagnosed with an ANPCNI, were randomly assigned into a Simple Skill Group (SSG) (n=13) or a Complex Skill Group (CSG) (n=13). Both groups received our standard of care: individualized program addressing pertinent impairments and functional limitations with an emphasis on functional activities and enabling participants to resume community ambulation, twice a week for 30 minutes for 12 visits over 6-8 weeks. The SSG practiced skills like transfer, ambulation and stairs. The CSG was trained and instructed in a HLM program applying the W&S framework structured around the hierarchy of mobility skills using the HiMat and biomechanical characteristic of running. Participants learned pre-running skills (toe walking, walking over obstacles, stairs), running skills (bounding, running) and post running skills (hopping, skipping, agility drills), with the goal to acquire the ability to run. To establish feasibility, recruitment, completion and adherence rates were measured. To determine safety, Adverse Events (AE) were monitored at each session. AE were measured as a new onset of lower extremity pain >4/10, a fall while in therapy, and/or a musculoskeletal injury.

**Results:**
From Jan 2018 to March 2019, among 38 subjects meeting inclusion criteria, 26 consented and 12 declined (5 wanted to be assigned to CSG, 2 wanted to be assigned to SSG, 1 fear, 1 not interested in study, 3 scheduling issues), resulting in a 68% recruitment rate. Among the 26 participants, 18 completed the study (CSG n=9, SCG n=9), 8 withdrew (CSG n=4, SSG n=4, 6 scheduling issues, 1 medical reason unrelated to study, 1 personal) giving a completion rate of 69%. All participants adhered to the assigned protocol, resulting in a 100% adherence rate. Three participants in the CSG were only able to practice pre-running skills. Two AE related to pain were recorded, 1 in each group.

**Conclusions:**
This study supports our hypothesis. HLM training is feasible and safe to perform on ambulatory subjects with ANPCNI.

**Clinical Relevance:**
This study is the first randomized control trial testing the feasibility and safety of HLM training in patients with ANPCNI. Neurological rehabilitation has traditionally focused on walking skills without considering a return to high-level activities. Running is a salient, more complex and intense task than walking, therefore it could be an effective and efficient intervention combining high intensity training with complex skill acquisition fostering greater functional recovery, consistent with the current literature and experts in the field of neurological rehabilitation. It is warranted to explore its efficacy.
Purpose/Hypothesis: Many stroke survivors exhibit deficits in functional mobility, a major contributor to decreased quality of life [1]. While substantial research is focused on the development of novel gait rehabilitation methods to address these deficits [2-3], many stroke survivors are excluded from such studies due to an inability to walk independently. To expand the reach of post-stroke gait interventions, we must: 1) understand the barriers preventing independent walking in chronic stroke; and 2) develop therapies to promote independent walking, thus potentially allowing entry into the “virtuous cycle” of increased activity participation [4]. The purpose of this exploratory study is to identify post-stroke postural metrics linked to an inability to walk independently. The present analyses focus on the ability to shift weight over the paretic leg, which has been linked to gait asymmetries among independent walkers [5], and could logically influence the ability to walk independently at all.

Number of Subjects: 43 individuals with chronic stroke (>6 months since injury) and self-reported deficits in walking function participated in this study.

Materials and Methods: Participants performed a series of overground walking trials at their normal and fastest speeds, wearing a harness that did not support body weight, but would prevent a fall in case of a loss of balance. Participants were defined as independent walkers if they were able to complete the walking trials without requiring assistance from an experimenter, the overhead harness, or an assistive device (i.e. cane, walker, rollator). Participants then performed a Limits of Stability test, in which they voluntarily swayed as far as they felt safe in eight directions, while center of pressure location was measured. As paretic weight bearing is often limited in stroke survivors [5], we focused on sway toward the paretic leg. Specifically, we quantified: 1) End Point Excursion for the initial weight shift, an indicator of participant perceived safety; 2) Maximum Excursion throughout the trial, an indicator of sway ability; and 3) Directional Control, an indicator of control accuracy. To investigate whether each of these metrics were predictive of independent walking, we performed receiver operating characteristic analyses.

Results: While all participants reported some manner of walking deficits, the majority (34/43) were classified as independent walkers. All three sway metrics performed similarly at predicting participants’ ability to walk independently, with specificity values ranging from 0.56-0.67 and sensitivity values from 0.97-1.0.

Conclusions: The high sensitivity values indicate that stroke survivors able to achieve a certain level of weight shift toward their paretic leg can reliably walk independently.

Clinical Relevance: The observed relationship between active postural sway and independent walking suggests that interventions focused on improving weight shift toward the paretic leg may help chronic stroke survivors achieve independent walking and qualify for more intensive gait rehabilitation.
Is High-Intensity Aerobic Activity Safe and Feasible during Early Stroke Rehabilitation: A Systematic Review

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Cody J. Bach, Kelsi Chazin, Maymol Jacob, Julia Catherine Madison, Colleen Touhey, Christine Tyrell

ABSTRACT BODY:

Purpose/Hypothesis: Historically, high-intensity aerobic exercise has been reserved for patients in the later stages of stroke recovery, partially due to clinician concerns about jeopardizing patient safety.\textsuperscript{5,17,18} Yet, research has shown that there is a higher capacity for neuroplastic change and cardiovascular recovery early after stroke, and that the intensity of activity may be the most important aspect of the therapeutic intervention.\textsuperscript{15,33} The purpose of this systematic review is to investigate the effectiveness, safety, and feasibility of high-intensity aerobic activity acutely after a stroke.

Number of Subjects: Six original research studies, 348 participants.

Materials and Methods: A systematic search of PubMed, Scopus, and CINAHL yielded 244 articles. Authors screened the articles using the following inclusion criteria: original research available in English, human subjects >18 years, stroke onset <6 months of the study start, and high-intensity aerobic exercise (>50% HRR and/or >60% VO\textsubscript{2} peak). Articles were excluded if they involved health conditions other than stroke. The six final articles were evaluated using the Downs and Black Scale.\textsuperscript{19}

Results: There was no significant difference in the Downs and Black scores across the six articles. Effectiveness was measured by statistically significant improvement in functional status (5/5 studies) and/or aerobic capacity (3/5 studies) after intervention. Safety was evaluated by the presence of adverse events, of which there were zero across the six studies.\textsuperscript{20-25} Feasibility was evaluated through attendance, and ability to tolerate the targeted intensity. The ultimate session attendance rate was 83.2% (+/- 10.25%).\textsuperscript{20-25} Of the three studies that reported target intensity, subjects were able to achieve it.\textsuperscript{20-22}

Conclusions: Although high-intensity aerobic activity is inconsistent in its impact on aerobic capacity acutely after stroke, it is consistently effective in improving functional status as quantified by commonly used standardized outcome measures.\textsuperscript{20-25} In contrast to traditional beliefs, such treatments are safe, and participants who engaged in the studied interventions had high adherence rates and were able to reach the targeted intensity set by the investigators.\textsuperscript{20-25}

Clinical Relevance: This review adds evidence to support the notion that aerobically intense activity is an essential component of the plan of care after stroke, as was recently reiterated by the Locomotor Training Clinical Practice Guideline.\textsuperscript{33} The current review expands on the statements of the CPG, by demonstrating a positive impact on the acute population of stroke survivors as well. This review provides evidence that clinicians should not wait until the chronic stages of stroke recovery to integrate high-intensity aerobic activity, as it has the power to positively affect functional, as well as locomotor abilities, which may facilitate an earlier discharge to home. In conclusion, patients can do it, are willing to do it, and the historical view that it may be dangerous during the acute stages of recovery is unfounded.
TITLE: Relationship between Berg Balance Scale, Gait Speed and Assistive Device Progression in Subacute Stroke

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Soo-Kyung Ock, Suzanne Babyar Rothbart, Jessica Pabotoy, Jennifer Langenberg, Aliza Aranoff, Anastasia Agababyan, Janet Anne Herbold

ABSTRACT BODY:

Purpose/Hypothesis: The purpose of this study was to determine cut-off scores for the Berg Balance Scale (BBS) and gait speed measured by the 50-foot walk test that were associated with type of assistive device (AD) used by patients with subacute stroke in an outpatient setting. We hypothesized that definitive cut-off scores for gait speed and BBS scores would be associated with the degree of dependence associated with various assistive devices.

Number of Subjects: Thirty-four outpatients with subacute stroke participated in this study.

Materials and Methods: The BBS and 50-foot walk test scores were collected during the initial evaluation, every four to six weeks, and at the time of discharge from physical therapy. Change in AD was noted throughout.

Results: The threshold values for determining progression from any AD to no device were 0.58 - 0.62 m/s (AUC 0.934) for gait speed and 42.5/56 (AUC 0.906) for BBS. Mean gait speed and BBS scores associated with quad cane were lowest: 0.23 m/s±0.12 and 25.0±10.2, respectively. Scores associated with no AD were highest: walk speed 0.97 m/s±0.30 and BBS 49.9±5.41 respectively. Gait speeds associated with use of rolling walkers were faster than those for use of any type of cane.

Conclusions: The BBS and the 50-foot walk test are strong predictors of AD progression. Patients’ personal preference in AD should also be taken into account. Sample excluded patients with cognitive impairment thus limiting generalizability across the stroke population.

Clinical Relevance: The BBS and the 50-foot walk test can be used as supplemental tools to guide clinical decisions by physical therapists for prescribing an AD to a patient with subacute stroke undergoing outpatient physical therapy.
Evaluation of a Carepartner-Integrated Telehealth Rehabilitation Program for Persons with Stroke

**CURRENT SECTION:** Neurology  
**CURRENT SUB-CATEGORY:** Stroke SIG  
**AUTHORS:** Sarah Richardson Blanton, Patricia Clark, George Cotsonis, Sandra Dunbar, RN, PhD, FAAN, FAHA, FPCNA

**ABSTRACT BODY:**

**Purpose/Hypothesis:** Family carepartners (CP) are critical for optimal stroke survivor (SS) rehabilitation, yet they often feel inadequately trained for this role. Developing family-centered therapy approaches that improve physical and psychosocial health for both the CP and SS are needed. The purpose of this study was to evaluate a novel, web-based intervention (CARE-CITE) to facilitate positive CP involvement during a home-based application of constraint-induced movement therapy (CIMT) for the upper extremity (UE).

**Number of Subjects:** 32 dyads including a SS and a CP

**Materials and Methods:** Dyads of SS (56.3% male, mean age 60.6±14.2 years; 18.4±13.3 months post stroke) and CP (62.5% female, mean age 58.7±13 years, 68.8% spouses of SS) were randomized to the CARE-CITE group (CIMT with structured CP involvement, n=21) and control (CIMT only, n=11). CARE-CITE consisted of six online, theory-based modules with exemplary videos of family scenarios of UE task practice in the home environment. The CP reviewed modules in parallel to the 30 hours of CIMT for the SS. Primary outcome measures included CP depressive symptoms (Center for Epidemiologic Studies Depression Scale) and family conflict related to stroke recovery (Family Caregiver Conflict Scale), and SS UE function (Wolf Motor Function Test log mean, WMFT-ln and Motor Activity, MAL).

**Results:** Within and between treatment group changes and differences were tested using mixed model ANOVA. For CP depressive symptoms, no significant between or within group changes were found. Within group improvements in family conflict were seen for CARE-CITE, mean pre 28.5±2.2, post 26.8±2.2, and follow-up 23.1±2.3 (p=0.02), but not the control group, mean pre 20.0±3.1, post 21.9±3.2, and follow-up 18.6±3.2 (p=0.42). For SS UE function, within group improvements were found in both groups (p<0.05) for WMFT-ln (CARE-CITE mean pre 2.0±0.2, post 1.8±0.2 and follow-up 1.6±0.2; and control group mean pre 1.9±0.3, post 1.3±0.3 and follow-up 1.4±0.3) and MAL (CARE-CITE mean pre 2.2±0.2, post 3.3±0.2 and follow-up 3.3±0.2; control group, mean pre 2.3±0.3, post 3.6±0.3 and follow-up 3.4±0.3); but no significant group or group*time differences.

**Conclusions:** Reduced CP family conflict around stroke recovery and improved SS UE function occurred for family dyads receiving a CP-focused intervention to facilitate skill building and problem solving in conjunction with intensive UE rehabilitation protocol, but did not affect CP depressive symptoms. An intensive home-based application of CIMT improved SS UE function with and without CP involvement.

**Clinical Relevance:** Interventions designed to improve CP skills and promote an autonomy-supportive home environment for rehabilitation may facilitate positive interactions for both the CP and the SS. The findings of this project provide evidence to guide engagement of families in the stroke rehabilitation process and lay the framework for a larger clinical trial to test the efficacy of the CARE-CITE intervention.
Purpose/Hypothesis: Stroke is a leading cause of disability in the United States.1 A common, disabling consequence of stroke, hemiparesis, leads to gait patterns characterized by decreased gait speed, decreased quality of life, and an elevated risk for falls.2 The innovative iStride™ device3 was developed to address the need for effective gait rehabilitation post-stroke. Initially designed to mimic the beneficial action of a split belt treadmill, the iStride™ device improves upon these mechanics as it is portable, can be worn for extended periods of time, and can be used in different environments such as one’s own home. Previous research demonstrated that the device significantly improved gait patterns for stroke survivors in the clinic setting.4,5 The purpose of this study was to investigate the efficacy and safety of iStride™ device usage in the home setting. We hypothesize that the iStride™ device in the home setting will safely yield clinically relevant improvements in gait and mobility for stroke survivors with hemiparetic gait.

Number of Subjects: Twenty-one participants completed the treatment protocol. Participants were at least six months post-stroke with hemiparetic gait and able to walk independently with or without a cane.

Materials and Methods: Participants were treated on the iStride™ device in their home environment three times per week for four weeks under the guidance of a physical therapist. Sessions consisted of walking with the iStride™ device on the foot of their non-paretic lower extremity for a goal of 30 minutes. Outcome measures assessed at baseline and 1-week post-treatment included: 10 Meter Walk Test (10MWT), Timed Up and Go Test (TUG), Berg Balance Scale (BBS), Functional Gait Assessment (FGA), and the Stroke Specific Quality of Life Scale (SS-QOL).

Results: Results showed statistically significant improvement from baseline to 1-week post-treatment (p=0.0001 for 10MWT, p=0.0001 for TUG, p=0.001 for BBS, p=0.0001 for FGA, and p=0.001 for SS-QOL). One hundred percent of participants improved beyond the minimal detectable change (MDC) on at least one outcome measure and 76% improved beyond the MDC on ¾ measures. Sixty two percent of participants improved at least one gait speed category and 90% reduced fall risk on at least one outcome measure.

Conclusions: The iStride™ device in the home environment facilitates clinically significant improvements in gait speed and fall risk for stroke survivors with hemiparetic gait.

Clinical Relevance: Nearly 800,000 Americans experience a stroke each year,6 however, less than 50% will regain the ability to ambulate independently in the community after their stroke.7,8 The results of this study emphasize the efficacy of the iStride™ device to improve gait parameters and reduce fall risk for stroke survivors while additionally demonstrating the safety of its usage in the home setting. An effective home-based gait treatment device may facilitate convenient, long-term, and frequent treatment opportunities for stroke survivors with hemiparetic gait.
Does Activity-Dependent Modulation of Interhemispheric Inhibition Contribute to Post-Stroke Hand Function?

