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THE APPLICATION OF SHAPING TECHNIQUES WITH LOWER EXTREMITY EXERCISES FOR COMMUNITY DWELLING ADULTS WITH CHRONIC STROKE: A FEASIBILITY STUDY

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By: Beth Gustafson, PT, MSEd

Accepted by:

Elizabeth S. Moore, PhD, Committee Member [redacted]

Stephanie Kelly, PT, PhD, Committee Member [redacted]

Stephanie Combs-Miller, PT, PhD, NCS, Committee Chair [redacted]

Laura Santurri, PhD, MPH, CPH [redacted]
Director, Postprofessional Programs

Stephanie Kelly, PT, PhD, [redacted]
Dean, College of Health Sciences
University of Indianapolis

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Beth Gustafson, PT, MSEd

gustafso006@gannon.edu

University of Indianapolis

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TABLE OF CONTENTS

Dedication

To individuals and their loved ones everywhere who are living with the effects of stroke.

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Abstract

Introduction: The purpose of this study was to investigate the feasibility and effects of applying the principles of shaping to part-task, pre-gait activities in persons with chronic stroke. It was hypothesized that this would be feasible and would result in positive treatment effects.

Method: Eleven participants completed this prospective, repeated measures study (6 male; mean age 61.18 ±10.41years; median months post stroke18.00 IQR 10.00; 7 left hemiparesis). The intervention was administered five times a week for two consecutive weeks for 60-minute sessions; each exercise performed for ten 30-second trials. Exercises addressed common gait impairments for individuals with chronic stroke. Verbal praise and informing participants of repetitions contributed to shaping. Outcomes assessed at baseline, post and retention were Five Times Sit to Stand (5xSTS), Functional Gait Assessment (FGA), Activities Specific Balance Confidence Scale, and gait symmetry for step length, swing time, stance time and velocity measured on an electronic walkway.

Results: The group of participants met pre-determined benchmarks for feasibility: intervention completion rate (100%), safety (0 falls, 0 emergency calls), tolerance (90% tolerated 30 second trials), 15% increase in repetitions (100%) and personnel (100% required two or less helpers). There was an increase in mean repetitions per session from 594 during days 1-3 to 1026 on the final day of intervention (P=.003). Only the 5xSTS and the FGA showed statistically significant improvements over time (P<.01).

Discussion: The study protocol was feasible and safe to implement for this sample. The protocol yields a high number of repetitions in a short, intense time with a positive treatment effect for functional measures of lower extremity strength and gait activity.

The Application of Shaping Techniques with Lower Extremity Exercises for Community Dwelling Adults with Chronic Stroke: A Feasibility Study

Cerebral vascular accident or stroke is a leading cause of serious long-term disability affecting an estimated 6.6 million adults in the United States aged 20 years and older.[1] Stroke takes a toll on the individual, on the family, and on society. The acute onset of stroke is followed by varying degrees of recovery; however, despite this recovery many individuals are left with impairments in cognition, speech, memory, higher order thinking skills, and limb use. Impairments contribute to activity limitations, such as inability to mobilize and/or perform activities of daily living (ADLs). Loss of autonomy effects one's role in life.[2,3] The dynamic relationship between spouses, between parents and children, and between employer and employee[4] may be impacted, contributing to participation restrictions. Rising healthcare costs, loss of productivity, and limited engagement in vocational and avocational endeavors impact the individual, the family and society at the local, state and national levels.[5]

Therapist-directed and insurance-financed rehabilitation is traditionally more comprehensive and frequent in the first few months following stroke.[5]As improvements slow down, rehabilitation often concludes, leaving individuals living with chronic effects of stroke (six months and longer post-stroke) and believing that most gains have been experienced. Individuals learn to compensate for deficits with increased use of the less-affected limb which reinforces limited use or learned non-use of the limbs affected by stroke. Evidence supports that gains can be made post stroke, even when an individual is living with the chronic sequelae.[5-12] It is increasingly clear that intensity in practice is important for driving change.[5,13,14] Systematic reviews[6-8] and published guidelines for management following stroke[5] do not yield conclusive evidence regarding the specific dosing needed to bring lasting change, especially in lower

extremity (LE) function, gait and gait-related activity.[5,14] Lack of any commonly used protocol contributes to the challenge of identifying dosing parameters for LE and gait intervention.[15]

Constraint-induced movement therapy (CIMT) utilizes a protocol for dosing and type of practice, developed through bench and clinical research to address learned non-use of the upper extremity (UE) following stroke. The protocol has been found to yield improvements, even when initiated years post stroke.[9,15-19] Repetitive, task-oriented training is one component of the protocol and includes two sub-components, shaping and task practice. Shaping is specifically applied to part-task exercises or activities, while task practice is applied to whole-task activities.

The UE CIMT protocol has been applied in various modified versions, including protocols that address the LE and gait activity.[10-11] In LE studies reviewed, there was more emphasis on task practice, even when part-task exercise was employed. There is evidence that shaping component, applied to part-task UE exercise, is the most effective means to maximize motor capacity[15] but shaping has not been adequately studied in LE studies.

Purpose

The primary purpose of this study was to investigate the feasibility of applying the principles of shaping to LE part-task, pre-gait activities, for individuals with chronic stroke who lived in the community and continued to experience mobility limitations. The secondary purpose was to investigate the treatment effect across all levels of the International Classification of Functioning, Disability and Health (ICF). Results from this study may help establish the feasibility of conducting a larger scale study and would add to the body of knowledge examining application of the principles of CIMT to the LE.

Hypotheses

Primary hypothesis. It will be feasible to apply principles of shaping to part-task pre-gait exercises. To test this hypothesis, the following objectives were addressed.

a. To establish the feasibility of the study process as measured through intervention completion and intervention attendance rates.
b. To determine safety of the study protocol as measured by falls and emergency medical calls. The study protocol will be considered safe if zero fall and medical calls are identified.
c. To assess the tolerability of the dosing used in the study protocol will be tolerable for planned dosing (ten 30-second trials for each exercise)
d. To establish if participants in the study yield an increase in repetitions performed over the course of the 10 treatment sessions.
e. To determine if management of the intervention protocol is feasible as measured through number of study personnel required per participant during intervention periods (maximum two) and ease of consistently applying positive reinforcement (observation/field notes) during the exercise bouts.
f. To determine if the allocated resources of physical space and exercise equipment are sufficient to carry out the study plan.

Secondary hypotheses. There will be positive treatment effect across all levels described in the ICF. To test this hypothesis, the following objectives were addressed.

a. To determine if LE motor function as measured on Five Times Sit to Stand test improves after intervention;

b. To determine if gait activity as measured on the Functional Gait Assessment and electronic walkway (gait velocity; step length symmetry, stance time symmetry, swing time symmetry) improves over time from pre-intervention to post-intervention;
c. To determine if participation as measured on the Activity Specific Balance Confidence Scale total score improves over time from pre-intervention to post-intervention.

Literature Review

Cerebral vascular accident or stroke occurs when there is a sudden interruption in blood supply to brain tissue from an ischemic or hemorrhagic event that results in neuronal cell death.[20] Stroke is a leading cause of serious long-term disability of adults in the United States. The American Heart Association[1] reported an estimated 6.6 million Americans aged 20 years and older have had a stroke with an estimated prevalence of 2.6% (2009 to 2012) and incidence of approximately 795,000 (610,000 new onset and 185,000 recurrent). The 2011 direct and indirect cost of stroke was $33.6 billion. The mean individual expense per patient for direct care in 2011 was estimated at $4692. The cost of direct care is projected to triple between 2012 and 2030 with an associated projected cost of $71.6 billion to $184.1 billion. Between 2001 and 2005, the average cost for outpatient rehabilitation services the first year after discharge from inpatient services was $11,145 (medication: $3376; rehabilitation $7418).[1] Identifying the most efficacious interventions is imperative to managing the burden of stroke on the individual, the family and society.

Impairments, Limitations, and Restrictions Following Stroke

The World Health Organization, (WHO) using the ICF, categorizes sequalea from illness and injury into three primary domains: impairments in body functions and structure (i.e. limited tissue flexibility), limitations in activity performance (i.e. standing, walking, driving) and

restriction in participation of life roles (i.e. family leadership and work). Stroke leads to long-term constraints in all domains.[2,4,21] Individuals post stroke experience challenges in moving the limbs (impaired body functions and structure), walking, completing household chores, using public transportation, driving, working, shopping, and socializing (activity limitations and participation restrictions).[4,6-8,21]

Recovery from stroke occurs most rapidly in the initial weeks post onset with the most measurable recovery occurring within the first three months, generally considered the acute phase.[2,5,20] As the individual improves during the early phases post stroke, he or she often learns to compensate for deficits in limb function by relying heavily on the less affected limb/limbs. Neglect of the affected limbs and compensation with the less affected limbs may further retard recovery of function.[15] During the sub-acute phase three to six months post stroke the individual continues to experience improvement in function but at a declining pace and with a declining impact. At six months post stroke, the condition is considered chronic.[2,6-7]

In the chronic phase of stroke, continued mobility impairment and inactivity further limit return to maximal function and full participation in life roles.[6,22] Individuals with continued impairments and inactivity are dissatisfied with performance related to cognition, outdoor activities, work/housekeeping, mobility, indoor leisure activities, and self-care.[4] Impaired ability to move the limbs in a smooth, coordinated fashion contributes to depression, decreased life satisfaction, and difficulty mobilizing in the home and community.[2,8,21] Post stroke, individuals can experience limitations with prolonged standing, stepping, turning, walking, lifting, and/or carrying items while walking, leading to restricted participation in life roles.[4,21,23-27] Life satisfaction post stroke is related to physical and cognitive independence, fatigue and mood.[2,4,21] Depressive status is more likely to increase with chronic stroke.[2]