**ABSTRACT BODY:**

**Purpose/Hypothesis:** Most stroke survivors experience residual paretic hand and arm dysfunction limiting their ability to perform functional tasks and activities of daily living. Post-stroke impairments are thought to be the result of neural cell death and hypoexcitability within the ipsilesional hemisphere, which may result in an imbalance of interhemispheric inhibition (IHI) between the ipsilesional and contralesional motor cortices (iM1 and cM1). Several studies have attempted to modulate IHI balance using non-invasive brain stimulation (NIBS) strategies such as transcranial magnetic stimulation (TMS). However, conflicting findings regarding the role of IHI in post-stroke paretic limb dysfunction suggest IHI is a complex phenomenon that has not been comprehensively characterized. The primary objectives of this study were to investigate transcallosally-mediated IHI during rest and active motor states and, evaluate the relationship between IHI and hand function in individuals post-stroke and older neurologically-intact adults.

**Number of Subjects:** Ten individuals post-stroke (aged 45-85y) with chronic paretic arm impairment and fifteen neurologically-intact older adults (aged 53-81y).

**Materials and Methods:** Participants completed a MRI scan to evaluate lesion characteristics and inform TMS-targeting of the representation of the first dorsal interosseous (FDI) muscle in M1 bilaterally. IHI was assessed using a paired-pulse TMS paradigm using two monophasic stimulators where a conditioning pulse was delivered over M1 followed by a test stimulus over the contralateral M1 at various inter-pulse intervals (IPIs). IHI assessment was performed for both hemispheres to characterize IHI bidirectionally. At rest, IHI was assessed with 10 randomized blocks (10 trials/block): 2 single-pulse unconditioned, and 8 paired-pulse conditioning blocks (IPIs: 1, 5, 8, 10, 12, 15, 25, and 50ms). During the active IHI assessment, participants maintained an isometric FDI contraction during unconditioned and conditioned (IPIs: 8 and 50ms) blocks. The ratio of conditioned to unconditioned motor evoked potential (MEP) amplitudes was the primary outcome measure to evaluate the effect of group, motor state, and direction on the magnitude of IHI. The relationship between IHI and hand function was evaluated using the IHI ratio and time to complete the nine-hole peg test (NHPT).

**Results:** Both groups exhibited significant IHI at various IPIs at rest; however, IHI from cM1 onto iM1 in the stroke group was only observed at 10ms ISI. Active IHI assessment revealed that with a volitional sustained isometric contraction, IHI was weaker or absent for older adults bilaterally and from iM1 onto cM1 post-stroke. However, IHI from cM1 onto iM1 was not modulated by activity and stronger levels of cM1 onto iM1 IHI during activity were correlated with poorer NHPT performance.

**Conclusions:** The primary study findings showed abnormal IHI after stroke where cM1 to iM1 IHI was reduced at rest and was not modulated by paretic muscle activity. Further, this abnormal lack of activity-dependent IHI modulation was associated with poorer hand function. These findings may suggest that the balance of IHI balance shifts in favor of reducing cM1 inhibition of iM1 activity at rest to compensate for iM1 hypoexcitability. However, given that IHI of iM1 abnormally persisted during paretic hand activity and was related to motor dysfunction, the current findings suggest modulation of IHI between motor motor states is an important consideration post-stroke. Further research investigating the mechanisms underlying state-dependent modulation of IHI may inform development of effective therapies to improve paretic hand and arm function post-stroke.

**Clinical Relevance:** Understanding the neurobiological substrates of post-stroke recovery are necessary to develop effective precision-based therapies that reduce disability and improve quality of life for stroke survivors.
ABSTRACT BODY:

Purpose/Hypothesis: It is unclear whether visual feedback during walking training imparts a significant cognitive load. The purpose of this study is to investigate the effect of visual feedback, in the form of projections on a treadmill, on muscle activation in comparison to other dual-tasks during treadmill walking in people with stroke. Since muscle activity during walking increases with increased cognitive load, we hypothesized that peak EMG and co-activation will be higher during walking with visual feedback than without and compared to other dual-tasks conditions.

Number of Subjects: Nine participants with chronic stroke (4 females, 5 males; mean age 63.6±6.9yrs; 13.1±7.6 years since stroke)

Materials and Methods: In this prospective cohort study, participants completed five conditions on an instrumented treadmill for one minute, each in standing and walking at comfortable walking speed: 1) Standing/walking (as baseline), 2) Stroop Test, 3) Easy Math (subtraction by 3s), 4) Hard Math (subtraction by 7s) and 5) Visual Tiles projected onto treadmill belt with same step length and width as during single-task walking condition. Lower limb surface electromyography (EMG) was recorded from bilateral biceps femoris, rectus femoris, tibialis anterior, and medial gastrocnemius (MG). Participants completed the Mini-Mental State Examination, Timed Up & Go (TUG), dual-task TUG (dTUG), 10 Meter Walk Test (10MWT), and dual-task 10MWT (d10MWT). Dual-task cost (DTC) was calculated as: DTC_{10MWT}=d10MWT–10MWT and DTC_{TUG}=dTUG–TUG. Co-activation was calculated as the common area between muscle pairs under the processed curve. Normalized peak EMG and co-activation of paretic limb muscles were compared between conditions with a two-way ANOVA with Tukey post-hoc tests. Correlation between clinical measures and peak MG EMG was calculated with linear regression statistical analysis.

Results: Peak EMG across conditions for all muscles was highest for Visual Tiles and Hard Math conditions throughout gait. For all muscles except MG, mean peak EMG was higher in the Visual Tiles condition than walking alone (p<.05). Co-activation during Visual Tiles and Hard Math was higher than during walking alone (p<.05), but not different from each other. There was a positive correlation between Peak MG EMG during Visual Tiles condition and DTC_{10MWT}(R^2=0.40, p=0.025) and DTC_{TUG}(R^2=0.38, p=0.03).

Conclusions: In conclusion, visual feedback during walking with tiles projected onto the treadmill imparts a dual-task cost to walking that is greater than single-task walking alone and no different than walking while completing hard math. Participants with less dual-task ability (i.e., higher dual-task costs in clinical measures) have higher EMG.

Clinical Relevance: Clinicians treating patients with chronic stroke should consider the high dual-task cost of visual feedback during gait training. Clinicians could use clinical measures for dual-task cost to identify patients able to participate in gait training with visual feedback, but future research is needed.
TITLE: Validity and Reliability of Hand Held Dynamometry Measurements in the Chronic Stroke Population

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Stroke SIG

AUTHORS: Kristin Elizabeth De Mars, George J. Beneck, Rachel Foust, Vince Giacalone, Rachel Roesgen, Erin Tidwell

ABSTRACT BODY:

Purpose/Hypothesis: Hand held dynamometers (HHD) provide objective measurement of isometric muscle strength. However, the validity and reliability of HHD measurements in the chronic stroke population has only been determined for the knee extensors. The purpose of this study was to determine the reliability and validity of measurements of force measurements in selected hip, knee and ankle muscles of the paretic limb in persons with chronic stroke. Two methods of HHD were compared: HHD manual (HHD-M) and HHD with external stabilization (HHD-ES).

Number of Subjects: 10 individuals with chronic stroke (age range: 20-77 years; chronicity: 24-132 months; functional ability: modified Rankin Scale score: 2-4)

Materials and Methods: A Hoggan MicroFET2 Hand Held Dynamometer was used for all HHD measurements. The external stabilization device consisted of a PVC pipe (2 sizes) which housed the HHD and was supported by a wall during testing. A Biodex Systems 3 Isokinetic dynamometer was used for isokinetic testing. The following muscle groups were tested using HHD-M, HHD-ES and IKD: hip flexion/extension/abduction and ankle dorsiflexion/plantarflexion. Ankle dorsiflexion however was not able to be tested using HHD-ES. All testing occurred in 2 days scheduled 3 days apart. Positions used for HHD testing were determined from prior pilot studies. Modifications to positioning for IKD testing were consistent with protocol published in previous studies for the chronic CVA population. Statistical analysis included intraclass correlation coefficients (ICC) and Pearson coefficient of correlation

Results: Concurrent validity was found to be good (r=0.83-0.90) for both HHD-M and HHD-ES for all muscle groups except for hip abduction (r=0.43) and ankle dorsiflexion (r=0.49). Intra-rater and inter-rater reliability for HHD-M and HHD-ES measurements were good to excellent (ICC=0.66-0.90) for all muscle groups except for poor reliability for hip flexion (ICC=0.48) with HHD-ES and ankle DF (ICC=0.49) with HHD-M. Higher intra- and inter-rater reliability were found for HHD-ES compared to HHD-M for hip extension (0.94/0.95 versus 0.71/0.72) and ankle plantarflexion (0.79/0.86 versus 0.66/0.56).

Conclusions: Measurements of force production in hip flexors/extensors, knee flexors/extensors and ankle plantarflexors determined by HHD in individuals with chronic stroke are valid and reliable with the use of standardized gravity-eliminated positioning and 2 hours of training. External stabilization improves reliability of testing stronger muscles.

Clinical Relevance: Recent studies have shown that progressive resistance training is effective in increasing strength in the paretic limb leading to improved function. Valid and reliable measures of force production are necessary in the clinic for therapists to accurately diagnose cause of movement dysfunction and to aide in developing specific interventions to target those impairments. Hand held dynamometry is an affordable and clinically feasible tool that provides valid and reliable measurements of lower extremity force production in the chronic stroke population.
Purpose/Hypothesis: Selective voluntary motor control (SVMC) is the ability to isolate the muscle activity in a selected pattern in response to the demands of a voluntary motion or posture. Impaired SVMC is a neurological deficit associated with injury to descending motor tracts, such as the corticospinal tract (CST), that results in the subsequent loss of descending excitatory and inhibitory signals. Ultimately, impaired SVMC results in loss of control of isolated joint motion. The Fugl-Meyer Assessment Lower Extremity (FMA-LE) tool assesses SVMC at the hip, knee, ankle, and foot in patients with chronic stroke. The Selective Control Assessment of the Lower Extremity (SCALE) is a newer assessment tool used to assess SVMC in individuals with cerebral palsy. The objective of this study was to compare the psychometric properties of the SCALE and FMA-LE assessments in adults after chronic stroke.

Number of Subjects: 16

Materials and Methods: The FMA-LE and SCALE were administered by 3 experienced physical therapists to 16 adults with chronic cerebrovascular accident (stroke). An intraclass correlation coefficient (ICC) was used to determine reliability between raters for the more affected lower extremity, and Spearman rank correlation coefficient was used to determine convergent validity between FMA-LE and SCALE.

Results: ICC = 0.8732 for the affected extremity (ICC guidelines range 0.00-1.00: ≤0.75 poor-moderate reliability, 0.75-0.89 good reliability, and ≥0.90 excellent reliability). For correlation between the FMA and SCALE, Spearman’s rho = 0.8093, p = 0.001 (correlation coefficient guidelines range 0.00-1.00: 0.00 no relationship between variables, 0.01-0.25 low correlation, 0.26-0.50 fair correlation, 0.51-0.75 moderate correlation, and 0.75-1.00 high correlation).

Conclusions: The inter-rater reliability for the affected limb was determined to be good based on ICC guidelines. The Spearman correlation value indicates high correlation between the FMA-LE and SCALE which is unlikely due to chance. The results of this study determined there is good inter-rater reliability in performing the SCALE assessment, and that the FMA-LE and SCALE have a high correlation that is unlikely due to chance. However, more research must be conducted to generalize these results to the population of individuals with chronic stroke. A larger sample size and clinic based setting rather than a university may capture different, more generalizable results.

Clinical Relevance: The FMA-LE assessment is underutilized for evaluating selective voluntary motor control in patients with chronic stroke in physical therapy clinics. The SCALE assessment could provide a more time efficient assessment used in clinic for adults with chronic stroke, and may allow clinicians to more easily track progress throughout treatment.
Purpose/Hypothesis: Decreased daily stepping and physical inactivity in stroke survivors may contribute to decreased cardiovascular endurance and declines in physical function and participation. A common primary goal of stroke survivors is to restore the ability to ambulate in the community, although few studies have been able to demonstrate significant improvements in stepping activity following physical training. Rather, previous studies suggest that certain clinical variables may predict changes in community mobility with training. Our recent study investigated the effects of intensity and variability on locomotor capacity as measured in the laboratory setting. The purpose of this secondary analysis is to evaluate changes in daily stepping activity following various training strategies and the potential relationships between clinical variables of mobility and motor impairments.

Number of Subjects: 58 individuals with history of stroke > 6 months duration.

Materials and Methods: Subjects were randomized to receive ≥30 sessions of high intensity variable stepping, high intensity forward stepping, or low intensity variable stepping. Participants wore a step activity monitor (SAM) for at least 1 week prior to and following training. The primary outcome for this sub-analysis was changes in daily stepping following training, and secondary outcomes were baseline measures and changes in 10 meter walk test (10MWT), 6 minute walk test (6MWT), Functional Gait Assessment (FGA), 5X sit-to-stand duration, Fugl-Meyer lower extremity assessment, graded treadmill test, and Activities-specific Balance Confidence (ABC) Scale. Participants were categorized as “responders” if gains in daily stepping were at least 500 steps per day (SPD), and “non-responders” if they did not improve by this threshold (Ardestani J Biomech 2019). Linear and logistic regression analyses were performed to determine potential predictors of changes in daily stepping.

Results: Across all participants, daily stepping increased by 451±1505 SPD (p = 0.03), with changes between training groups approaching significance (p=0.16). Incorporating only changes in clinical parameters as dependent variables in regression analyses, improvements in 6MWT was the only predictor of changes in daily stepping (p<0.01), explaining only 16% of the variance. Incorporating baseline clinical characteristics into the analyses indicated significant contributions of baseline Fugl-Meyer and peak treadmill speed in addition to changes in 6MWT using logistic regression (p<0.01).

Conclusions: The results suggest daily community stepping may improve following locomotor training, with changes in clinical measures of gait endurance (6MWT) as may be used as a predictor of change in daily stepping activity following stroke. Additional baseline impairments and peak treadmill speed may also contribute to community mobility.

Clinical Relevance: These data support the use walking training to increase SPD and the contribution of changes in 6MWT as a predictor of gains daily stepping.
Purpose/Hypothesis: Individuals post stroke often have multiple chronic morbidities. It is important for physical therapists to address the whole person during treatment post stroke, including comorbidities, not just the problems resulting from the stroke itself. It is unclear how common it is for PT to address multiple diagnoses at once using a wellness model. Therefore, the purpose of this scoping review was to examine current evidence regarding the role of physical therapy in addressing modifiable risk factors for individuals post stroke, in order to identify gaps in research associated with physical therapy management of related comorbid diagnoses during treatment for stroke.

Number of Subjects: Scoping review

Materials and Methods: A scoping review methodology was utilized searching PubMed and CINAHL databases to identify interventional research studies specifically addressing multiple modifiable risk factors utilizing physical therapy for individuals post stroke. Inclusion criteria included: research published between 2008-2018, participants 40 years and older who had a stroke, interventional research studies specifically addressing multiple modifiable risk factors, and physical therapy specific interventions (i.e. those within PT scope of practice and carried out in part or in full by a physical therapist).