Common Lower Extremity Impairments

A closer look at common gait abnormalities may help define intervention goals to remediate gait and mobility disability. If LE impairments and gait can be improved, activity, participation, and life satisfaction may improve as well. To move freely within the environment, the ambulatory person needs to respond to anticipated and unanticipated demands by altering limb movement, the direction of propulsion, and speed while maintaining a stable trunk and upright posture against gravity.[8,23,28] Efficient speed and tolerance for various distances are also needed.[27] Gait abnormalities from stroke impair the individual's ability to respond quickly and efficiently to environmental challenges, decrease speed and distance tolerance, therefore, impacting ambulation in the community.[4,8,21,23]

Gait can be objectively evaluated by examining temporal, spatial and kinematic parameters.[23,25-26,29] Temporal measures of gait quantify time to complete components of the gait cycle such as swing and stance time, single and double support time and gait velocity. Spatial measures of gait reflect distance associated with components of the gait cycle such as step and stride length and step width. Kinematic measures of gait quantify joint position during movement. The ambulatory individual must be able to effectively manipulate variables within these parameters in order to adapt to changing environmental and task demands encountered during mobility in the community.[8,23,25-27,30]

Gait impairments are often evident post stroke in the form of asymmetry in spatial and temporal parameters.[23,25-26,29] Individuals with stroke may present with asymmetry in stride length, step length, and step width; asymmetry often increases as the condition becomes chronic.[25] Poor motor recovery (Brunnstrom's Motor Recovery Stage for the LE ≤ stage III), and slow walking velocity (< .34 m/s) are also associated greater gait asymmetry.[26] Asymmetry may

contribute to difficulty with obstacle avoidance even in individuals who are relatively high functioning post stroke.[29] Subjectively, survivors of stroke relate impaired ability to move the lower limb to limited mobility in the community.[2,21] Improvements in gait asymmetries may lead to improved walking ability.[8]

Gait velocity, a temporal measure of walking, is considerably reduced after stroke compared to age-matched norms.[7,23,25-26] Slower velocity is associated with greater gait asymmetry[23,25] and mobility disability[28,30] and has been found to be a reliable predictor of household versus community ambulators.[31-32] Ambulation within the community is an integral part of adult life.[22] Impaired velocity, decreased capacity for distance, and decreased ability to avoid obstacles or adapt to environmental obstacles, greatly impact community mobility.[8,29-30] Shumway-Cook et al[30] found that individuals with mobility disabilities, defined as needing assistance to walk .8 km or as needing assistance to climb stairs, made fewer trips are made into the community and got less done when they were out. Impaired gait velocity contributes to mobility limitations within the community and is evident post stroke.

Another aspect to independent, safe, and efficient gait in the home and community is the ability to avoid unexpected obstacles and alter gait in response to changing environmental terrain.[8,28-30] Obstacle avoidance, negotiation through changing terrain, and fall avoidance require dynamic stability such that one limb can fully support the body weight while a stable head, trunk, and arm orient to the changing task, driven in part by the free limb and the supporting limb. Spatial and temporal asymmetry and altered kinematic execution after stroke impair the individual's ability to make efficient adaptive responses for successful obstacle avoidance and environmental accommodation.[8,29-30]

Gait Remediation Following Stroke

The effect of physical therapy intervention on gait post stroke has been investigated by many researchers.[5-8,10-12,14,22,24,33] A search of the literature resulted in finding several reviews, Cochrane[6,7,14,22] and other,[5,8,12,33] and a large RCT[24] which will be discussed in the following paragraph. Intervention and outcome measurement in domains of body function and structure[6,14,24] and activity[6,7,8,14,24] are the most commonly utilized and reported, even though the ultimate goal is to positively affect participation in life roles.[14,22]

Interventions investigated in the gait studies reviewed included low and high technology approaches. Some researchers investigated the impact of one type of intervention[6,7,14,22,33] while others compared two or more interventions.[5,8,24] Low technology interventions included OGT,[6,8,24] therapist manual guidance,[6] verbal cueing,[6] auditory cueing with rhythmic stimulus,[6,8,33] pre-gait activities such as stationary weight shifting, repetitive stepping, reaching,[6] community-based gait,[22] and use of an ankle foot orthosis (AFO).[8] Higher technology interventions included functional electrical stimulation (FES),[8] TT with[7,24] or without BWS,[7] and robotic assisted training overground or on a treadmill.[5] Environments utilized vary from clinic[6,7,14,24] to home[7,14,24] to community.[7,14,22]

The phrase repetitive task training or repetitive task practice was used often without a consistent definition across studies. French et al[14] in a Cochrane Systematic Review investigated the effects of RTT and defined RTT as "…an intervention where an active motor sequence was performed repetitively within a single training session, and where the practice was aimed towards a clear functional goal".[14(p3)] This definition allowed the inclusion of pre-gait and single task studies into the review. Pre-gait and single task studies were included as long as they

required repetitive, complex, multi-joint movements and had combined elements of intensity and functional relevance.[14]

Using the French et al[14] definition of RTT, a critique of the study outcomes shows common RTT interventions include pre-gait, continuous OGT, TT, and community ambulation. Community ambulation had no effect compared to other gait-based interventions for improving participation, gait speed or endurance.[22]

Pre-gait exercises/activities showed a positive effect on lower limb function (e.g. 6MWT, sit to stand, TUG), walking distance and functional ambulation,[14] but not on gait function as measured with multidimensional, ordinal measures of walking function (Rivermead Motor Assessment, Motor Assessment Scale, Stroke Rehabilitation Assessment of Movement, Barthel Index).[6] When used alone, pre-gait exercises showed a trend towards a positive effect for gait speed, but when used in combination with OGT, they did not.[6]

Overground gait training showed a positive effect lower limb function (e.g. 6MWT, sit to stand, TUG), walking distance and functional ambulation,[14] but not on gait function as measured with multidimensional, ordinal measures of walking function (Rivermead Motor Assessment, Motor Assessment Scale, Stroke Rehabilitation Assessment of Movement, Barthel Index).[6] When used alone, OGT showed a trend towards a positive effect for gait speed, but when used in combination with pre-gait exercises, it did not.[6]

Treadmill training with[7,8,12,24] or without BWS[7,8] showed a positive effect for functional walking category (based on gait speed)[24] and walking endurance,[7,24] compared to usual care.[24] Evidence for improving gait speed is conflicting with some reporting positive effects[7,24] and others reporting no effect.[8] The positive effects may be more beneficial if ambulatory prior to use of the TT.[7] Some researchers found less effect for gait speed and walking endurance[7] for

individuals with chronic stroke but others found improved cardiovascular fitness and walking function.[12] Use of TT did not have an effect on level of independence in walking[7] or on gait coordination measured through temporal and spatial parameters.[8]

In a 2016 document for the American Heart Association/American Stroke Association, endorsed by the American Academy of Physical Medicine and Rehabilitation and the American Society of Neurorehabilitation, Winstein et al[5] produced *Guidelines for Adult Stroke Rehabilitation and Recovery*. This broad detailed guide reports the best evidence for intervention outcomes for gait remediation is found with intensive, repetitive, mobility-task training or with the use of an ankle-foot orthosis (AFO) in individuals who meet select criteria (levels of evidence, class I, level A). Group circuit training, cardiovascular exercise and strengthening interventions are reasonable approaches to improve walking (levels of evidence, class IIa, level A). Neuromuscular electric stimulation is reasonable to manage foot drop (level of evidence, class IIa, level A). Circuit training incorporates intensive, repetitive, mobility- task training.[6] Several other physical therapy interventions for mobility (gait) were evaluated including treadmill training (with or without body weight support, robot-assisted), acupuncture, transcutaneous electrical nerve stimulation (TENS), rhythmic auditory cueing, electromyographic biofeedback, virtual reality, neurophysiological approaches (neurodevelopmental treatment, proprioceptive neuromuscular rehabilitation), aquatic therapy, and pharmaceutical intervention. These interventions are graded as class IIb, level A (treadmill and robotic therapy) or level B (all others) except for pharmaceutical intervention (class IIb, level C). Interventions rated at level IIb, class A are considered reasonable to include, sometimes depending upon specific patient populations post stroke. Those evaluated as class IIb, level B

have a recommendation of *benefit uncertain* or *benefit not well established*, except for virtual reality training which is recommended as *may be beneficial*.[5]

The evidence reviewed suggests that repetitive, task-oriented gait and mobility training yields positive gait outcomes for individuals living with chronic stroke. Progressive challenge and intense work appear to be important factors in driving change.[5-6,8,14,24] Standardized protocols for design and dosing do not exist in the research lab or clinic.[6,14] While some research protocols may yield higher levels of dosing,[24] the use of progressive challenge and intense work has not necessarily become standard practice in the clinic. In a follow-up study from Lang et al's[34] earlier work, Kimberly et al[13] found that therapists provided a mean of 37.25 (± 47.52) repetitions of active lower limb activity and 185.20 (± 130.1) steps with gait training per therapy session when either was included for patients status post stroke in an acute care and rehabilitation hospitals. The therapy sessions lasted a mean of 29.11 (± 12.14) minutes.[13] In addition to lack of consistency in protocol for type and dosing, most studies relative to gait intervention do not address the impact or show effect of the intervention on the individual at the participation level.[5-6,8,24]

Constraint-Induced Movement Therapy

In UE rehabilitation following stroke, CIMT therapy utilizes standardized protocols for participant selection and dosing.[16,18,35-40] The origin for CIMT can be traced back to the 1950s to the principle work of neuroscientist Edward Taub and associates.[18,37-38] Taub and others[18,37-38] studied the neurophysiology of motor control and were interested in the role of sensory feedback in movement and motor learning. In his early studies with monkeys, one upper limb was deafferented. This led to complete sensory loss and a period of spinal shock in which motor responses were absent. After the spinal shock resolved, Taub and others[18,37-38] observed that

although the monkeys had the ability to use the lesioned limb, they did not. The monkeys learned to compensate quite well performing all daily tasks (movement, postural adjustments, manipulation) with the three intact limbs. Taub and colleagues[37-38] discovered if the intact upper limb was restrained, use of the deafferented limb would begin almost immediately. Continued use of the deafferented limb would result in increased skill. If the restraint was removed too quickly (1-2 days) the monkey would resort to neglect of the deafferented limb even though use was possible. If the restraint was maintained for a longer period (3 days or longer) use of the deafferented limb continued even after removal of the restraint. Training that utilized various food-based reinforcement techniques to encourage limb use improved use during the training sessions but did not carry over to the natural setting. Operant conditioning or shaping was then applied to part-task activities. The task was broken down into components. As the monkey successfully completed the part of the task, a reward was given. The task was gradually made more difficult; success was rewarded on a consistent and frequent basis. As the skill improved, various parts of the task were carried out for longer periods with more complex steps. This process "shaped" the motor response. The use of shaping techniques resulted in generalizability of use to the natural environment not seen with the restraint alone.[37-38]

Taub and colleagues[18,37-38] theorized that the deafferentation with subsequent permanent sensory but temporary motor loss led to compensation with intact limbs which contributed to learned non-use of the deafferented limb. Intervention that restricted use of the intact limb made use of the affected limb more appealing and overcame learned non-use. As research on neuroplasticity evolved and as CIMT studies were carried out with human subjects, Taub[19] and others[15,17] began to recognize that cortical reorganization may be a mechanism to partially

explain the positive outcomes associated with CIMT. Increased use of the limb promoted cortical reorganization and, in turn, this cortical reorganization made use of the limb easier.[15,17-19]

Constraint-Induced Movement Therapy: The Upper Extremity Protocol

Inclusion criteria. The inclusion criteria for participation in CIMT studies has remained largely unchanged since the intervention was initially applied to participants' status post stroke.[15] Participants must have some residual function in the more-affected limb. Standard inclusion criteria include: at least 20 degrees of active wrist extension and 10 degrees of active finger extension at each metacarpalangeal and interphalangeal joint, all digits.[36,38] Wolf et al[16,39] in a multi-center RCT found statistically significant improved outcomes for two CIMT groups, one considered high functioning (meeting common inclusion criteria above) and one low-functioning (at least 10 degrees active wrist extension, at least 10 degrees thumb abduction/extension and at least 10 degrees of extension in two other digits). Both intervention groups (high and low functioning) had statistically significant positive outcomes compared to usual care. The low functioning group had no statistically significant differences in outcomes compared to the high functioning group.

Intervention elements. Morris et al[15] provide a detailed description of the treatment components of the CIMT protocol in a 2006 paper. The three components are: 1) repetitive, task-oriented training, 2) adherence-enhancing behavioral strategies (also called the transfer package), and 3) constraint. The repetitive, task-oriented training is broken down into two sub-components called shaping and task practice. The shaping sub-component of repetitive, task-oriented training consists of part-task practice. Shaping is a behavioral technique. In the context of CIMT, shaping as a sub-component describes part-task practice where frequent, positive reinforcement is used to enhance motor performance. Reference is additionally made to the use of shaping as a behavioral

approach applied less frequently during task practice. Task practice, as a sub-component of repetitive, task-oriented training focuses on performance of a functional task. Positive feedback and successive challenge are also provided, although less frequently compared to the shaping sub-component. Adherence-enhancing behavioral strategies are outlined in the transfer package. This component includes multiple strategies designed to continue elements of the protocol outside the clinic, during the intervention period. The final component is the constraint. The constraint typically takes the form of a bulky mitt worn on the less-affected UE. The mitt limits the assistance that can be provided by the more functional UE and serves as a reminder not to use it.[15]

Repetitive, task-oriented practice: shaping. The term "shaping" comes from the psychology literature and studies utilizing operant conditioning.[38] When part-task training is used for motor skill development, the task is broken down into parts, as described in the original research on monkeys. The parts of the task are then utilized as an exercise or activity and performed in succession, although not necessarily until the whole can be achieved.[37] In CIMT, the therapist or assistant selects a part-task that the participant has the capacity to complete. Success is rewarded with praise. The part-task is then made more difficult; the participant is encouraged through praise and knowledge of results and the cycle continues.[15,17-19,38,40-41]

Shaping involves:

a) providing immediate and very frequent feedback concerning improvements in the quality of movement,
b) selecting tasks that are tailored to address the motor deficits of individual participants,
c) modeling, prompting, and cuing of task performance, and

d) systematically increasing the difficulty level of the task performed in small steps when improvement is present for a period of time.[41(p1)]

To elaborate further, an example of shaping for the UE is provided. Part of the task of picking up a block is to reach with extended fingers. In part-task training, the individual may be asked to tap a block positioned one foot away with extended fingers. As the individual reaches for the block with extended fingers, he is praised as he nears or reaches the target. The individual received both internal and external confirmation of task achievement. To increase the complexity of this task, the block may be moved further away or the individual may be challenged to increase the number of repetitions completed in a given period. Cueing (i.e. "stretch your fingers") or other forms of assistance (i.e. a physical support to make reaching easier) can also be provided. If the task is too difficult, it is made easier. Success is important. As success is achieved, the goal is extended and the motor response is "shaped".[15,17-19,38,40]

Repetitive, task-oriented practice: Task practice. While shaping is focused on part-task practice with frequent positive reinforcement, task practice focuses on performance of whole tasks.[15] Positive reinforcement and purposeful task selection to ensure success remain integral to this sub-component. To extend the example from above into task practice, the individual may be instructed to pick up the cup and place the cup on a shelf, as if putting dishes away. Shaping and task practice activities do not have to be related. Additional examples for task practice included folding laundry or making a sandwich.[15,17-19,38,40]

Adherence-enhancing strategies: The transfer package. The transfer package is designed to assist with adherence to the protocol when out of the clinic. The transfer package is comprehensive. The elements are: behavioral contract, daily home diary, Motor Activity Log, problem solving, home skill assignment, home skill assignment after treatment, and post-

treatment telephone contact.[41] The behavioral contract is signed by the participant and caregiver and is an attestation to intent to comply with all recommendations. The daily home diary is used to record daily activity completed as specified in the behavioral contract. The Motor Activity Log (MAL) is a tool by which performance of 30 common ADLs is tracked. Participants' rate their ease in completing the tasks with the more-affected UE. Problem solving occurs daily as the therapist reviews the home diary and MAL. When problems are identified the therapist and participant work together to find solutions. For example, if a participant is worried about spilling his drink, the therapist might suggest filling the cup half-full. The home skill assignment requires daily task practice at home. Participants are given five easy and five more difficult ADL tasks they are to complete using the more affected limb. The home skill assignment after treatment is developed towards the end of treatment. Seven skill lists are developed for use each day of the week. The list contains three repetitive 15 – 30 minute tasks and seven ADLs. Post-treatment telephone calls are made weekly for one month after treatment to continue problem solving.[15,41]

Constraint. The most common form of constraint is the bulky mitt. However, the constraint can also include any mechanism used that promotes use of more-affected limb such as verbal cueing.[15]

Dosing. The protocol duration is six hours per day of therapist or assistant supervised repetitive task-oriented training, with adherence strategies employed during all outside-of-clinic time (mornings, evenings, weekend(s) and constraint of the more affected limb 90% of the waking hours. This protocol is maintained for two to three weeks, with individuals who have more severe impairments receiving three weeks.[15]

Intensity is managed through progressively increasing task difficulty. Shaping is dosed in ten 30-second trials for each part-task exercise or activity.[15] In an online supplement to work

published in 2013, Taub et al[41] describe the dosing more specifically as "sets of 10 discrete 30 sec trials with 1 min rests between trials and longer rests between sets of trials as needed to reduce fatigue. Approximately twenty-five trials are given per hour…"[41(p1)] Task practice activities are performed for 15 to 20 minutes.[15]

The placement and cycling of shaping and task practice within the six-hour day are not specified in the literature. Rest is offered between and within the two intervention sub-components.[15] Review of the literature from researchers in Taub's lab shows reference to a large bank of tasks used for shaping and task practice, with progressions outlined.[15,35-36] Only limited examples are provided in published work.