Results: The search yielded 5358 articles for review. After duplicates were removed (n=747), the titles and abstracts of each article were screened and results that were irrelevant to the purpose of this scoping review were removed. After this initial assessment, 97 articles remained for full-text review. After full-text assessment, an additional 85 articles were excluded, ultimately leaving 12 articles meeting inclusion criteria. Key findings included: 1) Only two studies included participants with significant mobility impairments, and none included individuals with communication impairments. 2) Only 4 of the 12 studies provided education as an active component in their study design. However, none formally measured any component of knowledge transfer or retention to assess the efficacy of the education provided. 3) Eight studies (67%) did not include any patient reported outcome measures (PROs). 4) Only 3 studies had any long-term follow-up assessments.

Conclusions: Comorbidities and secondary stroke risk factors, such as hypertension and diabetes, can be positively addressed using physical therapy interventions. However, gaps in the literature were identified including narrow inclusion criteria, lack of long-term follow up, limited use of educational interventions, and limited measurement of relevant outcomes.

Clinical Relevance: This review highlights the need for better integration of real world clinical considerations (e.g. PROs, patient and caregiver education, incorporation of multiple disability severity levels, long-term follow-up assessment, etc.) into stroke rehabilitation research as a whole, along with the need for additional research regarding the role physical therapy can play in addressing multimorbidity in individuals with stroke.
Purpose/Hypothesis: Treadmill high-intensity interval training (HIT) has shown promise for improving gait and fitness after stroke. However, translation into overground gait improvement has been limited for persons with chronic gait impairment. Here we assessed the effects of combined overground and treadmill HIT. Since persons with comfortable gait speed (CGS) ≥ 0.4 m/s have previously shown greater responsiveness to treadmill training, we also tested the prognostic effect of baseline gait speed.

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

Materials and Methods: Participants had a four-week no-intervention control phase, then an intervention phase with 12 sessions of HIT over 4 weeks, alternating between short and long interval HIT sessions. Both protocols included 10 minute bouts of overground HIT, before and after 20 minutes of treadmill HIT. Short interval HIT involved 30 second bursts at maximum safe speed and 30-60 seconds of rest. Long interval HIT involved 4-minute bursts at ~90% of peak heart rate and 3-minute recovery periods at ~70% peak heart rate. Gait function and subjective measures were assessed before and after each phase.

Results: Intervention phase improvement was significantly (p < 0.05) greater than the control phase for the 6-minute walk test (6MWT, +31 [16, 47] vs. -2 [-13, 9] m), comfortable 10m walk test (+0.13 [0.05, 0.21] vs. 0.00 [-0.05, 0.05] m/s), fastest treadmill speed (+0.29 [0.16, 0.42] vs. -0.01 [-0.07, 0.05] m/s), PROMIS-Fatigue scale (-4.3 [-8.2, -0.5] vs. 2.7 [-0.3, 5.7] on 8-40 scale) and participant global rating of change in walking ability (GROC-Walking, +4.4 [2.7, 6.1] vs. 0.5 [-1.9, 2.9] on -7 to +7 scale). The subgroup with baseline CGS ≥ 0.4 m/s (N=4) had significantly greater improvement in the 6MWT (+53 [39, 66] vs. +17 [6, 28] m). However, % change was similar for the two subgroups (+18.3 [0.5, 36.2] vs. +20.1 [5.5,34.6] %), as was GROC-Walking (+3.8 [0.9, 6.6] vs. 4.8 [2.5, 7.1] on -7 to +7 scale), and only the CGS < 0.4 m/s subgroup showed significant improvement in PROMIS-Fatigue (-2.0 [-8.1, 4.1] vs. -5.8 [-10.8, -0.8]).

Conclusions: In this preliminary study, treadmill and overground HIT elicited significantly greater improvements than no intervention for gait function and fatigue outcomes. As previously reported for treadmill training, persons with baseline CGS ≥ 0.4 m/s had greater 6MWT increases. However, we found similar proportional improvement between the two subgroups. In addition, the CGS < 0.4 m/s subgroup reported meaningful improvement in walking ability and decreased fatigue after the training program.

Clinical Relevance: The combination of treadmill and overground HIT seems to be a promising strategy for improving gait function and fatigue in chronic stroke. Patients with baseline CGS ≥ 0.4 m/s may tend to have greater 6MWT increases, but patients with CGS < 0.4 m/s also have potential for meaningful benefits.
TITLE: Can an Ankle Foot Orthosis with Heel Lift Decrease Genu Recurvatum in Adults Post Stroke?

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG

AUTHORS: Rosemary Gallagher, William Gregory Werner, Courtney Marie Whyte, Alexander Savva DPT, Nadia Zaman DO, Calvin Chen DO, Ona Bloom, Anthony Oreste,

ABSTRACT BODY:

Purpose/Hypothesis:
Hemiparetic gait in persons post-stroke can lead to genu recurvatum during the stance phase of gait resulting in further gait deviations. Ankle-foot orthoses (AFO) are commonly prescribed and may control genu recurvatum by influencing moments at the ankle, thus indirectly reducing knee hyperextension. Modifications may be made to the AFO, such as adding a heel lift, which results in the ground reaction force moving posterior to the knee, further reducing genu recurvatum. However, evidence regarding a heel lift added to an AFO to control genu recurvatum is limited. The purpose of this study was to investigate the effect of an AFO with heel lift on genu recurvatum in people post-stroke.

Number of Subjects:
Ten persons post-stroke with genu recurvatum [6 females, 4 males, mean age 65.6 years (SD 7.38), mean time since stroke 107.6 months (SD 90.32), side affected; left 7/10].

Materials and Methods:
Subjects walked over ground at a self-selected pace for a minimum of three 10-meter straight-line walking trials under three conditions: (1) No AFO (2) AFO (3) AFO with 1 cm heel lift. Spatio-temporal and kinematic gait parameters of the lower limbs during stance were quantified using an instrumented gait analysis system. A nine camera Vicon Nexus 2.6 Motion Capture System (Vicon Systems, CO) with lower body Plug-n-Gait model used to record walking trials. Data was processed in Nexus and exported to MATLAB (2018) to detect gait events and to Polygon 4.0 (Vicon Systems, CO).

Results:
Primary outcome: Peak knee extension range of motion during stance, peak knee flexion range of motion, cadence, walking speed, single support time, and step length were also examined. A within subject difference was found in peak knee extension (p=.006). This decrease was found between the No AFO to Lift (p=.010), and AFO to Lift (p=.035) conditions. Secondary Outcomes: There was a difference between subjects for peak knee flexion (p<0.000) and a difference across the three conditions with respect to walking speed right (p<0.034) and left (p<0.035), and right step length (p<0.002). These differences were found primarily between the No AFO to Lift conditions. Cadence, single support, and left step length were unaffected by the different conditions.

Conclusions:
These preliminary findings indicate the potential of adding a 1 cm heel lift to an AFO to improve genu recurvatum and spatio-temporal gait parameters in individuals post-stroke.

Clinical Relevance:
The addition of a heel lift to an AFO led to a more normal gait pattern as shown by a reduction in genu recurvatum, increased walking speed, and longer step length. The gait changes appear primarily due to the decrease in knee hyperextension during the stance phase.
TITLE: The Effect of Forward Versus Backward Locomotor Training on Forward Propulsion during Forward Walking Post-Stroke.

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Stroke SIG

AUTHORS: Kanika Bansal, Janki Patel, Arian Vistamehr, Christy Conroy, Emily Jane Fox, David Clark, Dorian Kay Rose

ABSTRACT BODY:

Purpose/Hypothesis: Post-stroke gait is characterized by reduced forward propulsion generation, which is associated with slower walking speeds. Various forms of Forward Locomotor Training (FLT) interventions have led to improved forward propulsion generated by the paretic leg. A novel locomotor training strategy, backward walking, has demonstrated increased forward gait speed, balance and endurance, but its effects on forward propulsion have not been examined. Therefore, we aimed to examine the effects of Backward Locomotor Training (BLT), compared to FLT, on the generation of forward propulsion. We hypothesized that FLT, more so than BLT, would improve forward propulsion generated by the paretic leg.

Number of Subjects: 18

Materials and Methods: Participants were randomized to FLT (n=9; age: 54.2±11.1 years; 6 males; 10.7±5.0 months post-stroke) or BLT (n=9; age: 58.8±6.3 years; 6 males; 13.5±5.8 months post-stroke). Each person received 18 sessions of direction-specific gait training on a treadmill and over-ground (6 weeks; 3 sessions/week; 90 min/session). Three dimensional ground-reaction-forces (GRFs) were obtained pre- and post-training during forward over-ground walking. Forward propulsion was calculated as the time integral of anterior GRFs (Newton.seconds), normalized by bodyweight (N.s/bw) and was compared between pre- and post-training by paired t-tests. Between group differences were determined by independent t-tests (Bonferroni correction p<0.025).

Results: For the entire cohort of 18 participants, forward propulsion from the paretic leg increased (p=0.02). Specifically, for the FLT group, pre- to post-intervention propulsion from the paretic leg increased by 163% (from 0.0038±0.18 N.s/bw to 0.01±0.13 N.s/bw; p=0.055; moderate effect size: d=0.75). Propulsion also increased for the BLT group, but only by 87% (from 0.003±0.014 N.s/bw to 0.0056±0.013 N.s/bw; p=0.26; small effect size: d=0.40). The difference between groups was not statistically significant (p=0.29; d=0.51). The propulsion from the non-paretic leg did not change for either group.

Conclusions: BLT contributed to improvements in paretic propulsion during forward walking, though not to the extent of FLT, likely due to the fact that BLT does not specifically target forward propulsion. Increased forward propulsion by the paretic leg was not accompanied by a similar increase from the non-paretic leg. This suggests that both FLT and BLT did not lead to an increased compensation from the non-paretic leg.

Clinical Relevance: These results corroborate previous work that standard forward gait training can improve forward propulsion generation from the paretic leg. We further uniquely demonstrated that Backward Locomotor Training has the capacity to maintain and potentially improve forward propulsion by the paretic leg, while also serving as an adaptability task, improving forward gait speed, balance and balance confidence post-stroke. Gait training in both directions can be utilized to enhance walking recovery for individuals post-stroke. Further investigation with a larger sample size is warranted.
Purpose/Hypothesis:
Utilization of outcome measures in the neurologic population is imperative for determining risk levels, making appropriate prognostic decisions, measuring patient progress, and informing evidence based practice efforts. In 2018, a clinical practice guideline (CPG) was established by the APTA recommending six outcome measures for neurologic patients. Our efforts are intended to guide therapist outcome measure utilization and establish a tracking system to support best practices in individual patient care and process improvement.

Number of Subjects:
155

Materials and Methods:
Medical records were analyzed retrospectively for all patients admitted through two hospitals with a diagnosis of acute stroke within a six month period (n>150). All episodes of physical therapy within the regional health system including acute, inpatient rehab, and outpatient practice settings were included. Outcome measure completion, test selection, and patient improvement across settings were tracked.

Results:
Compliance in completing at least one CPG recommended outcome measure ranged from 69% to 100% depending upon the setting. However, success was lower for capturing more than one measure as well as for capturing the same measure across the continuum of care. The Berg Balance test was the measure most frequently used. The average improvement in Berg score from acute hospitalization until discharging from inpatient rehabilitation was 18.6 (ranging from 8-34). For some patients who had Berg scores completed through outpatient therapy, there appeared to be a ceiling affect.

Conclusions:
Preliminary recommendations based upon findings include additional therapist training to standardize test protocols, encouraging therapists to attend to outcome selection and scores completed in prior settings, considering protocols for core outcome measurements to be utilized with all stroke patients, and completion of the Functional Gait Assessment if the Berg Balance score is high to avoid ceiling effects.

Clinical Relevance:
Use of neurologic clinical outcome measures is well supported. Though many physical therapists can cite emerging evidence and practice guidelines, translating these into practice within a health system is more difficult. This research provides timely feedback to rehab professionals to break down barriers in knowledge translation and facilitate achievement of best practices in the stroke population.
ABSTRACT BODY:
**Purpose/Hypothesis:** Asymmetrical walking is one of the most prevalent impairments in people with stroke. It increases energy expenditure and relates to safety and efficiency during gait after stroke. The literature shows that body-weight supported treadmill training (BWSTT) improves gait speed, endurance, and motor recovery of lower limbs. However, the effect of BWSTT on gait symmetry has not been systematically investigated. The purpose of this study is to determine whether BWSTT is more effective than conventional physical therapy in improving gait symmetry following stroke.

**Number of Subjects:** 820 articles

**Materials and Methods:** A systematic search was conducted for articles published over two decades (1998–2018) via PubMed, EMBASE, CINAHL, and PEDro. The quality of the studies was examined using the PEDro scale. Spatiotemporal gait symmetry was calculated based on the data extracted from each selected article. Descriptive analysis was performed to assess the effects of BWSTT on spatiotemporal gait symmetry after stroke.

**Results:** After screening the selected articles, 40 studies were assessed for eligibility. Four out of the forty studies met search criteria. The PEDro scales of the four studies ranged from 5 to 8 out of 10. Based on data analysis with the four articles, BWSTT was effective in improving spatiotemporal gait symmetry after stroke. However, its effects on gait symmetry were not significantly greater than that of conventional therapy.

**Conclusions:** The results of this study show that the effect of BWSTT on spatiotemporal gait symmetry is not superior to that of conventional physical therapy in people with stroke. Further research is needed to confirm the findings from this study.

**Clinical Relevance:** This study suggests that BWSTT alone may not be an effective treatment for improving spatiotemporal gait symmetry in individuals with stroke.
ABSTRACT BODY:

Purpose/Hypothesis: Individuals with chronic stroke demonstrate a myriad of impairments impacting reaching function including flexion synergy, limited passive range, flexor spasticity, and weakness. Most often, these impairments are studied qualitatively and/or in isolation, leaving precise relative and concurrent contributions of each unknown. The purpose of this study was therefore to investigate the constitutive impairments limiting reaching function in individuals with chronic stroke. Flexion synergy was hypothesized to be the principal underlying impairment.

Number of Subjects: 34

Materials and Methods: 34 participants with chronic hemiparetic stroke (23 males; 58.3 ± 10.8 years old; 11.8 ± 8.3 years post-stroke; 26 ± 7 Fugl-Meyer score) provided consent and completed the IRB-approved study. Reaching function was measured using a robotic admittance-controlled device (negligible inertia) and defined as maximum planar reaching distance against gravity. Six impairments were quantified using kinematics, kinetics, goniometry, and electromyography. These included: 1. maximal shoulder abduction and elbow extension strength (normalized to the less affected side), 2. spasticity-related biceps activation (change in normalized biceps EMG after reaching onset at a standardized abduction load), 3. flexion synergy emergence/takeover thresholds (highest shoulder abduction load during successful acquisition of standardized far/near targets), and 4. passive range of elbow extension. Multiple linear regression was used to investigate the constitutive impairments limiting reaching function.