The transfer package is designed to help the participant make a transition from use of the more involved UE in the clinic to use in the home (and community) environment. As detailed above, the transfer package is very extensive. Adherence to the package increases the use of the more affected extremity and is an integral part of the CIMT protocol.[15,41]

Constraint-Induced Movement Therapy Upper Extremity: The Evidence

The Extremity Constraint Induced Therapy Evaluation (EXCITE) trial[39] was a prospective, multicenter, single-blind, RCT completed January 2001 through January 2003. Two hundred twenty-two individuals participated in the trial. The experimental group (n = 106) received CIMT and the control group (n = 116) received usual care which consisted of no care, pharmacological care or physical therapy care. Time since stroke ranged three to nine months. The experimental group was stratified into low and high functioning as described in the inclusion criteria (for the CIMT protocol) above. The study protocol included repetitive, task-oriented practice with sub-components of shaping and task practice as described above, restraint use as described above, and use of the transfer package as described above except the home skill

assignment consisted of two to three home assignments versus ten as in the original protocol. The home skill assignment after treatment was altered to encouraging 30 minutes of task practice daily after the intervention period ended. There were only minor differences in the groups at baseline (comorbidity of diabetes and performance on one component of a baseline test). Retention testing occurred at four, eight and 12 months. Seventy-six percent returned for retention testing as 12 months. The CIMT group showed larger improvements in most primary and secondary measures for quality and speed of movement and quality and amount of use of the more affected UE, at post-treatment testing ($P < .05$). Most of these outcomes persisted at 12 months.[39]

There are numerous published studies of various rigor regarding modified versions of CMIT.[9,42-44] A quick search on Pubmed yields 165 studies. The purpose of this section is to provide a brief overview of some of the manipulations with outcomes relative to work with the stroke population to convey the breadth of the work. Page et al[44] utilized a single-blinded RCT with participants a least 12 months post stroke. The experimental group received 30 minutes of one-on-one therapist sessions three times per week for 10 weeks. Sessions consisted of shaping similar to the procedures described in the shaping section above. Throughout the 10 weeks, the participants also wore a constraining hemi-sling five hours per day, weekdays, during the hours they would most likely need to use the UE for ADLs. A behavioral contract was utilized to assist with adherence. There were no significant differences in the baseline characteristics of the groups (mCIMT, usual care and no treatment). The mCIMT group had significant increases in outcome measures for Amount of Use and Quality of Movement scales. Participants in the mCIMT group reported doing more with the more affected limb throughout the study period. The intervention helped them realize they were capable of doing more with the affected limb.[44]

Lin et al[43] use a pre-test, post-test RCT with two groups; participants were at least 12 months post stroke. The experimental group received two hours of intensive training per weekday and wore a mitt on the less affected hand six hours per weekday for three consecutive weeks. Intensive training included activities such as picking up marbles and combing hair. Baseline characteristics were similar in both groups. Kinematic analysis showed significant positive change in favor of the experimental group for reaching and grasping ($P = .02$) and movement strategy use with better feedforward control ($P = .05$). Improvements were also positive in favor of the mCIMT group for improvements on the Motor Activity Log ($P < .001$) and Functional Independence Measure ($P = .02$).[43]

Brogårdh and Sjölund[42] utilized the standard protocol of six hours per day, two weeks, and components shaping, task practice, and the mitt 90% of the walking day. Instead of one-on-one sessions, small group sessions were utilized with two to three patients per one therapist or other staff. In addition to shaping and task practice, participants completed fine motor tasks, strengthening with use of weights and ADLs such as cleaning, playing games and indoor sports. After the two-week training period, the participants were randomized into continued mitt use group or discontinue mitt use group. The mitt use group wore the mitt for 90% of the day, every other day for periods of two weeks, during three months. Hand function, amount of use and quality of use significantly improved following the mCIMT intervention. There were not additional benefits from the extended mitt use and adherence was difficult.[42] Brogårdh and Flansbjer[9] reassessed the participants after four years and found the improvements in hand function were maintained.

Taub et al[35] stated that the TP is missing from many studies that purport to utilize the CIMT or a modified CIMT (mCIMT) protocol. Improved use outside the clinic is the most

important outcome of any intervention. The TP is designed to assist with adherence and subsequently carryover of function obtained in the clinic to home.[15,41] To examine the contributions of the TP and shaping to the CIMT protocol, Taub et at[35] used a 2x2 factorial components analysis to assess the role of the TP and shaping. The four groups were shaping plus TP (n = 11), repetition plus TP (n = 11), shaping without TP (n = 12) and repetition without TP (n = 11). The intervention lasted 10 consecutive weekdays for three and one half hours per day training. The amount of contact with in-laboratory treatment and therapists was equal in all groups. The with-TP groups wore the mitt 90% of the waking hours. The without-TP only wore the mitt during laboratory practice. Shaping and task practice (referred to repetition in the study) were completed as outlined in the CIMT UE protocol section of this paper. The TP was completed as described in the same section, including the home skill assignment after treatment and follow-up phone calls. Eighty-nine percent completed the study with dropouts dispersed equally among groups.[35]

Outcome measures consisted of the MAL and the WMFT. Results indicated that inclusion of the TP with shaping or task practice yielded 2.4 times greater use of the affected extremity ($P < 0.001$) compared to use of either component without use of the TP. These gains persisted at 12-month follow-up. Use of the TP and shaping protocol enhanced motor capacity of the affected UE greater than TP and task practice ($P < .05$). The TP had the greatest individual effect but shaping also brought statistically significant improvements. In a sub-study, an additional group was randomly selected to receive repetition without use of TP, however this group then received weekly phone calls the first four months following treatment. The baseline characteristics of the sub-study group and the outcome from repetition without TP were consistent with findings of the same group that received the same intervention in the main study.

Six months after treatment, the sub-study group made half the gains that the repetition plus TP group made compared to the repetition group without TP. The gains were not sustained at 12 months. The authors concluded that the sub-study indicates other elements of the TP, not just the follow-up phone calls, are necessary to make long-term MAL gains. For the main study, the authors concluded that the use of TP enhances spontaneous use of the more affected UE and maximum motor capacity and shaping more specifically enhances the later.[35]

In a 2015 Cochrane Review, Corbetta et al[45] sought to "assess the effects of constraint-induced movement therapy (CIMT) on ability to manage daily activities and on the recovery of movement in the paralyzed (sic) arm after a stroke".[45(p2)] Forty-two studies published through January 2015 were utilized for the review, including several reported on in this paper.[37,39,43-44] Collectively, study participants had some residual function in the UE most-affected by stroke. Methods varied between hours of constraint and amount of active use required with the more affected UE; CIMT and mCIMT studies were included. Intervention groups were compared to either usual care or no intervention. Eleven studies assessed the effect of CIMT on improving disability. There is no evidence from these studies that CIMT (meaning CIMT or mCIMT) has a positive effect on overcoming disability. Significant improvements were not made or reported in ability to use the more affected UE for ADLs. Twenty-eight studies demonstrated that CIMT (meaning CIMT or mCIMT) was superior to usual care or no treatment in improving movement of the more affected UE. The quality of the evidence was considered low for disability and very low for movement. The authors noted that these findings differ from a 2009 Cochrane Review in which 19 studies were evaluated.[45]

Constraint-Induced Movement Therapy Applied to the Lower Extremity

Constraint induced movement therapy applied to the LE is considered mCIMT.[10-11] Interest in applying CIMT to LE intervention and gait following stroke has grown over that past decade and more studies have been published. The concept of learned non-use may not be fully applicable to the LE as the LE cannot be fully neglected following stroke if some form of transfer, standing, and/or gait is attempted. However, impaired sensorimotor status may lead to compensatory patterns previously described in the Common Lower Extremity Impairments section of this paper. The term *learned misuse* has been proposed to replace learned non-use.[15,18,19] Misuse also contributes to cortical reorganization after stroke, but in a manner that may hinder, not facilitate recovery in the more affected limb.[15,17,19]

Lower extremity CIMT protocols vary in many regards. Selection criteria ranged from barely ambulatory to ambulatory[18]; with or without assistive device and/or orthosis[10-11]; some active flexion and extension at the hip, knee, and ankle of the affected LE[11]; or remaining motor impairment in the affected limb[10]; and six months or longer post stroke.[10-11] Most studies[10-11] excluded participants who had cardiopulmonary and/or orthopedic conditions that would affect their ability to participate in a rigorous exercise program. Sample size ranged from five[10] to 38.[19]

Duration of the intervention varied among studies. Taub et al[18] initially used seven hours per day for three weeks, but over time implemented an initial start of six hours per day with a gradual decrease to three hours per day over a three-week course.[19] Six hours per day for two weeks was common.[10-11]

Interventions for the LE CIMT included massed practice with functional activities such as treadmill walking (with or without body-weight support),[11,18] sit to stand,[18] lie to sit,[18] step climbing[18,10] cycling,[10] pool work,[10] functional strength training,[10] coordination, speed, and range

of motion exercises,[11] weight transfer,[10] and weight bearing[11] activities and walking over a variety of surfaces.[10-11] If specified, dosing for the active portion ranged from 15 – 30 minute bouts throughout the day[11] to 40 minutes of activity every hour.[10]

The protocol for the transfer package ranged from nothing[10] to one-half hour per day[19] to wearing of a mildly noxious stimulus (nubby insole) on the less affected side 90% of the waking hours to remind the participant to avoid overweighting the less affected side.[11] One study protocol included the use of a restraint of the less affected LE during the clinic intervention period.[10] Others used various mechanisms to provide sensory feedback to minimize use of the less affected LE[11,19] or to increase use of the more affected LE.[19] Most studies reported a one to one ratio for participant to assistant[10,19]; one used a group design with three to four participants for one to two assistants.[11]

Gains reported included improved ambulation status from fully dependent to fully independent or minimal assist,[18] improved gait coordination,[18] statistically significant improvement on some outcome measures including LE function[10] (Fugl-Meyer), fall risk[10-11] (Timed Get Up and Go), LE weight distribution,[10] gait speed,[11] dynamic balance[11] (Four Square Step Test) and walking endurance[10] (Six Minute Walk Test). Retention of results was reported as positive for many outcomes at three and six months,[10] one year,[11] and two years.[19]