Results: The regression model was significant (F(6,18) = 3.724, p = 0.014) with an R² of 0.554. Reaching function (Mean ± SD; 0.608 ± 0.358) was significantly correlated with flexion synergy emergence (0.310 ± 0.244, r = 0.634, p = 0.001), shoulder abduction strength (0.557 ± 0.193, r = 0.390, p = 0.023), and elbow extension strength (0.437 ± 0.186, r = 0.407, p = 0.017). Passive elbow extension, flexor spasticity, and flexion synergy takeover did not significantly correlate with reaching function. A subsequent model dropping non-correlated regressors (such as takeover threshold due to a ceiling effect) was significant (F(3,22) = 6.858, p = 0.002) with an R² of 0.483. Flexion synergy emergence threshold was the only significant regressor in both the complete (standardized beta coefficient = 0.594, p = 0.007) and reduced (standardized beta coefficient = 0.521, p = 0.005) models.

Conclusions: Impairments such as weakness, flexor spasticity, and passive range of motion limitations may not contribute to reaching dysfunction to the same extent as flexion synergy. The significant standardized beta coefficient can be interpreted as a one unit increase in flexion synergy emergence threshold (less synergy impairment) being associated with a 0.521 unit increase in reaching function.

Clinical Relevance: A large standardized beta coefficient suggests that prioritizing flexion synergy impairment is likely to have the greatest impact when attempting to restore reaching function in chronic moderate to severe stroke.
Title: High Intensity Gait Training Once per Week Improved Gait for Individual One Year Post Stroke

Current Section: Neurology

Current Sub-Category: Stroke SIG

Authors: Mandy Baniszewski, Christopher Droesch, Monica Lee Arrigo, Olivia DeFabritiis, Jaclyn Villane, Nicholas John Waltz, Wendy M. Romney

Abstract Body:

Background and Purpose: High Intensity Gait Training (HIGT) is walking overground, on treadmills and on the stairs at intensities of 75-85% heart rate (HR) max. HIGT has been proven to improve walking speed, distance, balance and endurance, yet it is not routinely done in outpatient physical therapy. The purpose of this case report is to describe the use of HIGT on an individual after a stroke seen in an outpatient setting.

Case Description: A 53 year old male who sustained a left sided stroke one year ago with right sided hemiparesis, increased tone, decreased gait speed, increased risk for falls and decreased ability to complete stairs participated in 6 one hour high intensity gait training sessions over the course of six weeks. Following the protocol in Holleran et al 2014, HIGT on the treadmill included wearing a safety harness and walking at fast speeds, on inclines, and with ankle weights on the hemi-paretic side. Following treadmill training, the individuals performed walking overground in multiple directions and over obstacles, as well as ascending/descending several flights of stairs for one hour. Outcomes were assessed to determine time in target HR zone for high and moderate intensity using a polar H10 Heart Rate monitor and BORG rate of perceived exertion (RPE) for each session. The Six Minute Walk Test (6MWT), and 10 Meter Walk Test (10MWT) were examined pre and post.

Outcomes: Following 6 treatment sessions, the individual's time in high intensity (75%-85% HR Max) improved from 1.5 minutes to 21 minutes and moderate intensity HR zone (65%-75% HR max) improved from 5 mins to 19 mins. Scores on the 10MWT improved from 0.53 m/s self-selected and 0.57 m/s fast to 0.59 m/s and 0.63 m/s, respectively. The 6MWT improved from 500 ft to 717 ft.

Discussion: In this case report, an individual with chronic stroke demonstrated improvements in gait speed and endurance with one visits per week over a period of six weeks. HIGT research recommends a frequency of four times per week, but outpatient scheduling and insurance restrictions may make it difficult to adhere to the treatment protocol. Future research should investigate other individuals with stroke seen in the outpatient setting and the frequency needed per week to demonstrate a significant improvements.
Purpose/Hypothesis: Robotic Exoskeleton (EKSO) is a dynamic device used to retrain standing and gait in people with unilateral or bilateral lower extremity weakness. Common deficits after stroke include mobility impairment such as gait asymmetries. The acute effects of EKSO on gait kinematics in people with stroke are unknown. The purpose of this study was to compare limb symmetry in kinematic and temporospatial gait parameters before and after a single EKSO session in people with stroke.

Number of Subjects: Six adults (3 female, 3 male) aged 44.7±14.6 years with chronic stroke (mean years since stroke = 4.5±1.9) participated in this study. Participants walked without physical assistance (Functional Ambulation Category, range = 4 to 5).

Materials and Methods: Each participant walked under two conditions: pre-EKSO, and immediately post-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. Average EKSO session lasted 22.3±6.8 minutes total ‘Up’ time and comprised of 7.2±1.5 minutes ‘Walk’ time with 250.7±40.0 steps. Wilcoxon Signed Rank tests were used to analyze differences between involved and uninvolved lower extremities in kinematic and temporospatial gait parameters for the pre- and post-EKSO conditions, respectively.

Results: In stance phase, significant differences between uninvolved and involved joint range of motion were found in the pre-EKSO condition, but not in the post-EKSO condition, including knee flexion (pre-EKSO, 7.7 degrees, p=.03; post-EKSO, 7.4 degrees, p=.22), knee extension (pre-EKSO, 6.7 degrees, p=.03; post-EKSO, 6.4 degrees, p=.22), and hip flexion (pre-EKSO, 5.2 degrees, p=.03; post-EKSO, 4.5 degrees, p=.22). In swing phase, significant differences between uninvolved and involved joint range of motion were found in pre-EKSO with decreased variance in post-EKSO hip flexion (pre-EKSO, 4.7 degrees, p=.03; post-EKSO, 3.2 degrees, p=.69). No significant differences in range of motion asymmetry for both conditions were seen in the ankle in stance and swing phases or the knee in swing phase. In addition, there was no significant difference in gait speed (pre-EKSO, 0.74 m/s; post-EKSO, 0.72 m/s) although trends were observed for increased stance time on the involved limb (pre-EKSO, 0.83 seconds; post-EKSO 1.09 seconds; p=.08) and increased double limb support time (pre-EKSO, 0.43 seconds; post-EKSO, 0.56 seconds; p=.08) after a single EKSO session.

Conclusions: The results suggest improved limb symmetry in kinematics in both the stance and swing phases of gait immediately after a single EKSO session in individuals with chronic stroke. However, these kinematic changes were insufficient to alter temporospatial parameters.

Clinical Relevance: EKSO training appears to acutely alter gait in people with chronic stroke. Future studies should assess whether robotic gait training can demonstrate long-term benefit on gait patterns after stroke.
TITLE: Obstacle Crossing As a Risk Assessment Tool for Future Falls in Subacute Stroke

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Stroke SIG

AUTHORS: Jody Ann Feld, Prudence Plummer

ABSTRACT BODY:

Purpose/Hypothesis: The majority of stroke survivors who are discharged home from the hospital are experiencing falls at a high rate, despite the fact that many have recovered the ability to walk independently prior to hospital discharge. The simplicity of assessing obstacle crossing as pass or fail at hospital discharge provides an opportunity to estimate fall risk early post stroke. The purpose of this prospective study was to examine the use of obstacle crossing at hospital discharge to predict fall risk in the first 3 months post hospital discharge. We hypothesized that people who fail the obstacle task on at least one trial will be more likely to experience a fall within the 3-month follow up period than those who pass the obstacle task.

Number of Subjects: 47

Materials and Methods: The 47 subjects (43% female) were on average 59.8 (SD=11.7) years old, and a median of 14 (IQR=7-21) days post stroke. At hospital discharge, subjects completed 4 obstacle-crossing trials (height: 10% of leg length) at their self-selected walking speed on an instrumented walkway. Following discharge, subjects completed a prospective falls diary for 3-months. Logistic regression modeling examined the relationship between obstacle-crossing performance (pass/fail) at discharge and fall status (faller/non-faller) at 3 months post discharge.

Results: Of the 45 subjects with fall data at 3 months post hospital discharge, 21 subjects reported experiencing at least one fall with 52% of the falls occurring within the first month after hospital discharge. Eight subjects reported more than one fall, with a total of 39 falls. Of the fallers, 67% were discharged home from acute inpatient rehabilitation. Of the 21 fallers, 14 (67%) failed the obstacle-crossing task. Of the 24 non-fallers, 20 (83%) passed the obstacle-crossing task. The logistic regression model correctly classified 76% of the subjects. Subjects who failed the obstacle-crossing task at hospital discharge were 10.00 (95% CI: 2.45, 40.78) times more likely to fall in the first 3 months after discharge and had 3.00 (95% CI 1.51, 5.94) times the risk of falling than those that passed the task. A greater number of days post stroke confounded the relationship between obstacle crossing ability and the odds of falling.

Conclusions: Obstacle-crossing may be a useful discharge assessment tool for identifying future fallers based on the odds ratio and relative risk. Use of obstacle-crossing ability as a risk assessment tool appears to be appropriate for the inpatient rehabilitation setting based on the proportion of fallers discharged from this setting and the impact of time post stroke on the relationship between obstacle crossing ability and the odds of falling.

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. Identification of fall risk at hospital discharge post stroke is critical for early implement of preventative measures and targeted rehabilitation.
TITLE: The Effects of Aerobic Exercise Preceding Upper Extremity Training in a Person with Chronic Stroke
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Stroke SIG
AUTHORS: Sondra Gail Siegel, Cathy Lee Stucker, Nicole Andrade, Erik Bou, Morgan Cooper, Caren Dinshah, Erin Marie Ellison, Kayla Pelletier, Kathleen Anne Pratt

ABSTRACT BODY:

Purpose/Hypothesis: High intensity aerobic exercise (AEX) positively impacts motor performance in chronic stroke survivors; however, many people who have experienced a neurological insult may not be able to sustain exercise at this intensity. The effects of less intense exercise, which is more representative of the abilities of clinic populations, has not been investigated. We hypothesized that the addition of moderately intense AEX prior to therapy would improve performance on upper extremity (UE) function more than a sham activity of equal length.

Number of Subjects: The one participant in this study was a 71-year old female, who was five years status post stroke.

Materials and Methods: This was a single participant A-B-A-C-A study, with each “A” phase involving no intervention. The “B” phase (SA-PT) included 40 minutes of sedentary social activity (SA) consisting of board games followed by a 30-minute physical therapy (PT) session. The “C” phase (AEX-PT), serving as the intervention phase, entailed 40 minutes of moderate intensity AEX performed on a seated stepping machine followed by 30 minutes of PT. The PT for both phases involved UE therapeutic activities addressing the participant’s deficits. Outcome measures included the Wolf Motor Function Test (WMFT), 9-hole peg test (9HPT), Box and Block Test (BB), Handwriting Assessment Battery, Spiral Drawing Test, and a cutting activity.

Results: Significant improvement was noted on the 9HPT and positive trends were seen on the majority of the handwriting tests during the SA-PT phase only. Performance on the WMFT and BB test changed minimally throughout the study, while performance on the cutting activity improved most during the AEX-PT phase.

Conclusions: Social interaction appeared to have had a surprisingly robust positive impact on the efficacy of associated therapy sessions. In contrast, AEX performed prior to treatment in a relatively sedentary patient may have limited the effects of therapy due to fatigue. Alternatively, the AEX in this study may not have been sufficiently vigorous to elicit the improvements seen by other researchers. Further research is needed to compare the influence of various exercise intensities and temporal proximity of AEX on motor performance. These results do not support our hypothesis, but the unexpected benefit from social interaction warrants further investigation.

Clinical Relevance: The level of activity of our participant was likely representative of common clinical populations. This group of people may not initially tolerate levels of activity that are sufficiently vigorous to result in the reported benefits of adding AEX to a therapy program focused on UE performance. Moreover, social interaction between therapists and patients may have a robust influence on outcomes and should be given important consideration in planning treatment sessions.
The purpose of this study was to begin the process of validating the recently developed patient self-reported survey, the Upper Cervical Questionnaire (UCQ). The UCQ is designed as a tool to help clinicians identify which patients exhibit upper cervical dysfunction, as defined by a positive supine flexion-rotation test. Our hypothesis is that the questionnaire will indicate which patients show subjective signs of upper cervical dysfunction upon manual evaluation. It is hoped that this patient self-reporting questionnaire will improve the early recognition and treatment of patients with cervicogenic dizziness, vertigo or post-concussion syndrome.

Number of Subjects:
There were 72 participants (49 females and 23 males) included in this study. The average female age was 35±16.4 years old and the average male age was 39±29.3 years old. Twenty-eight of the subjects had been referred for physical therapy for treatment of dizziness, vertigo, benign paroxysmal positional vertigo (BPPV), chronic headache, chronic migraine and cervicogenic headache or migraine. The remaining 44 were healthy college age students acting as controls.

Materials and Methods:
Subjects were included if they were at least 18 years old and able to attend a 30-minute testing session on an assigned date. Subjects were excluded if they had a past medical history of cervical fracture or cervical fixation/fusion (involving OA, AA, C2-3, C3-4), history of stroke, uncontrolled seizure disorder, neurological pathologies (Parkinson’s disease, Guillain-Barre Syndrome, multiple sclerosis, muscular dystrophy, Cerebral Palsy, Down’s syndrome), drop attacks, a previously diagnosed Chiari malformation, active illness, or active cancer. Subjects completed a demographic intake sheet, NDI and the UCQ. The supine cervical flexion-rotation test was performed by passively flexing the head maximally towards the chest and then rotating the head maximally to the left and then to the right. Unilateral or bilateral restrictions in range of motion were documented. The seated cervical flexion-rotation test was performed in the same manner as the supine version only the subject was positioned in a high-backed chair with the back supported. Results were documented as described for the supine version. Each subject then underwent unilateral pain pressure threshold (PPT). Testing sites included C2-C5 dermatomes, upper trapezius (5-8 cm supromedial to the superior angle of the scapula),1,2 and anterior tibialis (upper one-third of the muscle on the anterior distal shin). Each site was assessed sequentially on both the right and left side of the body for a total of three tests per location. The digital pressure algometer (FDX Wagner Instruments, Greenwich, CT) was placed on a testing site while the tester applied a vertical force at a rate of 1 kg/m2 until the patient reports that the sensation of pressure transitions to pain.3,4 This threshold was determined by the subject raising the opposite hand of the side being tested with the pressure algometer and saying “now.” Upon completion of the testing, the average score was calculated for each site. The deep neck flexor endurance (DNFE) test was then used to measure performance of the deep cervical flexors. Subjects performed the test in supine by lifting their head and neck approximately 2.5 cm off the treatment table with a tucked chin. The subject held this position until failure, indicated by engagement of the sternocleidomastoid or anterior scalene muscle or dropping of the head.5,6 Lastly, subjects completed the second NPRS in order to determine any changes in symptoms.

Mann-Whitney U tests were performed using SPSS (version 25, IBM Armonk, NY) to analyze our nonparametric data. A cut score of 11 or greater on the UCQ was determined to be the threshold for indicating that the upper cervical spine was dysfunctional. Limitation in either both or one direction during the supine cervical flexion-rotation tests was considered positive for upper cervical dysfunction based on the article by Blanpied et al.1 We then compared the dichotomous positive results using the Mann-Whitney-U Test which determined that a statistically significant relationship existed.

Results:
No statistical differences were found between males and females across any of the tests performed in this study (P>0.05). There was a statistically significant relationship between subjects who scored 11 or greater on the UCQ and those who had a positive supine cervical flexion-rotation test (p<0.001). There was also a statistically significant relationship between UCQ scores and seated cervical flexion-rotation test (p<0.001). There was no statistically significant findings (p>0.05) for subjects who demonstrated below normal DNFE testing and the supine cervical flexion-rotation test or positive UCQ scores.

Conclusions:
The literature suggests that the gold standard for determining upper cervical dysfunction is the supine cervical flexion-rotation test.1,2 Subjects who scored an 11 or higher on the UCQ had a statistically significant probability of demonstrating a positive supine cervical flexion-rotation test as well as a positive seated cervical flexion-rotation test. These results correlate with the findings Blanpied et al.1 described in the Neck Pain CPG for the supine cervical flexion-rotation test. While deep neck flexor testing is important, and the literature has shown to have a correlation in patients with neck pain, there was no correlation between DNFE and the supine cervical flexion-rotation test. Similarly, positive UCQ tests did not correlate to those whose DNFE was below previously described norms for either males or females. This may be due to the attachments of the deep neck flexor muscles, specifically longus colli and longus capitis, which extend below the upper cervical spine. This finding does not correlate with Jarman et al.5 as this study stated that the DNFE test has been used to successfully identify impairments in cervical dysfunction, with a cut off score of 33.96 (+3.59) seconds for subjects between 14 and 22 years of age. This difference may be due to the fact that Jarman et al.5 was specifically looking for dysfunction within the entire cervical spine. However, in this study, we were isolating to only the upper cervical spine. This combined with the fact that the deep neck flexors attach from the sixth cervical vertebrae all the way to the occiput may account for the difference in results.

Additional research is currently underway to expand upon these results and better refine the utility of the tool.

Clinical Relevance:
The UCQ appears to provide a simple mechanism for clinicians to identify when they should clear the upper cervical spine when assessing their patients. This patient self-reported questionnaire is easy to administer and grade and should only take the patient 3 to 5 minutes to complete. Using the current cut score of 11 or higher as an indicator that the upper cervical spine may be involved and should therefore be assessed. This may be of particular importance to those assessing patients with non-orthopedic diagnoses such as vertigo, dizziness, BPPV, migraine or post-concussion syndrome.
TITLE: Effect of Optic Flow Speeds with Concurrent Cognitive Tasks on Prefrontal and Vestibular Cortex Activity

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Vestibular SIG

AUTHORS: Jennifer Marie Shaw, Brian Sylcott, Shanyue Guan, Sarah Wills, Malack AIHuman, Chia-Cheng Lin

ABSTRACT BODY:

Purpose/Hypothesis: When flying in space, pilots and astronauts experience optic flow (OF) stimulation. It is often necessary for them to perform concurrent cognitive tasks in the presence of OF. Little is known about how the human brain processes this massive intake of information in the challenged environment. Previous studies using functional Near-Infrared Spectroscopy (fNIRS) have shown the temporo-parietal junction (vestibular cortex) integrates multiple sensory information, such as visual and vestibular. In this study, we investigate the activation pattern in the prefrontal and vestibular cortices during different speeds of OF with a concurrent auditory cognitive task.

Number of Subjects: 6 healthy adults participated in this study.

Materials and Methods: All participants were screened prior to data collection to ensure healthy status. Two sets of fNIRS devices (NIRSport, NIRx, Germany) were used to measure changes of oxy- and deoxy-hemoglobin in the right and left temporo-parietal junctions (VEST) and prefrontal cortex (PFC) by source-detector arrays. A block design (A-B-A) was used to elicit hemoglobin changes in the regions of interest. The participants were instructed to perform either simple reaction time tasks (SRT) or choice reaction time tasks (CRT) while experiencing OF in the speed of 0 m/s (static), 5 m/s (slow), and 20 m/s (fast) through Virtual Reality (VR) goggles (HTC Vive™) in sitting. Each trial started with 30-seconds of baseline (OF) immediately prior to four repetitions of 30-seconds of condition (SRT/CRT + OF) coupled with subsequent 30-seconds of baseline (OF). The OF speed maintained consistent within each trial. A trial lasted for a total of 270 seconds. A total of six test trials included: 1) SRT + static OF, 2) SRT + slow OF, 3) SRT + fast OF, 4) CRT + static OF, 5) CRT + slow OF, and 6) CRT + fast OF were performed. SRT and CRT tasks were practiced prior to data collection. A 2-minute seated rest break was allowed in between trials to reduce fatigue. FNIRS data were analyzed based on a spatial-temporal version of a general linear relationship model. Group-level analysis across subjects was performed using a random-effects model of brain activity. The level of significance was set up at \( p < 0.05 \).

Results: The spatial maps of source-detector pairs revealed increased activation in PFC and both VEST in trials 1 and 4. In trials 2, 3, 5, and 6, performing SRT or CRT significantly increased activation in both VEST, while increasing PFC activation in fast OF conditions.

Conclusions: Our preliminary findings suggest that performing concurrent cognitive tasks during different speeds of OF may require more attention and cognitive processing.

Clinical Relevance: People with vestibular disorders may receive OF stimulation as part of their physical therapy intervention. Our results suggest PFC and VEST could be further activated with concurrent cognitive tasks. OF stimulation may be integrated with dual-task training to enhance the outcomes after vestibular rehabilitation.
Purpose/Hypothesis: Vestibular and ocular motor impairments are common after concussion. The purposes of this investigation are to examine interrelationships between various Vestibular/Ocular Motor Screen (VOMS) items, to characterize change in VOMS performance in a sample of post-concussion adolescents treated with vestibular physical therapy (VPT), and to compare VOMS scores at the last visit of VPT to scores obtained from healthy controls.

Number of Subjects: 154 subjects: seventy-seven patients with concussion and seventy-seven healthy participants.

Materials and Methods: Seventy-seven patients with concussion completed the VOMS test at the initial and last VPT visit. Seventy-seven healthy participants without concussion completed the VOMS test one time. Spearman-rho ($r_s$) correlation coefficient was used to examine interrelationships between VOMS items. Wilcoxon signed rank test and McNemar’s test were used to examine changes in VOMS over the course of VPT. Mann-Whitney U and c² test were used to compare VOMS scores at the conclusion of VPT to healthy controls.

Results: With the exception of NPC distance, all VOMS items were inter-related ($r_s$=0.42-0.79, p<0.001). Over the course of VPT, significant improvements in VOMS performance and significant reduction in the percentage of patients with positive VOMS scores was observed. At the completion of VPT, VOMS performance scores were similar between post-concussion patients and healthy adolescents.

Conclusions: The VOMS test measures moderately related aspects of vestibular and ocular-motor function. VOMS can capture changes over the course of VPT.

Clinical Relevance: Clinicians should be cautious in interpreting the NPC distance. Moreover, clinicians should consider positive VOMS findings in post-concussion patients within the context of the risk of “false positive” observed in healthy adolescents.
Females Exhibit Greater Balance, Vestibular and Oculomotor Dysfunction Than Males Following Pediatric Concussion

Purpose/Hypothesis: Currently, few studies have compared female and male pediatric patients with concussion on vestibular, oculomotor and balance measurements. The purpose of our study was to examine differences between males and females on measures of balance, vestibular and oculomotor function within 3 weeks of concussion among patients presenting to a pediatric sports medicine clinic. We hypothesized females would demonstrate greater deficits in both vestibular and oculomotor function relative to males.

Number of Subjects: 578

Materials and Methods: We conducted a secondary analysis of data obtained from a prospective clinical registry of pediatric patients seen at Children’s Hospital Colorado for post-concussion care. A total of 197 females (37%; median age= 15.2 years) and 381 males (66%; median age= 14.6 years) completed Balance Error Scoring System (BESS), Romberg, tandem gait, vestibulo-ocular reflex (VOR) and near point of convergence (NPC) tests. We conducted univariable comparisons between groups using Mann Whitney U tests and Chi-square analyses, and multivariable logistic regression models were constructed to adjust for the effect of age, days post-injury, attention deficit/hyperactivity disorder (ADHD), as well as post-injury headache, sleep disturbance, and symptom frequency.

Results: A higher proportion of females exhibited abnormal NPC (22% vs. 14%; p=0.017), VOR (53% vs. 43%; p=0.028), Romberg (27% vs. 15%; p=0.002), and tandem gait tests (20% vs. 13%; p=0.026) compared to males. No differences were found between females and males for each BESS condition with the exception of the double-leg firm ground condition, although between-group effect sizes were very small (median errors=0 for both females and males). Multivariable analysis indicated that there was an independent association between being female and increased odds of abnormal NPC (adjusted odds ratio [aOR]= 1.79, 95% CI= 1.07-3.00), Romberg test (aOR=1.93, 95% CI=1.15-3.22), and tandem gait tests (aOR=1.96, 95% CI=1.12-3.41) following concussion. Multivariable analysis indicated no independent associations between sex and the number of errors observed in any of the six BESS conditions.

Conclusions: Our results indicate that within the first three weeks of a concussion, female pediatric patients demonstrated increased odds of exhibiting abnormal NPC, Romberg test, and tandem gait test performance compared to male patients.

Clinical Relevance: Concussion is a multifactorial injury requiring healthcare professionals to determine appropriate individualized treatment pathways to ensure high quality of care. Our findings give PTs additional information regarding sex differences in pediatric patients with concussion. This allows PTs to adapt treatment plans of care for pediatric patients presenting with vestibular and oculomotor dysfunction post-concussion.
BACKGROUND AND PURPOSE:
To investigate the effectiveness of vision and vestibular rehab along with the implementation of a calcium channel blocker (CCB) on the improvement of exertion symptoms, visual acuity, depth perception, and visual field testing on a patient 5 months post mild traumatic brain injury (mTBI) with loss of consciousness (LOC) and right eye traumatic optic neuropathy.

CASE DESCRIPTION:
A 32-year-old male, Army service member, 5 months post mTBI with LOC and right eye traumatic optic neuropathy, was treated in a multidisciplinary outpatient day program for service members with mTBI. The patient’s chief complaints were: headache, fogginess, and right eye blurred vision with exertion.

OUTCOMES:
Exertion testing with a recumbent bike was used to assess exertion symptoms (headache, dizziness, fogginess, blurred vision). Static visual acuity of oculus dexter (OD), oculus sinister, and oculus uterque was assessed using a Snellen eye chart pre and post exertion. Depth perception was assessed using an OPTEC pre and post exertion. Outcome measures were completed at the following intervals: pre-treatment, after 1 month of physical therapy (PT) and occupational therapy (OT) only, after 2 months of PT and OT and 2 weeks of a CCB, and 7 weeks after discharge from PT and OT while maintaining compliance on a CCB. PT and OT sessions consisted of twice weekly, one-hour sessions for vision, vestibular, and exertion training for 12 weeks. The CCB, Verapamil, was prescribed at 120 mg once a day, 2 weeks prior to discharge. PT and OT were effective interventions for exertion symptoms in mTBI. After 2 months of therapy, no symptoms of headache, dizziness, or fogginess were reported with exertion. In this case, OD and depth perception were unchanged during exertion with therapy alone at 2 months. After the initiation of a CCB, reassessment revealed OD improved from 20/40 to 20/16 and depth perception improved from intact at 30 seconds of arc to intact at 20 seconds of arc with exertion. All findings were maintained 7 weeks after discharge while continuing the CCB. Humphrey visual field testing was completed pre and post intervention. Prior to treatment, Humphrey visual field test revealed significantly decreased visual field OD, which returned to normal post intervention.

DISCUSSION:
PT and OT was an effective intervention in the treatment of exertion symptoms in mTBI. The outcomes from this case suggest that symptoms of headache and fogginess can improve with therapy. Therapy alone did not effectively treat OD visual acuity and depth perception impairment from traumatic optic neuropathy. The addition of a CCB was able to effectively treat impaired OD visual acuity and depth perception with exertion. Future research using randomized control trials needs to be conducted. PT and OT along with a CCB appear to be viable interventions to treat impairment in mTBI with co-occurring traumatic optic neuropathy.
Purpose/Hypothesis: People with vestibular disorders present with a combination of physical and psychological symptoms that may adversely affect activities of daily living and quality of life, placing burdens on individuals, families, and the healthcare system. Some individuals with vestibular disorders have visual vertigo (VV) symptoms, described as dizziness, disorientation, and/or impaired balance induced by environments with conflicting visual and vestibular information or complex visual stimuli. The purpose of this study was to explore differences in fear-avoidance and lifespace in individuals with and without VV. Individuals with VV were hypothesized to have greater fear-avoidance and less lifespace than those without visually-induced symptoms.

Number of Subjects: A convenience sample of fourteen individuals with VV (mean 39 years old [SD 11], 85% women) who were referred to a neuro-otologist at the University of Pittsburgh Medical Center and fourteen age- and gender-matched healthy controls (CON) was utilized.

Materials and Methods: A cross-sectional descriptive study was used to explore differences in anxiety, depression, balance confidence, and mobility in individuals with and without VV. Participants were asked to complete the Hospital Anxiety and Depression Scale (HADS), Activities-Specific Balance Confidence Scale (ABC), Life Space Assessment Tool (LSAT), and the Five Times Sit-to-Stand Test (5xSTS). Comparisons between individuals with and without VV were made using dependent t-tests or Wilcoxon Signed Ranks tests where appropriate.

Results: The HADS Depression score for VV (mean 6 [SD 4]) was significantly greater than CON (mean 1 [SD 1]), Z = -3.306, p = 0.001. The HADS Anxiety score for VV (mean 12 [SD 5]) was significantly greater than CON (mean 5 [SD 3]), t(13) = 5.16, p < 0.001. The ABC Score for VV (mean 63 [SD 21]) was significantly less than CON (mean 98 [SD 3]), Z = -3.296, p = 0.001. The LSAT for VV (mean 75 [SD 37]) was significantly more restricted than CON (mean 102 [SD 17]), t(13) = -2.615, p = 0.021. The time to perform the 5xSTS was significantly longer in VV (mean 12.3 seconds [SD 3.2]) than in CON (mean 9.3 seconds [SD 2.5]), Z = -1.977, p = 0.048.

Conclusions: There were between-group differences in anxiety, depression, balance confidence and mobility. Individuals with VV reported higher levels of anxiety and depression, less balance confidence, and more restricted mobility compared to CON.

Clinical Relevance: Individuals with vestibular disorders with VV symptoms had worse anxiety, depression, fear-avoidance and restrictions in mobility and life space compared to those without VV symptoms. It may be important for clinicians to screen for psychological symptoms and recommend timely, appropriate referrals for individuals with VV to minimize activity and participation restrictions.
TITLE: Seated Cervical Flexion-Rotation Test Is Comparable to Supine in Patients with Dizziness and Vertigo.

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Vestibular SIG

AUTHORS: Karlee Rose Picard, Sandra Plant Gibson, Paul Anthony Ullucci, Rebeca Hinckley, Brian Reis, Soleil Avena, Andrew Connor Kalach

ABSTRACT BODY:

Purpose/Hypothesis:
The supine cervical flexion-rotation test (SupCFRT) is recommended for the evaluation of upper cervical mobility restrictions.\(^1\) The upper cervical spine should be assessed in patients with dizziness, vertigo and benign paroxysmal positional vertigo (BPPV).\(^2,4\) A limitation of the SupCFRT, is that in some cases patients with dizziness, vertigo or BPPV are unable to tolerate the supine testing position. We hypothesized that by stabilizing the lumbar and thoracic spine in a chair and flexing the head maximally to the chest, then rotating it in a similar fashion to the SupCFRT we would be able to get comparable results. The purpose of this study was therefore to assess the seated cervical flexion-rotation test (SeatCFRT) in both normals and in those diagnosed with and referred to physical therapy for dizziness, vertigo or BPPV.