Limitations included lack of control groups,[10-11,18-19] lack of blinded assessors,[10-11] small sample sizes,[10-11,18] poor generalizability of results to the larger stroke population with multiple sequalae,[11] and difficulty measuring application to the real world.[18] Critical details were lacking in the LE CIMT studies reviewed. Methodology was often not described in detail, especially relative to the application of shaping[10-11,18-19] and results were sometimes reported in general terms (i.e. significant gains made) versus objective data.[18-19] Many authors[10-11,18-19] referred to the

use of shaping in their methods, but without sufficient detail to allow replication of their LE shaping protocol. Authors did not make a distinction between whole and part-task activities but primarily described the repetitive, whole task activities.[10-11,18-19] There was more discussion on the inclusion of whole-task practice or continuous gait (treadmill training and overground walking most specifically) than inclusion of pre-gait, part-task activities.[10-11,18-19] Shaping, in UE CIMT, is applied more frequently and systematically to part-task activities.[15,41] The LE CIMT intervention appears to rely heavily on task practice vs. shaping. In UE CIMT shaping enhanced maximum motor capacity.[35]

Study Hypothesis

Individuals living with chronic stroke experience ongoing body function and structure impairments, activity limitations and participation restrictions. Impairments in the more affected limb likely contribute to compensatory patterns that further decrease use of the limb and/or encourage compensation with overuse of the less affected lower limb. Impairments contribute to activity limitations and participation restrictions.[2,4,21] Rehabilitation literature reveals a long history of intervention for gait following stroke. Many interventions show positive effects.[5-6,8,10-11,14,19] The most consistent variable in gait intervention studies with positive effects is the inclusion of intensive, repetitive practice.[5,14] The dosing for intensive, repetitive practice is not standardized.

Constraint-Induced Movement Therapy utilizes a standardized protocol for UE intervention post stroke and application of CIMT to the UE motor control and function has been studied extensively with positive and long-lasting results reported.[15-19,35,38-41,44-46] Application of the UE protocol to LE studies has been less consistent with researchers adopting part but not all

of the UE protocol. The application of shaping to part-task activities for LE intervention has not been specifically studies.

Part-task, pre-gait exercises, or activities should address common lower limb impairments including lower limb coordination,[21] adaptability,[8,29] increased stance time and swing efficiency.[8,25-30] Gait-related exercise should incorporate activities such as holding items while stepping, reaching and stepping, head turns and stepping, and stepping in different directions. The LE exercises should be performed on a variety of compliant and non-compliant surfaces and may include stepping up and down from various height stools.[30] This study aimed to determine the feasibility of applying the principles of shaping to LE part-task, pre-gait activities for individuals with chronic stroke who live in the community and continue to experience mobility impairment.

Method

Study Design

A prospective, repeated-measures within-group design was used to evaluate the primary study hypothesis of feasibility and the secondary hypothesis of positive treatment effect when incorporating a shaping protocol into a LE exercise program for people with chronic stroke. Participants were evaluated three times across the study before, immediately after, and 16-19 weeks after completion of the intervention (baseline, post-test, and retention, respectively). The study was approved by the Institutional Review Boards (IRB) at the University of Indianapolis (study #0646) and Gannon University (14-06-02) prior to participant recruitment. Approval from both institutions was retained throughout the study period. Data were collected August 2014 – February 2016.

Participants

Several authors[47-49] make recommendations for feasibility study sample size. The sample must be representative of the study population and large enough to provide data regarding the feasibility aspect of the study. Moore et al[47] cited the work of van Belle[50] and Julious[51] to recommend a sample size of 10 to 15, with 12 being the preferred minimum number of participants for pilot or feasibility studies. Moore et al[47] reported that "…increasing the sample to 12 participants made a profound difference in the width of confidence intervals for mean response, whereas increasing the sample size beyond 12 participants did not."[(p6)]

A convenience sample was recruited from the greater Erie, Pennsylvania area within a 25-mile radius of Gannon University where the study was held. The aim was to enroll 12 to 15 individuals.

Inclusion criteria. The following inclusion criteria were used:

- Community dwelling (lives in home or apartment alone or with another who's primary role is not caretaker)
- Age 18 years or older
- Sustained an ischemic or hemorrhagic stroke at least six months prior to the start of the study
- Ambulatory with or without an assistive device, with or without orthosis, requiring no more than occasional minimal assistance for balance to ambulate short distances within their home
- Presence of self-reported residual motor impairments in the involved LE affecting movement patterns and gait, confirmed by observation and subsequently during baseline testing (Fugl-Meyer Sensorimotor Assessment (LE) and electronic walkway)

- Ability to follow a three-step command with or without supplemental visual demonstration
- Received medical clearance to participate in the study
- Agreed to attend all intervention sessions throughout the entire study period

Exclusion criteria. The following exclusion criteria were used:

- History of second or recurrent stroke including a transient ischemic attack
- Inability to participate in intermittent standing activities for greater than one hour
- Presence of co-morbidities or pre-existing cardiovascular conditions that would prohibit gait training and exercise
- Presence of a pre-existing neurological or current musculoskeletal conditions that limit gait ability separate from the effects of the stroke
- Participating in physical therapy sessions during the intervention period

Data Collection

The onsite principle researcher was responsible for data collection. Data collection forms were utilized during testing and intervention, as detailed below and shown in appendices. Data were transferred from the forms to an Excel spreadsheet after all data were collected. This process was completed by the primary onsite researcher and checked by two assistants. The Participant: Eligibility and General Information Form (Appendix E) was used to screen interested persons for the study, prior to informed consent. The Demographic Form (Appendix F) was used to confirm eligibility criteria and to collect demographic information used to describe the study participants. The test tracking form (Appendix G) was used to record data from baseline, post- and retention-test sessions. The Daily Intervention Log (Appendix H) was used to record attendance, reasons for absence, vital signs, trial and bout summary, and notes

(observations, participant statements). Trial and bout summary information was taken from the Trial Tracking Form. Finally, the Trail Tracking form (Appendix I) was used to record repetitions for each trial, trial length (e.g. 30 seconds), total time for each bout, rate of perceived exertion (RPE) before and after each bout, and number of exercises completed per intervention day.

Instruments

The Fugl-Meyer Assessment Lower Extremity. The Fugl-Meyer Assessment Lower Extremity [FMA-LE (Appendix A)] is considered a gold standard for quantifying recovery of function following stroke and has been used in many clinical trials.[52-54] A 3-point ordinal scale is used to objectify motor impairment and function. The scale covers five domains for motor and sensory function, balance, range of motion and pain. Subscales further quantify upper and LE function. The LE motor subscale was used in this study.[52-54] Intrarater reliability on the LE subscale has been found to be excellent in several studies (r = .96). Construct validity for the FMA-LE motor subtests was considered good when compared to several functional scales.[54]

Outcomes

Primary hypothesis: feasibility.

Study process: intervention attendance rate. Attendance was calculated as the number of days a participant attended the intervention. The intervention attendance rate was calculated as the number of participants who attended all 10 days. A benchmark was set at 80% will attend all 10 intervention sessions. While 100% attendance for all 10 days was desired, 80% accounted for unexpected events in 20% of participants.

Study process: intervention completion rate. The intervention was considered complete if a participant attended all 10 sessions, was absent but returned to finish the intervention within the

10 day intervention period or if the participant missed the first or final day for reasons unrelated to the study. The intervention completion rate was calculated as a percentage of those who completed the intervention. A benchmark was set at 80% will complete the intervention. While 100% completion was desired, 80% accounted for unexpected events in 20% of participants.

Study protocol: safety. Protocol safety was measured by fall rate (#falls/#participants) and emergency medical call rate (#calls/#participants). A benchmark was set at 0% will fall or require emergency medical care. It was expected that study personnel would be able to provide sufficient guarding, a safe exercise environment, and individually tailored exercises to prevent falls. It was expected that study personnel would be able to utilize measures of physiological tolerance, participant RPE and monitoring for signs and symptoms of physiological intolerance to alter the intervention if signs of intolerance developed. Zero percent was reasonable for a small sample size.

Study protocol: tolerance. Tolerance for the planned dose was measured by the percentage of participants who were able to complete the intervention using 30-second trials for each bout of each exercise, each day. A benchmark was set at 80% will complete the intervention using 30-second trials. Since tolerance for this dosing is not known, it is reasonable that 20% may not be able to complete the intervention using 30-second trials.

Study protocol: repetitions. Mean of repetitions from the first three days was compared to the final session count. Using the mean repetitions of the first three days for baseline allowed the focus to be on identifying the best exercises to use for the remainder of the sessions versus on accruing repetitions.

Management: study personnel. Number of study personnel needed to safely and efficiently implement the testing and intervention was monitored. It was anticipated that at least

two were needed per participant. While two is not ideal for use in the clinic, it was anticipated that one would be needed to guard the participant and one needed to set-up, implement and track the activity/exercise associated with the given trial and bout. A benchmark was set at 80% will require two or fewer assistants for safety and process. It was reasonable to expect that 20% may need more than two study personnel to maintain safety or manage the exercise process.

Management: ease of providing positive reinforcement. The application of positive reinforcement is an integral part of shaping. Because it was anticipated that the implementation of the intervention bout would be hectic, no attempt was made to track positive reinforcement. The importance of providing positive reinforcement was stressed during training of study personnel. This management construct was described in general terms in the results, but not directly measured by the research team.