Number of Subjects:
Eighty two subjects took part in this study. 45 college age students (23.7±3.3 years old) acted as controls. The remaining 37 subjects were referred to physical therapy for treatment of dizziness, vertigo or BPPV. Of those, 10 subjects were diagnosed with dizziness (54.7±22 years old), 6 diagnosed with BPPV (60±7.4 years old) and 21 diagnosed with vertigo (61.3±8.2 years old). All subjects signed the appropriate consent forms prior to data collection.

Materials and Methods:
The data from the 45 college age students was collected as part of a different study and used here as controls, as they did not have neck pain, dizziness, vertigo or BPPV at the time the data was collected. The remaining 37 subjects were referred to physical therapy for treatment and were enrolled in another study currently underway at the facility.

The SupCFRT was performed in supine by passively flexing the head maximally towards the chest and then rotating the head maximally to the left and then to the right. The SeatCFRT was performed in a similar manner as the supine version only the subject was positioned in a high-backed chair with their back supported and the head was flexed downward then rotated. Unilateral or bilateral restrictions in range of motion were then recorded for analysis. Limitation in either both or one direction during the SupCFRT was considered positive for upper cervical dysfunction.\(^1\) The data for both the SupCFRT and the SeatCFRT was converted into either positive, presence of limited range of motion, or negative no detectable limitation. A second conversion was performed listing the specific limitation found, left, right or bilateral. A reliability analysis, Intraclass Correlation Coefficient (ICC) using a two way mixed, absolute agreement model, was performed on both sets of data to determine if the SeatCFRT was comparable to the SupCFRT. All analyses were performed using SPSS (version 25, IBM Armonk, NY).

Results:
Twenty-four of the thirty-seven subjects, 65%, referred to physical therapy for dizziness, vertigo or BPPV tested positive on the SupCFRT. Twenty-six, 70%, tested positive on the SeatCFRT. There was a statistically significant relationship, p<0.001, when comparing the SupCFRT and the SeatCFRT for all 82 subjects, between just normal controls and in the 37 subjects referred for physical therapy for the treatment of dizziness, vertigo and BPPV.

Conclusions:
The upper cervical spine is a causative factor for symptoms associated with the diagnoses of dizziness, vertigo and BPPV.\(^2,4\) The SupCFRT is recommended as a reliable way for physical therapists to assess upper cervical mobility in patients.\(^1,5\) The SeatCFRT appears to correlate well with the SupCFRT in both normals and those previously diagnosed with dizziness, vertigo and BPPV. The SeatCFRT appears to offer the clinician an alternate way to access the upper cervical spine in patients who do not tolerate the supine position, such as those suffering from dizziness, vertigo or BPPV. This study is the first to describe the intra-rater reliability of the SeatCFRT compared to the SupCFRT. Additional studies are currently underway to establish the inter-rater reliability.

Clinical Relevance:
Clinicians familiar with performing the SupCFRT can perform the SeatCFRT on patients in order to assess the upper cervical spine. The SeatCFRT is easily performed in the clinic and does not require patient repositioning. This may make it the preferred testing position for those treating patients with dizziness, vertigo or BPPV, especially when those patients do not tolerate the supine position.
Purpose/Hypothesis:
Vestibular rehabilitation focuses in part on gaze stabilization exercises and requires an appropriate dosage of head movements (frequency, amplitude, velocity) to drive improvement in gaze stabilization through vestibular ocular reflex (VOR) adaptation or compensatory saccade mechanisms. However, the fidelity of gaze stabilization exercises is often assessed via visual observation therefore the dosage delivered is often unclear. To address this issue, we examined the delivery of vestibular based treatment over a 6-week intervention period using wearable inertial measurement units (IMUs). We hypothesized that IMUs would allow us to 1) detect differences between a specific gaze stabilization exercises (GSE) group and a vestibular neutral exercises (VN) group, and 2) accurately capture the progression of VOR exercises across the treatment period.

Number of Subjects:
16 individuals enrolled in an ongoing clinical trial examining gaze and postural stability exercises in people with MS with complaints of dizziness and falls were included. Nine (66% F, mean age 60 y/o, mean EDSS 4.1) individuals were in GSE group and 7 (57% F, mean age 48 y/o, mean EDSS 3.1) were in the VN group.

Materials and Methods:
A forehead worn IMU (Opal, APDM, Oregon) was used to track head movements of participants at 3 time points during the 6-week intervention period: early (week 1), mid (week 3), and late (week 6) while completing their protocol in the clinic. A custom Matlab (MathWorks Inc.) algorithm was used to determine yaw plane head turn performance in the total session as well as to isolate periods of active VOR training. Yaw plane outcomes were the frequency (head turns/sec [hertz]) and average peak amplitude (degrees) and velocity (degrees/sec) of head turns for the total treatment and VOR periods. 2-way ANOVAs were used to examine group and time effects between the GSE and VN groups. Within the GSE, we then characterized outcomes from the early to the middle and late sessions to assess progression of exercise dosage.

Results:
A significant group effect was noted for head turn frequency and amplitude but not for time. The GSE group had significantly greater frequency of head movements at the middle time point, but no other pair-wise comparisons reached significance (p>0.05). The frequency of head turns performed during VOR exercises increased on average 68% from the early to mid and 87% from early to late sessions. The same increases in velocity and amplitude were not observed. The mean peak velocities during gaze stabilization exercises were 114.9 deg/sec (early), 127.3 deg/sec (mid), and 124.9 deg/sec (late).

Conclusions:
A head mounted wearable sensor allowed us to detect differences in frequency of head movements between the groups, document progression of head movements over 6 weeks, and confirm that head movement velocity was sufficient to bias VOR gaze stabilization mechanisms.

Clinical Relevance:
Objective measurement of gaze stabilization exercise dosage via wearable sensors may allow physical therapists to understand the fidelity of their prescribed vestibular rehabilitation programs.
TITLE: Influence of Evaluator Position and Patient Height on Movement Metrics of the Dix-Hallpike Maneuver

CURRENT SECTION: Neurology

CURRENT SUB-CATEGORY: Vestibular SIG

AUTHORS: Dalerie Jean Lieberz, Mariah Jeanne Fier, Carissa Anne Fuller, Alannah Baker, Cayla M. Fogle, Matthew James O'Connor, Stephanie Strandberg, Jon Nelson

ABSTRACT BODY:

Purpose/Hypothesis:
The Dix-Hallpike is strongly recommended for diagnosing posterior canal BPPV. The maneuver is performed by “bringing the patient from an upright to supine position with the head turned 45° to one side and neck extended 20° with the affected ear down”. The Dix-Hallpike is also recommended to be performed briskly to elicit symptoms. The head velocity metrics are undefined in the reviewed literature; however, it is suggested that the sensitivity of the test is optimal when the movement from upright to supine is completed in 1 to 2 seconds. The Cranial DHP (CDHP) is performed with the clinician at the head of the patient. The Lateral DHP (LDHP) is performed with the clinician at the side of the patient. The purpose of this study is to compare the movement metrics of the LDHP and CDHP to determine a preferred testing method.

Number of Subjects:
Sixteen doctor of physical therapy students who had completed coursework related to Dix-Hallpike testing were recruited for the study.

Materials and Methods:
Video and written instructions on the execution of both the CDHP and LDHP maneuvers were provided prior to testing. All participants performed one CDHP and one LDHP on two mock patients of differing heights. Mock patients were fitted with cranial and mandibular markers. Movement metrics were measured using Qualysis, 8 camera motion capture system. Data were reduced and processed with Visual 3D Biomechanical Analysis software. Statistical analysis was performed with SPSS.

Results:
A significant difference in peak head angle was identified (p=0.00) between mock patient height when performing both the CDHP and LDHP. When performing on a tall mock patient the mean peak head angle was 53.7 degrees (± 11.2) versus when performing on a short mock patient the mean peak head angle of 46.1 degrees (± 11.2) was measured.

A significant difference in peak head velocity was identified between the two mock patient heights (p=0.00). Mean peak head velocity was 174.3 deg/s (± 31.2) for the tall mock patient and 149.7 deg/s (± 23.3) for the short mock patient. Peak head velocity was also significantly different between evaluator location (p=0.00). Mean peak head velocity was 139.7 deg/s (± 27.3) for the CDHP and 184.2 deg/s (± 27.2) for the LDHP. No difference in head velocity was identified when evaluator location and mock patient height was coupled.

Conclusions:
The diagnostic accuracy of the DHP may be enhanced with the evaluator performing the LDHP over the CDHP.

Clinical Relevance:
BPPV is present 17-42% of the time in patients with dizziness and is known to be the most successfully treated form of vertigo. Socioeconomic and personal costs associated with managing BPPV are significant, approaching $2 billion annually. Promoting an accurate and efficient diagnosis of BPPV is critical to the effective management of individuals with BPPV. This study suggests that the LDHP may be a preferred approach to the Dix-Hallpike.
Purpose/Hypothesis: Dizziness and balance problems are common symptoms of sport related concussion (SRC). Thus, assessing the function of the vestibular ocular reflex (VOR) is an important component of SRC assessment. The VOR acts to move the eyes equally in opposition to the head, which maintains a stable in-focus visual field when a person is moving. The gaze stabilization test (GST) is a computerized measure of VOR function. GST assesses the highest head velocity at which a person can move his/her head and maintain clear vision. Recent studies suggest healthy adults under age 60 in community samples achieve on average, 155 d/sec in the yaw plane on computerized measures of gaze stability. Gaze stability in athlete samples shows typically better performance, with average achieved head velocities ranging from 160 deg/sec to 220 deg/sec. In each of these studies, all subjects were male and to our knowledge, there are no published studies for GST in athletes under the age of 18. The purpose of this study was to compare gaze stability in young athletes compared to adult male elite athletes.

Number of Subjects: 101 (25 female and 76 male) club sport athletes aged 7-17 years (mean age =13.74) (SD 2.00)

Materials and Methods: Subjects were tested using the Bertec® gaze stability testing protocol: static visual acuity (SVA), visual perception time test (VPT), and GST in the high-performance range (GST-HP). GST-HP has an initial trial velocity of 140 d/sec, with a range of 120 d/sec to 400 d/sec. The program determines the velocity for the next trial based on the athlete’s response. Each athlete sat in a chair, five feet from a laptop screen, to have his/her head moved passively in yaw by a trained therapist. An accelerometer secured to the athlete’s forehead conveyed head velocity to the laptop. The optotype, an E, set to be 0.2 logMAR larger than SVA. The E flashed on the screen when the athlete was within an appropriate range of that trial’s intended velocity for 3 turns in a row. The program’s algorithm determined the maximum velocity at which the athlete’s head could move and maintain visual acuity.

Results: Average head velocity for these athletes was 183.55 deg/sec (left-L) (SD 41.834) with a range of 120 to 330 d/sec; and, 191.24d/sec (right-R) (SD 42.09) with a range of 120 to 280 d/sec. Trials for L and R GST resulted in high consistency markers for all trials indicating valid results.

Conclusions: Our study demonstrated that young athletes have higher mean GST compared to adult community samples and, are more like collegiate athletes. But, this youth sample has lower GST than elite adult male athletes.

Clinical Relevance: As our understanding of SRC expands, the potential impact of concussion on vestibular function has become more apparent. All Concussion in Sport Consensus Group underscore the importance of multidisciplinary assessment and management. Establishing normative performance data for youth athletes on higher-level visual tasks will aid providers in better understanding when an athlete’s function has truly returned to expected levels, which will hopefully lead to reduced risk of reinjury and better management of the return to play process.
Purpose/Hypothesis: Balance often relies on gaze stabilization mediated by the vestibular system which helps regulate appropriate postural muscle contractions to maintain upright stance. When externally perturbed, short-lived head movements activate the vestibular system, which activates the oculo-motor, cervico-motor and spino-motor pathways to maintain balance. Modifying the output of these pathways for therapeutic benefit can be achieved through repeated, rhythmic headshake activities to induce vestibular habituation and/or adaptation. In the current study, we hypothesized that the effect of such training would significantly alter the vestibular role in maintaining postural stability as measured by vestibulo-colic and vestibulo-spinal reflexes (VCR and VSR).

Number of Subjects: Forty-two young healthy individuals (18-35 years old)

Materials and Methods: Participants were randomly assigned to one of four groups: No training (CTL), weight shift training (WST) with no headshake (NHS), WST with active horizontal headshake (HHS), or WST with vertical HS (VHS). Training was performed for 20 minutes/day for 5 consecutive days. Pre- and post-assessments using Sensory Organization Test (SOT) and ramp perturbation trials were performed on all participants with average activation of postural musculature collected using surface electromyography (EMG) as the dependent variable. Significance was set at p<0.05.

Results: VHS showed significantly decreased activation of the medial gastrocnemius post-training during SOT assessment (p=0.03). The decrease in muscle activity was predominantly found in SOT conditions 4, 5 and 6 suggesting a visual, vestibular and visual-vestibular reweighting. Also, the change in the muscle activation suggests vestibular habituation of the VSR produced by the vertical headshake. For the ramp trials, the muscles that showed significant changes for the ramp up perturbation were the left cervical erector spinae (time onset, p=0.01), left rectus femoris (peak amplitude, p=0.03) and medial gastrocnemius (peak amplitude, p=0.04). The faster cervical response and decreased muscle activation in the medial gastrocnemius was evident in the headshake groups, particularly, the VHS group. However, the decreased muscle activation in the left rectus femoris was found in the NHS.

Conclusions: Combined vestibular activation and WST modified vestibular-dependent responses after a short training intervention. The change in muscle activation and onset after headshake training may be as a result of vestibular habituation and/or adaptation of VCR or VSR which induced sensory reweighting.

Clinical Relevance: Findings may be used to guide development of a postural rehabilitation intervention in populations with vestibular disorders.
Effectiveness of Home-Based Virtual Reality on Vestibular Rehabilitation Outcomes: A Systematic Review

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Vestibular SIG
AUTHORS: Bonni Kinne, Katelynn Jo Owens, Brittany Ann Rajala, Stephanie Kay Ticknor

ABSTRACT BODY:
Purpose/Hypothesis: The vestibular system is a complex network with multiple areas for dysfunction. With the advancement of technology, researchers have been exploring the use of virtual reality for treating vestibular dysfunction. Because home-based exercises are the preferred method of vestibular rehabilitation treatment, the purpose of this systematic review was to examine the effectiveness of home-based virtual reality systems on vestibular rehabilitation outcomes.

Number of Subjects: N/A

Materials and Methods: The following databases were examined: CINAHL Complete, ProQuest Medical Database, and PubMed. The following search terms were utilized: "video OR computer" AND "vestibular" AND "home". The inclusion criteria consisted of (1) adults who have a vestibular dysfunction; (2) home-based virtual reality systems as a component of the intervention; (3) standard vestibular rehabilitation or no treatment as the comparison intervention if the study is a randomized controlled trial; (4) valid and reliable vestibular outcome measures; and (5) studies that are classified as level 2, level 3, or level 4 evidence. The evidence level for all of the included articles was evaluated using the Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence, and the methodological rigor for all of the included articles was evaluated using a ten-item tool created by Medlicott and Harris.

Results: The online databases identified 3123 articles, and two additional articles were found using other sources. Seven articles met the inclusion criteria and were qualitatively analyzed. The case series demonstrated that the primary goals of vestibular rehabilitation could be achieved through the use of virtual reality interventions. Three of the randomized controlled trials that compared the use of virtual reality interventions to traditional vestibular rehabilitation found that the two treatment approaches were equally effective in terms of the short-term results. One of the randomized controlled trials that compared the use of a combination of traditional vestibular rehabilitation and virtual reality interventions to traditional vestibular rehabilitation alone found that the combination intervention group demonstrated greater improvements than the control group in the short-term. The final two studies examined the long-term effects of a home-based virtual reality program and found an overall long-term maintenance of the functional improvements.

Conclusions: Clinicians should consider a combination of home-based virtual reality interventions and traditional vestibular rehabilitation to treat individuals with vestibular dysfunction.

Clinical Relevance: The use of home-based virtual reality interventions was able to achieve the primary goals of vestibular rehabilitation and was equally as effective as traditional vestibular rehabilitation. Individuals who participate in virtual reality interventions may also note higher enjoyment levels, lower fatigue levels, and less difficulty with their balance as compared to individuals who participate in traditional vestibular rehabilitation. It may be most beneficial if virtual reality interventions are combined with traditional vestibular rehabilitation.
**Title:** Is There a Difference in Gaze Stability Scores between Ball Athletes, Non-Ball Athletes, and Non-Athletes?

**Current Section:** Neurology  
**Current Sub-Category:** Vestibular SIG  
**Authors:** Rosemary Josefa Smith, Natalie Albright, Lindsay Morgan Wilde, John Chesney, Hannah Grace Dorian, Jessica Elisabeth Fischetti, Rachel Ann Smith, Molly Kathryn Bishop, Jessica Lieb Cammarata

**Abstract Body:**

**Purpose/Hypothesis:** Previous research has found that athletes have better performance on gaze stability testing than non-athletes, but little work has been done to determine if there is variation due to specific demands of the sport, such as tracking a ball. Understanding this difference could be used to further individualize vestibular rehabilitation. The purpose of this study was to investigate gaze stability test (GST) scores between 3 participation categories: Division I ball athletes, Division I non-ball athletes, and non-athletes. It was hypothesized that there would be a significant difference in GST scores between the 3 categories.

**Number of Subjects:** Subjects included 21 Division I ball athletes, 20 Division I non-ball athletes, and 21 non-athletes from one rural private university.

**Materials and Methods:** Subjects meeting all inclusion and exclusion criteria were separated into 1 of 3 participation categories according to involvement in Division I sports. The NeuroCom inVision® system was used to test static visual acuity, perception time, and high performance gaze stability in the pitch and yaw planes. One-Way ANOVA, Pearson correlation coefficients, and regressions were used to analyze the data.

**Results:** Ball sport athletes consistently produced the highest average GST performance in each plane, including left (193.86 ± 31.85 °/s), right (183.86 ± 44.09 °/s), up (189.38 ± 31.74°/s), and down (196.81 ± 41.57°/s); however, no significant difference was found between the 3 participation categories and GST performance. The relationship between participation categories and average achieved velocity in the up direction approached statistical significance (p = .064, r = -0.237). There was a significant correlation between perception time and down/up (DU) velocity symmetry (p = .044, r = -0.258), as well as between age and DU velocity symmetry (p = .002).

**Conclusions:** No statistically significant relationship was found between participation category and GST performance, disproving the hypothesis. The relationship between participation category and up average achieved velocity approached significance. Future research may attempt to control for hours of practice time, past involvement with sports, and physical activity not associated with the designated sport. Future research may also look at the relationship between dominant hand and velocity symmetry in the yaw plane.

**Clinical Relevance:** Even though not statistically significant, the higher average achieved velocities in the upward plane demonstrated by ball athletes as compared to non-ball athletes and non-athletes suggests a need for increased training intensities in the pitch plane following vestibular injury to return this population to baseline function. Additionally, the significant findings related to DU velocity symmetry indicate that there are different factors, including an individual’s age and perception time, that may cause velocity asymmetry without a known vestibular deficit. Better understanding of factors that affect GST performance will ultimately serve to improve individualized vestibular rehabilitation.
Effect of Repetitive Administration of the Bertec Balance Advantage Sensory Organization Test

Neurology

Vestibular SIG

Colin R. Grove, Susan L. Whitney, Bryan C. Heiderscheit, G Mark Pyle

Purpose/Hypothesis: The Sensory Organization Test (SOT) is well-established as a performance-based measure of postural balance; however, the psychometric properties of the SOT conducted with the Bertec Balance Advantage (BBA) computerized dynamic posturography device have not been fully established. A better understanding of these properties of BBA SOT is required to support its use. The aims of this study were to assess the test-retest reliability and learning effect of multiple administrations of the BBA SOT, as well as provide the foundation for establishing the threshold for the minimal detectable change (MDC) for the BBA SOT.

Number of Subjects: Thirty-four adults (27 women; age 47.5 (15.6) yr), of which 14 had peripheral vestibular dysfunction, participated. Vestibular-impaired participants currently receiving vestibular rehabilitation were not eligible.

Materials and Methods: The BBA SOT was administered one time per week for four weeks, then again one month later. Test-retest reliability (interclass correlation coefficient (ICC(3.1)) for the BBA SOT was determined using data for the composite (COMP), somatosensory (SOM), vision (VIS), vestibular (VEST), and visual preference (PREF) scores collected at visits 1 and 2. The Learning effect was assessed by analyzing the change in the COMP score of the BBA SOT from one visit to the next across all 5 visits. Additionally, data from all visits was used to determine the MDC for the COMP score of the BBA SOT.

Results: Analysis of the BBA SOT data across all participants produced the following ICCs (95% CI): 0.96 (0.92, 0.99) (COMP), 0.21 (-0.13, 0.51) (SOM), 0.93 (0.86, 0.96) (VIS), 0.92 (0.84, 0.96) (VEST), and 0.26 (-0.08, 0.55) (PREF). The mean differences (95% CI, p-value, SEM, MDC) for the COMP score between each administration were as follows: 2.2 (0.5, 4.0, 0.12, 2.3, 6.4) for visits 1 and 2; 2.0 (0.2, 3.7, 0.03, 1.9, 5.2) for visits 2 and 3; 1.4 (-0.4, 3.2, 0.117, 1.7, 4.8) for visits 3 and 4; and 0.1 (-1.8, 1.9, 0.949, 1.3, 3.6) for visits 4 and 5. The COMP score MDC was 7.94 when accounting for variability within subjects and in the learning effect across visits 1 to 3.

Conclusions: The COMP, VIS, and VEST scores from the BBA SOT have excellent test-retest reliability. Poor test-retest reliability for the SOM and PREF scores of the BBA SOT was present; however, reduced between-subject variability in these measures may have affected our results. A learning effect was identified for the BBA SOT as performance plateaued after the three administrations of the test and was maintained through the fifth test as seen in the COMP score.

Clinical Relevance: The COMP, VIS, and VEST scores of the BBA SOT are reliable measures of postural balance in adults with and without vestibular dysfunction. We believe an increase in the COMP score from the BBA SOT of 8 points may be used as a benchmark to determine whether a person’s balance has improved.
TITLE: Inter-Rater Differences of Vor Gains Using Video Head Impulse Test: A Reliability Study.
CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Vestibular SIG
AUTHORS: Jennifer L. Millar, Michael C Schubert, Yoav Gimmon
ABSTRACT BODY:
Purpose/Hypothesis: The purpose of this study is to assess inter-rater reliability of the video head impulse test (vHIT). We hypothesized that there would be no differences in same day vHIT results by two examiners (E1 and E2) in patients with dizziness.
Number of Subjects: 35
Materials and Methods: To date, 35 patients have been tested with the vHIT (Otometrics, Natus) for assessment of VOR gain in each semicircular canal by two examiners within a single clinic visit. The reported VOR gains are based on the software analysis algorithm that uses the ‘area under the curve’ method. Each semicircular canal impulse plot was examined and “bad” trials (blink artifact, noise, an abnormally high gain, goggle slippage) were removed. 18 of the 35 subjects had at least one semicircular canal vHIT requiring the impulse data to be amended.
Results: Intra-class correlation (ICC) examined VOR gains between E1 and E2 for all 6 semicircular canal gains. Bland-Altman analysis examined the level of agreement between E1 and E2 (difference between examiners as a function of mean VOR differences between E1, E2) at 95% confidence intervals. Amplitude of passive head velocities (°/s) between examiners were determined using the paired samples t-test. ICC values between E1 and E2 reveal strong correlation for the horizontal (left HC 0.967; right HC 0.899) and LARP (LA 0.776; RP 0.863) semicircular canal gains, but weak to moderate correlations for RALP gains (RA 0.583, LP 0.709). We found a high level of agreement between examiners, although E2 achieved significantly higher mean gains in right posterior (p=0.002) and right anterior canals (p=0.013) Passive head velocities differed between examiners for the right horizontal (p =0.013), right posterior (p=0.026) and left posterior semicircular canals (p=0.04).
Conclusions: vHIT has good inter-rater reliability for the yaw and LARP plane with poor consistency in the RALP plane.
Clinical Relevance: vHIT has good inter-rater reliability for the yaw and LARP plane with poor consistency in the RALP plane among experienced and novice clinicians.
Purpose/Hypothesis: The Sensory Organization Test (SOT) is considered a gold standard postural balance test; however, the validity of the SOT conducted with the Bertec Balance Advantage (BBA) computerized posturography device has not been established. Thus, a better understanding of the psychometric properties of the BBA SOT is required to support its use as an outcome measure. The aims of this study were to assess the concurrent and criterion validity of the BBA SOT.

Number of Subjects: Eighteen healthy adults (14 women, age of 38.7 (11.1) yr) and 18 adults with peripheral vestibular dysfunction (9 women, age of 61.5 (9.9) yr) participated. Vestibular-impaired participants currently receiving vestibular rehabilitation were eligible.

Materials and Methods: We based concurrent validity on the results of paired t-tests comparing the BBA SOT and SOT composite (COMP), somatosensory (SOM), vision (VIS), vestibular (VEST), and visual preference (PREF) scores across all participants. We also analyzed the results of vestibular-impaired and healthy adults separately for the BBA SOT and SOT using two-sample t-tests. Criterion validity was evaluated by comparing the area under the curve (AUC) for the receiver operator curve (ROC) for the BBA SOT and SOT. We used simple randomization to determine whether the BBA SOT or SOT would be conducted first during the study visit.

Results: Across all participants, means for the COMP and VIS scores were significantly lower on the BBA SOT compared to the SOT (75.3 (15.3) vs 78.4 (14.0), p = 0.001 and 81.6 (18.9) vs 90.8 (7.0), p = 0.004). The mean SOM score across all participants was significantly higher on the BBA SOT compared to the SOT (97.8 (4.7) vs 94.9 (4.7), p < 0.001). The means for the COMP, VIS, and VEST scores were significantly lower for vestibular-impaired adults compared to healthy adults on the BBA SOT (65.3 (17.4) vs 84.1 (3.5), p < 0.001; 71.9 (24.0) vs 90.2 (4.7), p = 0.011; and 52.8 (29.9) vs 83.5 (4.6), p = 0.001). Similarly, the means for the COMP, VIS, and VEST scores were also significantly lower for the vestibular-impaired participants compared to healthy adults on the SOT (68.7 (15.4) vs 86.9 (2.8), p < 0.001; 86.5 (7.8) vs 94.6 (3.0), p = 0.001; and 50.9 (3.9) vs 81.2 (6.1), p < 0.001). The AUC for the BBA SOT and SOT was 0.943 (95% CI: 0.870, 1) and 0.988 (95% CI: 0.965, 1) respectively (p = 0.164).

Conclusions: Vestibular-impaired and healthy adults show similar patterns of performance on the BBA SOT and SOT; however, our data suggests that the degree of postural challenge differs between these two tests. The BBA SOT and SOT have comparable ability to discriminate between vestibular-impaired and healthy adults.

Clinical Relevance: The BBA SOT and the SOT are valid measures of postural balance for adults with and without vestibular dysfunction. The results from the BBA SOT and SOT should not be used interchangeably.
Purpose/Hypothesis: Coordination of the visual, vestibular, and somatosensory systems are required to function normally and maintain balance or postural stability. The Dynamic Visual Acuity (DVA) test is used to assess different aspects of vestibular function including the vestibulo-ocular reflex. The purpose of the current study was to evaluate the relationship of DVA tests between static standing compared to ambulating on a treadmill at a self-selected walking speed. A secondary analysis was done using the Neurocom® BalanceMaster DVA compared to the Neurocom® laptop DVA.

Number of Subjects: 70

Materials and Methods: Seventy participants (23 males, 47 females; mean age =28.29±9.33 years) completed three DVA tests in one session. Participants were 19 to 54 years old and had no lower extremity injuries in the past 3 months; head injury in the past year; or a diagnosis of a visual, vestibular, or balance disorder. The static, left and right logmar DVA scores were used to compare the Neurocom® BalanceMaster DVA, Neurocom® laptop DVA, and self-selected treadmill speed with Neurocom® laptop DVA. Intraclass correlation coefficients (ICCs) were calculated using a 2-way, random-effects model.

Results: Weak correlations were observed between the DVA for static standing compared to ambulating on a treadmill at a self-selected speed while performing DVA for static (ICC=0.42), for left (ICC=0.44), and for right (ICC=0.29). The secondary analysis of the Neurocom® BalanceMaster DVA differed from the Neurocom® laptop DVA. An ICC of 0.76 (95% CI, 0.66-0.83) was demonstrated between the Neurocom® standard DVA test compared to the portable DVA test.

Conclusions: The reliability of the DVA decreases with ambulation suggesting dual task cost which has been identified as increasing fall risk. The reliability between the Neurocom® standard DVA compared to the portable DVA test was not as good as expected.

Clinical Relevance: These findings may assist clinicians in assessing VOR during a complex cognitive task during ambulation. The Neurocom® standard DVA test is the size of a phone booth, restricting the DVA test, a criterion test, to primarily clinical research only. The clinical usefulness of this study may allow clinicians to conduct the DVA test in a wide variety of settings, rather than being confined to a large clinic or research setting. Having a clinically useful and portable test allows clinicians to effectively evaluate patients in which dynamic visual acuity may be impaired.
ABSTRACT BODY:

Purpose/Hypothesis: About one-third of community dwelling older adults suffer falls related to imbalance each year. Ten percent of older adults who fall sustain serious injuries such as fractures, dislocations, or head injuries, ranging from mild to severe. Loss of vestibular function is correlated with increased risk of falling, however, no studies have examined the prevalence of falls in people with a diagnosed vestibular condition. In this retrospective study, we examined fall rate in people with a vestibular disorder and associated factors in this population that contribute to falls including demographics (age, gender, and race), and comorbidities (i.e. presence of neuropathy, depression, anxiety, sleep disorders, and head trauma).

Number of Subjects: 539 patients were identified.