Allocated resources. Space and equipment utilized were consistent with what would be found in a physical therapy clinic of a medium size hospital. It was anticipated that the resources allocated for space and equipment would be sufficient. The resources construct was described in general terms in the results, but not directly measured by the research team.

Secondary hypotheses: treatment effect.

Lower extremity motor function. The Five Times Sit to Stand [5xSTS (Appendix B)] is a body structure and function-domain performance-based functional measure of LE strength.[31] In this ratio scale measure, five repetitions of sit to stand are timed. Time has been significantly associated with knee flexor strength in subjects with stroke ($P < .006$). Intrarater, interrater, and test-retest reliability were found to be excellent [intraclass correlation coefficient (ICC) = .97-.98, 1.00, .99-.1.00, respectively].[55]

Gait activity. Gait activity was measured with the Functional Gait Assessment [FGA Appendix C)] and the ProtoKinetics Zeno electronic walkway and PKMAS software (Zeno Corp., Havertown, PA). The FGA is an activity-domain performance-based measure of gait and gait tasks.[31,53] This ordinal scale measure utilizes a four-point scale to rank performance on 10 gait tasks that are commonly associated with functional and efficient gait.[31,53,56] Postural stability (use of assistive device or personal assistance), path of travel (ability to maintain forward/backward direction in a 12 inch path of travel) and gait efficiency (speed, change in speed, change in gait pattern) are evaluated. Tasks require gait on level surface, gait with a change in speed, gait with horizontal, gait with vertical head movements, gait with a turn and stop, continuous gait that requires stepping over an obstacle, gait with a narrow base of support, gait with eyes closed, backwards gait, and gait up and down stairs. Minimal Detectable Change (MDC) has been established at 4.2 points or 14.1% change for persons with chronic stroke. Test-retest reliability was found to be excellent (ICC .95). Floor and ceiling effects were excellent.[56] Cut-off scores for predicting falls in older adults (60 – 90 years of age) have been established for a score of ≤ 22/30 (sensitivity 100%, specificity 72%, positive likelihood ratio [LR] = 3.6 and negative LR = 0).[57]

The ProtoKinetics Zeno electronic walkway provides ratio-level measures of gait and was used to capture spatial (step length) and temporal (stance time, swing time, velocity) measures of gait. The Zeno electronic walkway with video is 4 foot in width and 16 foot in length, constructed of 36,864 pressure sensors arranged on 0.5-inch centers in a 96 x 384 grid. The active pressure sensors are 0.4-inch squares with 16 levels of dynamic pressure, dual control. The PKMAS software detects footfalls, alongside assistive devices, and outputs temporal (timing), spatial (distance), pressure, and center of mass estimated (COMe) data. The

software exports 140 variables including velocity, cadence, step length, step time, toe in/out angle, instantaneous center of pressure (COP), COMe, COP for individual footfalls, total pressure, and path efficiency. Symmetry values for step length, swing time and stance time[23,25-26,29] and gait velocity[23,25,27-28,30-32] were obtained through walkway data. Meaningful change categories for gait speed change have been established in older adults with mobility impairments, patients with subacute stroke and community-dwelling older adults. Small meaningful change ranges .04 to .06 m/s and substantial change ranges .08 to .14 m/s.[58]

Participation. The Activities-Specific Balance Confidence Scale [ABC (Appendix D)] is considered both an activity-domain and a participation-domain self-report tool which measures confidence in balance while performing various walking tasks.[52,59] This ratio scale measure requires users to rate their confidence in performing 16 walking tasks on a scale of 0 (no confidence) to 100 (completely confident). Tasks vary in complexity from walking around the house, to walking in a crowded mall and being bumped into, to stepping onto or off-of an escalator while holding packages such that the railing cannot be held. Test-retest reliability for all items combined has been found to be excellent (ICC .85); item level test-retest reliability has been found to be adequate to excellent (ICC ranged from .53 [walking up/down stairs] to 0.93 [walking up/down a ramp]).[60] A score of 81.1 predicted that an individual with chronic stroke was not likely to have a history of multiple falls (positive LR = 3.6; negative LR = 0.00), thus establishing a cut-off score.[61] Floor and ceiling effects were found to be minimal for three items and zero for the total score.[62] Scores lower than 50 indicated a low level of function. Scores between 50 and 80 were associated with a moderate level of function and over 80 with a relatively high level of function.[63]

Procedures

Testing procedures, exercises, safety procedures and safety monitoring used during testing and intervention were considered standard care, not experimental. The manner in which the exercises was delivered was experimental.

Recruitment. Participants were recruited locally through distribution of a flyer (Appendix J) and through word of mouth. Flyers were placed in public and private facilities including local medical and physical therapy clinics. Individuals were solicited by flyer through the local stroke support groups and through the Gannon Doctor of Physical Therapy Community Volunteer pool. This study was open to all individuals who met study inclusion and exclusion criteria.

Eligibility determination. Interested persons were told about the study using the Initial Contact Script (Appendix K). Individuals who indicated continued interest were screened using the Participant: Eligibility and General Information Form. If it was determined during the baseline consent screening that the interested person did not qualify for the study, personal information was not kept unless the individual requested contact information be kept for future studies. If the interested person appeared to meet eligibility criteria and wanted to continue with study enrollment, an appointment was made for study orientation.

Orientation and informed consent. Study purpose, potential benefits and risks, and participation requirements were reviewed during orientation and through the informed consent process (Appendix L). The potential participant was allowed to have a support person present during the process. Potential participants and support persons if applicable had the opportunity to ask questions. If the potential participant wanted to continue, Informed Consent was signed and witnessed. A copy was issued to the participant. Once consent was obtained, demographic

information was obtained using the Demographic Form. At this time, the eligibility criteria were verified through medical history; the form for medical release (Appendix M) completed.

Testing. There were three testing periods, baseline, post-test and retention testing. Each testing session took approximately 90 minutes. Vital signs [heart rate (HR), blood pressure (BP), respiratory rate (RR), partial oxygen saturation (PaO_2)] were taken after the participant rested five minutes. If resting vital signs were high (BP < 140/90mmHg, HR > 100bpm, RR > 20 bpm) or low (PaO_2 < 90%) or were considered not normal for participant by self-report prior to testing, additional rest was given and then measured again. If vital signs remained high or low for the given participant or if the participant was symptomatic, the participant's primary care physician, who provided the medical clearance for the study, was contacted for advice.

The order of testing was randomized for each participant and then maintained each testing period. The Test Tracking Form was utilized to record data and organize the testing session. Baseline testing was completed three to five days prior to intervention. Baseline testing included the FMA-LE, FGA, 5xSTS, ABC, and gait metrics on the ZenoWalkway. Post-testing was completed three to five days following the last day of intervention. One participant was tested 10 days following the last day intervention secondary to hospitalization during the post-test period. Post-tests included FGA, 5xSTS, ABC, and gait metrics on the ZenoWalkway. Retention testing was completed 16 to 19 weeks following that last day of intervention and included the same post-test measures. Testing and intervention occurred over a 14 month period with intervention dates 8/11/14 – 8/22/14, 9/8/14 – 9/19/14, 10/6/14 – 10/17/14, 4/27/15 – 5/8/15, 9/14/15 – 9/25/15, and 10/5/15 – 10/16/15.

Fugl-Meyer Assessment of Lower Extremity. The FMA-LE was use during baseline to confirm limb coordination impairment and to classify participants according to severity.

Functional Gait Assessment. Items 1 – 7 and 9 were completed over the Zeno electronic walkway and video recorded. Item 8 (walking with eyes closed) was completed over tile as the walkway edge may have provided unwanted cues as to position. Item 10 was completed in a stairwell. Taped walkways 1x20 feet were positioned on the Zeno electronic walkway and tile, per test instructions. Walkway data, including video were not utilized in data analysis but were available if needed for review. Participants were allowed to sit and rest between test items if needed.

Five times Sit to Stand. Participants held arms across chest (if able) and moved from sitting to full stand to sitting, five times, as quickly as possible, using a standard height chair. If necessary, participants were allowed to push from the armrest. Participants had 1 to 2 warm-ups as needed to assure understanding and readiness. The timer started at the word GO and ended after sitting the last time. The test was timed once.

Activities Specific Balance Confidence Scale. Test instructions were read and/or reviewed with the participant and reiterated as needed. If a participant was unsure as to how to answer an item, the item was re-read with the instructions "how confident are you that you would be able to _____ without losing your balance or becoming unsteady."

Gait measures. Participants completed four passes across the 4 foot by 30 foot Protokinetics Zeno electronic walkway at their self-selected, usual gait speed. Participants used an assistive device and/or orthotic if they typically used such when walking within their home. Participants started walking off the walkway, turned off the walkway at the opposite end and repeated twice for four passes. While multiple gait measures were captured, only spatiotemporal measures of gait velocity, step length symmetry, stance time symmetry, and swing time symmetry were used.[25-26] The video data were not utilized for this study but were available for

recheck of data if needed. Walkway data were edited to remove data from any assistive device, foot drag, heel drag, incomplete footfalls and footfalls in the pass after incomplete footfalls. A footfall was considered incomplete if less than 90%, estimated by visual inspection, was on the walkway file. Additionally, footfalls in the first and last four feet of the walkway file were eliminated allow the participant to achieve a steady state for walking speed. For this edit, if more than 50%, estimated by visual inspection, was in the deletion zone, it was deleted.