Materials and Methods: We used the Healthcare Enterprise Repository for Ontological Narration (HERON) database at the University of Kansas Medical Center to identify our population. The search was conducted between 1/1/2017-12/19/2018 to include people with a diagnosed vestibular disorder using at least 2 codes of ICD-9 or ICD-10 (320-389.99, H60-H95) separated by one day. Dual codes were utilized to confirm the diagnosis and strengthen the data collection accuracy. Variables of interest were demographics (age, gender, and race) and comorbidities with at least 2 ICD-9 or ICD-10 codes including neuropathy, depression, anxiety, sleep disorders, and mild traumatic brain injury (Glasgow Coma Scale 13-15). The main outcome was selected from flow sheet information including history of falls in the past 12 months and was linked to the index date of vestibular disorder within one year. Patients were further categorized into fallers (with at least one fall) and non-fallers. Step-wise conditional logistic regression was conducted to identify risk factors of fall at 0.05 alpha level.

Results: The search revealed a total of 539 people with a prior history of a vestibular disorder. Of these, 103 had accidental falls (19.1 %) in the past 12 months. People with falls were older than those who did not fall, however, it was not statistically significant. The prevalence of mild traumatic brain injury (mTBI) among fallers (15.5%) was significantly higher than non-fallers (5.7%) (p=0.001). The results of logistic regression showed that only mTBI (OR 2.95; 95% CI 1.50-5.83) and neuropathy (OR 2.36; 95% CI 1.07-5.19) were significant factors associated with falls in people with vestibular disorders. People with mTBI were about 3 times more likely to experience falls compared to those without mTBI, while people with neuropathy were about 2 times more likely to experience falls compared to those without neuropathy.

Conclusions: Adults with a vestibular disorder are more likely to fall if they have peripheral neuropathy or have suffered a mild traumatic brain injury.

Clinical Relevance: People with an existing vestibular disorder may benefit from identification and management of risk factors, particularly peripheral neuropathy and prior history of mTBI, to prevent future falls.
TITLE: Patients with Cerebellar Ataxia Reporting Gaze Instability Demonstrate Abnormal Oculomotor Patterns during Passive Head Rotation

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Vestibular SIG
AUTHORS: Jennifer L. Millar, Michael C Schubert
ABSTRACT BODY:

Background and Purpose: Patients, diagnosed with cerebellar dysfunction, referred for physical therapy commonly report complaints of gaze instability (perception of blurred vision with head movement). There is scant literature available describing passive eye and head movement patterns in cerebellar ataxia patients. In ataxia patients who have reported gaze instability, we have started to include video head impulse testing (HIMP) as part of their clinical PT evaluation as well as utilize a recently developed oscillopsia measure, validated in the vestibular population. The purpose of this study is to describe eye and head movement patterns in patients diagnosed with cerebellar ataxia and, as well as to begin to address the question, “Are gaze stability exercises effective in reducing symptoms of oscillopsia in cerebellar ataxia patients?”

Case Description: 22 patients with cerebellar dysfunction (diagnosed with spinocerebellar ataxia types 2, 7, 8, or cerebellar ataxia of unknown etiology with family and without family history), completed the Oscillopsia Functional Index Scale (OFIS). The HIMP protocol in the yaw and vertical planes and the Suppression Head Impulse Test (SHIMP) in the yaw plane was conducted in 22/22 and 3/22 patients respectively. Additional clinical oculomotor tests and functional outcome measures were recorded.

Outcomes: Varied eye movement patterns were observed with HIMP and SHIMP testing including 1) anti-compensatory saccades with normal, hypometric, or hypermetric VOR 2) hypermetric VOR 3) hypometric VOR responses without compensatory saccades 4) hypometric VOR responses with overt/covert saccades, 5) hypometric bilateral VOR with saccades. Functional outcome measures revealed self-reported gaze stability and balance confidence and well as functional performance impairments, below normative values. (See Table 1).

Table 1: Functional Outcome Measures

<table>
<thead>
<tr>
<th></th>
<th>OFIS</th>
<th>ABC (%)</th>
<th>10 MWT (m/s)</th>
<th>TUG (seconds)</th>
<th>TUG Cog (seconds)</th>
<th>DGI</th>
<th>SARA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient mean</td>
<td>72.2</td>
<td>51.5</td>
<td>1.0 ± 0.3</td>
<td>12.8 ± 7.3</td>
<td>17.9 ± 8.5</td>
<td>12.1 ± 6.6</td>
<td>14.1 ± 4.7</td>
</tr>
<tr>
<td>SD</td>
<td>±33.4</td>
<td>±19.5</td>
<td></td>
<td></td>
<td></td>
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</tr>
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Normative values: < 12 > 80% > 1.3 m/s < 11 < 15 > 22/24 < 0.4

OFIS – Oscillopsia Functional Index Scale; ABC – Activities Balance Confidence Scale; 10MWT – Ten meter walk test; TUG- Timed up and go; TUG Cog – Timed up and go cognitive, DGI – Dynamic Gait Index; SARA – Scale for assessment and rating of ataxia

Discussion: Our data reveals abnormal oculomotor behavior during head rotation in patients with cerebellar pathology and a report of gaze instability, including an undiagnosed cerebellar ataxia with bilateral vestibular dysfunction - CABV2. Our data suggests rehabilitation to address the gaze instability is warranted, though future study on efficacy of such training is unknown.
Purpose/Hypothesis: Horizontal (HC) benign paroxysmal positioning vertigo (BPPV) is a common form of BPPV. Numerous maneuvers have been proposed for the treatment of this condition. The purposes of this study were to determine the efficacy of the individual treatment techniques and to compare the relative efficacy of the different treatment techniques for HC BPPV.

Number of Subjects: 15 studies (1317 subjects)

Materials and Methods: This study was performed following the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines. A systematic search was performed in 3 databases, MEDLINE, CINAHL, and Embase from their inception until May 2018 using selected search terms. Articles were screened by 2 authors to ensure they met the pre-specified inclusion criteria. Two other authors independently assessed the methodological quality of the studies using the Physiotherapy Evidence Database (PEDro). Fixed-effect meta-analyses were run to produce estimates of the overall efficacy of the individual maneuvers and to compare the relative efficacy of the maneuvers.

Results: 15 of the initial 349 articles that were identified met the inclusion and exclusion criteria. Five treatments were examined: Gufoni for geotropic nystagmus, Gufoni for apogeotropic nystagmus, canalith repositioning maneuver for the HC (CRMhc), forced prolonged positioning (FPP), and head shaking (HS). The methodological quality of the studies ranged from Poor to Good. Four studies were included in the meta-analysis for the CRMhc. The Relative Risk (RR) was 1.39 (95% CI 1.14–1.69), indicating the treatment was better than a sham treatment. Three studies were included in the meta-analysis for the Gufoni maneuver for geotropic nystagmus. The RR was 2.14 (95% CI 1.62–2.83), indicating the treatment was better than a sham treatment. Three studies compared the CRMhc to the Gufoni maneuver for geotropic nystagmus. The RR was 0.9 (95% CI 0.79–1.04), indicating there was no difference in the efficacy of the treatments. Three studies were included in the meta-analysis for the Gufoni maneuver for apogeotropic nystagmus. The RR was 1.62 (95% CI 1.32–1.99), indicating the treatment was better than a sham treatment.

There was reasonable data supporting the use of the FPP maneuver; however, there was insufficient data to conduct a meta-analysis. There was limited data on the use of HS to treat HC BPPV.

Conclusions: Based on the results of the meta-analyses, both the Gufoni maneuver for geotropic nystagmus and the CRMhc are effective treatments, with no apparent difference in the overall outcomes. Similarly, the Gufoni maneuver for apogeotropic nystagmus was shown to be an effective treatment. The other treatments proposed for these conditions have insufficient data to support their use.

Clinical Relevance: Based on the results, HC BPPV canalithiasis should be treated with the Guffoni maneuver or the CRMhc. Treatment selection should be based on the clinician’s assessment of the patient’s ability to perform the maneuvers. HC BPPV with apogeotropic nystagmus should be treated with the Gufoni maneuver.
**Background and Purpose:**
Current literature on post-concussion syndrome (PCS) highlights the significance of psychosocial factors such as anxiety and depression that contribute to symptom magnification. Personal beliefs and expectations for recovery influence outcomes in both normal subjects and PCS. Despite increasing evidence that physical therapy (PT) is beneficial in the treatment of PCS sequelae, there lacks substantial literature on treatment recommendations and outcomes of PCS with somatization. This case study demonstrates the efficacy of (PT) in resolving aphysiologic symptoms related to PCS in an adolescent male.

**Case Description:**
The patient is a 15-year-old male who sustained a concussion while playing football. He presented to PT six months post-injury reporting ongoing dizziness, headaches and balance deficits affecting daily activities and preventing return to sport. On evaluation, he demonstrated typical PCS symptoms including slowed vestibular ocular reflex (VOR), headaches with exertional activity and motion sensitivity. However, his gait and balance tests were characterized by atypical movements including repetitive head oscillations and large amplitude thoracolumbar trunk flexion/extension. He demonstrated significant difficulty performing simple tasks (stair negotiation, walking with head turns, Rombergs) but completed challenging ones without loss of balance or excess movement (single leg squats, bounding, running backwards with ball toss). His aphysiologic movement patterns and imbalance were attributed to somatization.

Treatment began with traditional vestibular physical therapy and graded return to aerobic exercise based on the Leddy protocol. Vestibular symptoms and exertional headaches resolved, however aphysiologic movement patterns persisted with basic activities. Treatment shifted to performing high level agility exercises, sport-specific drills and faster versions of functional tasks (running stairs) as no aphysiologic movement was present with these activities. Exercises were gradually regressed, which ultimately reduced aphysiologic movement patterns with lower level activities. Throughout this approach, the patient received positive reinforcement of normal movement patterns coupled with extinction of aphysiologic ones. He was educated on the impact of anxiety and social stressors on PCS, as well as stress management and gradual return to normal sport schedule.

**Outcomes:**
Functional Gait Assessment Score improved from 23 to 30; VOR speed improved by 100% to normal levels; Dizziness Handicap Inventory improved from 66 to 2; and ABC scale score improved from 40%-90%. There were no aphysiologic movements noted on the final evaluation. He safely resumed football drills with his highschool team.

**Discussion:**
The patient made significant recovery despite his complex presentation. In addition to addressing his vestibular symptoms, a biopsychosocial framework was utilized to instill a sense of personal control in the patient, mitigating emotional distress that contributed to somatization and leading to resolution of aphysiologic symptoms.
Establishing a Vestibular Classification System: Fostering Evidence-Based Care, Quality Improvement and Research

CURRENT SECTION: Neurology
CURRENT SUB-CATEGORY: Vestibular SIG
AUTHORS: Janene M. Holmberg

ABSTRACT BODY:
Purpose/Hypothesis: Dizziness and Instability are common disabling complaints for which vestibular rehabilitation has been found effective. Increasing clinical outcome measures and clinical practice guidelines are available to help guide treatment, however translating this to best practice and documenting effectiveness remains challenging. Clinically-relevant classification systems in orthopedics have been found useful in driving better documentation and outcomes. The purpose of this study was to develop, implement and evaluate the effectiveness of an outcome-linked treatment-based vestibular classification.

Number of Subjects: 882

Materials and Methods: A vestibular classification was developed and implemented in large not-for-profit healthcare organization that consisted of with 14 vestibular-specialized therapists across 7 sites with total average of 3,000 new evaluations annually. Therapists were supported by initial in-person collaboration, email support, and phone contact at various intervals. Classification and outcome data were collected over a 6-month period.

Results: An Electronic Health Record query over a 4-month interval revealed a total of 249 different ICD-10 code combinations. Previously, isolated outcome collection, without connection to a specific classification system, had failed to lead to any meaningful data or clinical impact. Compliance on classification and outcome reporting improved from 6% to 74%. Ten major classifications were utilized with only 15 (2%) patients unclassified. Descriptive subcategories were utilized in some of the categories with significant modifying co-morbidities reported in approximately 40% of cases, most commonly central findings, pain, or peripheral neuropathy. Primary classifications were consistent with what would be anticipated for tertiary care presentations with acute presentations accounting for 40% of cases. Most common outcome measures were the Dizziness Handicap Inventory, Functional Gait Assessment, and the Disability Rating Scale. Unwarranted variability was noted between some clinics indicating the need for further training and program refinement. Limited pre and post outcome data was available (20%), however minimal clinical important difference was met 70%.

Conclusions: A treatment-based vestibular classification was able to be successfully implemented. Evidence for meaningful clinical data related to treatment efficacy, prevalence, modifying co-morbidities, and identifying quality improvement needs were obtained. Study supports the classification’s potential for fostering optimal documentation of care.

Clinical Relevance: Healthcare’s value-based transformation is demanding physical therapists increase accountability to evidence-based outcomes. Prior outcome measurements in this healthcare system, without a classification system, were not found sustainable or meaningful where current data shows potential for more detailed analysis of effectiveness, better capacity to identify areas for clinical improvement and foundation to foster research.
Background and Purpose: Those who experience a traumatic brain injury (TBI) frequently have central and peripheral vestibular pathologies. However, central vestibular pathologies are not as common or widely understood. Frequently, individuals with central vestibular disorders following a TBI present with signs and symptoms such as imbalance, multi-directional nystagmus, hearing loss, dysphagia, dysarthria, diplopia, dysmetria, gait disturbances, dizziness, and nausea. Although central vestibular disorders are less common than peripheral vestibular disorders 7%-45% of individuals seeking vestibular care have some form of central vestibulopathy. The vestibular system is often neglected when addressing postural instability deficits in individuals with central neurological disorders potentially due to the paucity of evidence on the rehabilitation of central vestibular disorders. The purpose of this case study is to explore the effects of vestibular retraining in an individual with a chronic, central neurological disorder and postural instability.

Case Description: A 31-year-old male who was involved in a bicycle accident resulting in a TBI in 2014. His recovery was complicated by meningitis, a pontine stroke, and hydrocephalus requiring shunt placements and multiple revisions. On initial examination, the patient presented with multi-directional nystagmus and a positive head impulse test bilaterally. The patient reported inconsistent diplopia and wore glasses with a partial visual field block on the right. The patient participated in 60 minutes of physical therapy (PT) two times a week for five weeks. PT interventions included ocular and vestibular retraining consisting of vestibulo-ocular reflex (VOR) cancellation on firm and unsteady surfaces, VOR x 1 exercises in sitting on stable surfaces and unstable surfaces, gait training with head turns and visual tracking exercises, saccade training in sitting and standing on stable and unstable surfaces, as well as various postural interventions on a variety of surfaces with vestibular tracking exercises.

Outcomes: Overall functional balance was enhanced after 10 sessions of physical therapy with a focus on vestibular retraining resulting in a Mini-BESTest increase from 14/28 to 25/28 which greatly exceeds the MCID of 4. Objective increases were noted in the “anticipatory”, “reactive postural control”, “sensory orientation” and “dynamic gait” subcategories of the Mini-BESTest. The 6-minute walk (6MWT) test was also performed during the examination (337m) and discharge (264.45m). Although the distance for the 6MWT decreased, there were positive qualitative changes during gait.

Discussion: While there are considerable amounts of research available for the treatment of individuals with peripheral vestibular disorders, there is currently limited research available for individuals with central vestibular pathologies. After five weeks of physical therapy services, the patient was able to make meaningful and measurable improvements in postural stability following vestibular retraining. Further research into this specific type of vestibulopathy would be meaningful and beneficial.