Intervention. The intervention consisted of 10 sessions over five weekdays for two consecutive weeks. All exercises were done in standing with support if needed. Exercises were part-task, pre-gait exercises that required repetitive, alternating, random, patterned rhythmic stepping and/or kicking. There were no whole-task, continuous gait activities. Exercises were made more challenging in a number of ways including decreasing UE support, increasing repetitions, standing on an unstable surface, closing eyes, holding a glass of water. More details are provided below. All variables in this *Intervention* section were tracked and recorded on the Trial Tracking Form and/or Daily Intervention Log.

Monitoring physiological tolerance. Vital signs (HR, BP, RR, PaO_2) were taken at the beginning and ending of each intervention day, after the participant rested five minutes. If resting vital signs were high (BP > 140/90mmHg, HR > 100bpm, RR > 20 bpm) or low (PaO_2 < 90%) or were considered not normal for the participant by self-report prior to testing, additional rest was given and then measured again. If resting vital signs remained high or low for the given participant or if the participant was symptomatic, the participant's primary care physician, who provided the medical clearance for the study, was contacted for advice.

If the participant demonstrated an abnormal response to exercise, monitored through signs and symptoms, including HR, BP, RR, PaO_2, the activity was slowed or stopped, rest was

allowed with continued monitoring of signs and symptoms. This data, along with self-reported perceived rate of exertion, and observation (color, diaphoresis, anxiety) were utilized to determine if the participant would be allowed to continue, required to rest, if the physician needed to be contacted or if an emergency call was indicated.

A BCI handheld pulse oximeter (BCI Pulse Oximeter System, Hand-Held, Model 3301 from Smiths Medical ASD, Inc.) was used to measure HR and O_2 sat. A Polar Heart Rate Monitor (Polar F1 Heart Rate Monitor, from http://www.polar.com) was worn by each participant to allow continual monitoring of HR throughout the intervention, although it was recognized this might not have provided an accurate measure of tolerance if the individual was on a beta-blocker. Therefore, multiple measures were used to determine tolerance.

Monitoring self-reported tolerance. The RPE is a 15-point ordinal measure for self-reporting level of exertion,[64-65] used during intervention. The bottom of the scale, 6 equates to no exertion at all; the top of the scale, 20 equates to maximal exertion. Participants self-rated RPE prior to and after exercise. If a participant stopped the exercise secondary to self-reported intolerance, he/she was asked to provide an RPE from the exercise, once resting. Self-reported RPE between 11 (fairly light) and 14 (somewhat hard) and stable vital signs and symptoms were considered an acceptable measure of physiological stress[65] and the activity/exercise was continued after rest.

Monitoring pain. At the beginning of each intervention session and throughout the session as indicated, participants were asked, “How are you feeling”. If pain was reported, the Numeric Pain Rating Scale (NPRS)[66-67] was utilized to provide a self-report measure of pain. This commonly used is an 11-point self-report tool used to quantify pain experienced by the rater. Users rate pain on a zero to 10 scale. Zero is no pain and 10 is the worst pain imaginable.[31]

Once pain was reported, the level of pain was tracked until the rating was low (i.e. "2") and the participant indicated the pain was not excessive or interfering with intervention exercises or activities during the day. The development of pain was used to guide activity/exercise development or modification and to determine if physician or if an emergency medical call needed to be made.

Exercise design, selection, and implementation. Guidelines for exercise design were developed from the literature reviewed on shaping techniques,[15,38,40-41] part-task pre-gait exercises,[8] and common impairments in gait[23,25-26] and related LE coordination following stroke.[8,28-29] A bank of exercises was developed and utilized for this study to guide exercise progression (Appendix N).

a. Bout/trial: a bout of exercise consisted of 10 trials. One trial lasted 30 seconds. If a participant could not tolerate 30-second trials, trials were shortened to 20 seconds. Refer to Figure 1.
b. Rest period: a rest period was taken at the conclusion of each bout. The initial rest period lasted a minimum of 5 minutes. It was extended if indicated by participant tolerance. After the third day, rest times were shortened if indicated by participant tolerance. The three-day wait period allowed the study personnel to assess for delayed onset muscle soreness[66] which further guided exercise decisions.
c. Repetitions: the number of successful repetitions for each trial was tracked in real-time using a manual tally counter; recorded on the Trial Tracking Form and Daily Intervention Log. When the activity involved stepping, movement of the limb away from or movement towards the midline of the body or starting point was considered one repetition. For example stepping forward and then backward was counted as two

repetitions. Kicking activities were counted as one repetition per kick. Repetitions that did not meet the activity goal were not counted. For example, if a participant kicked at and missed the ball, it was not be counted.

d. Exercise selection: exercises were selected to address stance, swing, alternate stepping, random or patterned rhythmic stepping goals. Bouts were most often alternated between stance and swing or stance or swing and alternating, random, or patterned rhythmic stepping. If a participant reported leg fatigue or to avoid leg fatigue, trials within a bout were alternated between stance and swing guided by participant preference. The majority of exercises required transition over the stance limb (e.g. stepping forward and backward in stride stance). Bilateral and in-place exercises (e.g. knee bends, marching in place, standing knee flexion) were used to further accommodate fatigue.
e. Orthotics: if the individual used an orthotic device for gait inside the home, use was encouraged during intervention. An orthotic was only required if exercising without it contributed to unwanted instability or toe drag.
f. Upper extremity support: bilateral or unilateral UE support was used when needed to maximize ability to move LE and/or to achieve exercise goal. Support was provided from parallel bars, an Eva walker, bedside table, straight cane or through hand-held assist from research personnel.
g. Standing surfaces: included flat tile, foam, and steps.
h. Activity/exercise tools: small every-day items were used to help create movement goals. Bright colored pom-poms were randomly thrown near one foot to create a random stepping activity. Bright orange practice golf balls were used for kicking

activities. Hard plastic brown two-inch diameter furniture protectors provided a more difficult target for kicking. Badminton birdies, net down, provided a difficult toe or heel-touch target. Bright colored tape or flat bright colored discs were placed on the floor to create stepping targets. Several different step stools and a set of training stairs with bilateral handrails were used for toe or heel-touch activities or step-up/step-down activities. A metronome was occasionally used for rhythmic goals. A plastic squirt bottle with narrow opening could be held by the participant and was used to add challenge to the gait activity. The bottle could be filled with various amounts of water and could be replaced with a plastic cup to further increase the challenge.

i. Demonstration and manual cueing: was provided as needed to help the participant understand the movement goal, to assist with stability, safety, and quality of the movement. These techniques were decreased as soon as possible.

j. Training environment: coaching, verbal reinforcement, and praise were given throughout the trial, bout and day. Every repetition was marked with the use of a tally counter that gave an audible “click” each time the target was reached. At the end of most trials, the repetitions completed were stated aloud as they were recorded on the trial tracking form. When the participant was moving quickly (i.e. 30 contacts in a 30-second trial), occasional “credit” was given for a missed target. The study personnel and participant worked together to make sure the count was accurate. Most participants set personal goals for repetitions (i.e. beat the previous trial or yesterday’s total) and everyone cheered when goals were met. The environment was positive, energizing and fun. Negative feedback minimized. Every attempt was made to replace phrases such as “don’t do that” with “do this”.

k. Movement goal: perfection in movement was not required. If the movement goal was too difficult or easy, the parameters or activities were altered. Exercise parameters used to shape the movement goal included number of repetitions completed in a trial, bout, or day; maintenance of pace with a metronome; connection with a target (step to a target, kick a ball to a target, step to a height, etc…) with distance, direction or speed altered. Exercise difficulty was also increased by adding in head turning, holding a cup of water, standing on an unstable surface and/or keeping eyes closed, based on progress made, participant interest, and study personnel informal assessment of ability to benefit.

Study personnel. Study personnel completed the following tasks: guarding, monitoring, setting timers, and activity/exercise management during each activity/exercise. The complexity of these tasks varied depending upon participant needs, movement goals and activity. Guarding required either close supervision or light contact. This could be minimized for more able-participants through exercise set-up. For example, a more able participant may be safe working in the parallel bars, hovering hands over bars, with a chair behind in case quick sitting was needed. Study personnel monitored the participant for signs and symptoms of exercise intolerance and for achievement of movement goals. Multiple timers were set: 30-second timers, total bout timer; rest timer and intervention time. Activity/exercise management included set-up before, during and after the activity. For example, kicking exercises required continual manual placement of the target in front of the foot.

The onsite principle researcher was a licensed physical therapist with over 30 years of clinical experience. The onsite principle researcher oriented and trained the research assistants who were graduate students in the Gannon Doctor of Physical Therapy Program. The Study

Personnel Training checklist (Appendix O) outlines the training covered. Study personnel received an orientation to the purpose of the study, signs/symptoms of exercise intolerance, study protocol for management of intolerance and emergency management procedures. Participant privacy rights and right to refuse continued participation were reviewed. Research assistant certification in CPR, First Aid and Collaborative Institutional Training Institute (CITI) Training were confirmed.

Data Storage

Data were collected through paper-pencil and electronic means. Hard copy paper-pencil data were stored in a locked file in the faculty office of the onsite principle investigator. Access to the locked file was limited. Electronically stored data were secured with a passcode that only the principle, co-investigators, and research assistants had access to. The data were de-identified prior to analysis.

Data Analysis

Descriptive statistics were conducted for all variables to assess data quality, identify patterns of missing and out-of-range values, and evaluate the assumptions of statistical tests. Feasibility data (completion rate, attendance, study personnel required, falls, emergency calls, repetitions, trial length, increase in repetitions) are reported as frequency and percentages against benchmarks established a priori. Continuous variables (age, time since stroke, FMA, 5xSTS, ABC, FGA, gait speed, stance time symmetry, swing time symmetry, step length symmetry, repetitions) are reported as mean with standard deviation or median and interquartile range dependent on whether or not the data were normally distributed. Categorical variables (side of hemiparesis, type of stroke, gender, marital status, race/ethnicity) are reported as frequency and

percentage. For continuous variables, the assumption of normality was assessed using the Shapiro-Wilks test.

Repeated measures ANOVA was used to analyze differences across time using a last-observation-carried-forward approach[39] for missing data for one participant post to retention. Sphericity was assessed using the Mauchly's test and if the assumptions of sphericity were violated, the Greenhouse-Geisser results are reported. Bonferroni tests were used for post hoc analysis. Freidman's ANOVA was used to analyze differences across time for data that were not normally distributed, using the same carrying forward procedure for the one participant, post to retention. Post-hoc analysis of significant results was completed using Wilcoxon signed-ranks test and a Bonferroni correction at an adjusted alpha significance of .017. Outcome measures with significant findings were analyzed at post and retention time periods for correlation to total number of repetitions performed using Pearson for parametric data and Spearman rho statistics for non-parametric data. Correlations coefficients were interpreted based on the following: little, if any correlation was r = .00 - .25; low correlation was r = .26 - .49; moderate was .50 - .69; high was .70 - .89. and very high was .90 – 1.00[68] Data were analyzed using IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk, NY) and all comparisons were two-tailed and the level of statistical significance was set at $P < .05$.

Results

Fourteen individuals responded to solicitation. Three did not meet study inclusion criteria. One respondent was excluded secondary to a diagnosis of heat stroke and two were excluded through the screening and orientation process. One of the excluded had a recent history of dizziness with head turns and one had no observable gait disturbances.

Eleven individuals consented to participate in the study. Of those, 10 completed the entire study, including intervention and three test periods. One participant could not participate in the retention testing due to an injection in the LE prior to that testing period. The mean age of participants was 61 years and most participants were white, male, married, with left side paresis. Participant characteristics are presented in Table 1.

Primary Hypothesis: Feasibility

Results of the analysis of the feasibility data are presented in Table 2. Results of each objective that was addressed to determine the feasibility of the study process and protocol are presented below.

Study process: Intervention attendance rate. Attendance rate benchmark 80% will attend 10/10 sessions was not met. Seven of 11 (63.6%) participants attended 10/10 of the intervention sessions. Three participants had absences not related to the study. One fell at home at night and cancelled the subsequent session to allow rest. A second participant missed one session with reports of not feeling well with hesitation to provide specific details. A third participant was ill the final day and subsequently admitted to the hospital for prostatitis. One participant had a study-related absence. This participant was referred back to his physician with calf pain that was subsequently diagnosed as a gastrocnemius muscle strain (affected side). This participant missed two intervention sessions.

Study process: Intervention completion rate. The completion rate benchmark of 80% will complete the intervention was met. Eleven of 11 participants completed at least 80% of the intervention.

Study protocol: Safety. Study protocol safety benchmarks of 0% falls and 0% emergency medical calls were met. Contact was made to six of the participants' referring

primary care physician (PCP). The PCP for a participant with chronically high blood pressure was contacted during the baseline visit. The participant was under ongoing care and was asymptomatic. Blood pressure readings were reported to the PCP after each session and the physician provided continuing clearance for participation. This eventually resulted in PCP alteration of medication, as reported at the retention testing visit. During intervention, a PCP was contacted once for four participants secondary to high or low blood pressure. All contacts resulted in continued clearance with requests for ongoing monitoring during exercise. Two contacts led to physician follow-up with changes in blood pressure medication. As stated in the attendance rate section above, one PCP was contacted secondary to participant complaints of calf pain. The participant presented on day six of the intervention with complaints of affected-side calf pain. He initially attempted to participate but pain increased and the session was stopped without a complete bout. He was referred to his physician and that day was diagnosed with a calf strain. He missed the subsequent day and resumed day eight to complete the study, with clearance from the physician.

Study protocol: Tolerance. The study tolerance benchmark of 80% will complete 30-second trials was met. Ten of the 11 (90.9%) participants tolerated 30-second trials. A few participants occasionally needed to rest between trials of one bout and several needed increased rest time between some bouts, especially during the first week. These rests did not violate the protocol. The participant who subsequently developed the calf strain required modification day one to 20 second bouts with increased rest periods that were gradually decreased although the trial length was never increased.

Study protocol: Repetitions. The study benchmark to increase repetitions by 15% or greater was met. All participants demonstrated an increase in the number of repetitions by 15%

or greater. In addition, there was a statistically significant increase in the mean number of repetition completed during the first three days compared to the final session count 594.09 (154.67) and 1026.72 (273.22), respectively, $P = .003$.

Management: Study personnel. The management benchmark that 80% will require two or fewer assistants for safety and process was met (100%). Testing could be completed with one study personnel. Ten (90.9%) participants required two study personnel for intervention to manage safety, data collection during trials, exercise set-up during and between trials, and the provision of positive feedback. One participant completed the intervention with one study personnel.

Management: Ease of providing positive reinforcement. Positive verbal feedback was routinely, but not systematically provided during intervention. Repetition totals were routinely, but not systematically stated following each trial and/or bout and/or as a daily summary. Use of the tally counter for successful attempts provided clear, positive knowledge of results through the audible click. When a participant's pace of the intervention was fast, use of the tally counter was difficult, with occasional miscounts during a trial. When counting was off with the tally counter, the participant and researchers would work together to correct mistakes. The mistake frequency was not tracked; but mistakes did not frequently occur.

Allocated resources. The resources allocated for physical space and exercise equipment were sufficient to carry out the study plan. The intervention could be completed with equipment typically found in a physical therapy clinic including parallel bars, assistive devices, step stools, and items to create the exercise (e.g. non-slip targets to step on; items to kick). Low-tech, low cost items were purchased including bright tape, practice golf balls, and bad mitten whiffles.

Secondary Hypothesis: Treatment Effect

Results of the comparison of the 5xSTS scores, FGA scores, and ABC scores across time, from baseline to the retention visit are reported in Table 3. Each objective addressed to determine the effectiveness of the treatment are presented below.

Lower extremity motor function. There was a statistically significant increase in 5xSTS scores over time (P = .004). Post hoc analysis showed a significant increase between time period baseline to retention (P = .004) and but not baseline to post (P = .04) or post to retention (P = .96). Little to low correlations without significance were found between change scores of 5xSTS and total number of reps completed between time period baseline to post (r = -.06, P = .85), baseline to retention (r = .44, P = .42), and post to retention testing (r = .26, P = .45).

Gait Activity.

Functional Gait Analysis. There was a statistically significant increase in FGA scores over time (P = .003). Post hoc analysis showed a significant increase from baseline to retention (P = .006), but not baseline to post (P = .36) or post to retention (P = .18). Three (27.27%) participants met or exceeded the established MDC value of 14.1% between baseline to post testing and baseline to retention testing. Two additional participants exceeded the MDC value between baseline to retention testing, resulting in five (45.45%) individuals demonstrating clinical improvement over time. Low correlations without significance were found between change scores of the FGA and total number of repetitions completed between time periods baseline to post (r =.32, P = .34), baseline to retention (r = .27, P = .42) and a negligible correlation was found from post to retention (r = -.04, P = .90).

There were no statistically significant differences over time for symmetry with stance time, swing time, or step length (spatiotemporal parameters of gait). In addition, there was no

statistically significant difference over time for gait speed. However, from baseline to post, of the 11 participants five (45.45%) had improved gait speeds with change that ranged from .01 to .09 m/s. However, six (54.54%) had slower gait speeds with change that ranged from -.05 to -.10 m/s. Of the five participants who had improved gait speed at post, four continued to have improved gait speed at retention with final change scores ranging .07 to .20 m/s. One was not tested at retention. Of the six participants who did not have improved gait speed at post, three had improved gait speed at retention with final change scores ranging .02 to .06 m/s. The change scores for the remaining three participants who did not have improvement in gait speed at post continued to show a slowing of gait speed at retention with final change scores ranging from -.07 to -.20 m/s.

Several participants met the criteria established by Perera et al[58] for meaningful change. From baseline to post, three participants demonstrated small meaningful change (.05 to .06 m/s) and one demonstrated substantial change (.10 m/s). From baseline to retention, three demonstrated small meaningful change (.04 to .07 m/s) and three demonstrated substantial change (.15 to .21 m/s).

Participation. There were no statistically significant change in ABC scores over time with baseline to post change range -28.00 to +35.00 and baseline to retention change range -32.00 to +40.00.

Discussion

The purpose of this study was to investigate the feasibility and effects of applying the principles of shaping to part-task, pre-gait activities in persons with chronic stroke. It was hypothesized that shaping part-task, pre-gait exercises would be feasible and result in positive treatment effects across all levels of the ICF. All benchmarks for feasibility set a priori, except

attendance, were met. Three participants missed one session for non-study related reasons. One missed two days secondary to the calf strain. The participants worked hard, increasing mean repetitions from 594 to 1026 over the course of 10 sessions. Of the 11 participants, five (45.45%) had blood pressure readings prior to testing or exercise that led to follow-up phone calls with the referring physician. Ongoing monitoring assisted the physicians in making decisions to alter medications for two participants. One participant had an increase in dosage during the intervention. One had BP medication discontinued secondary to low blood pressure readings. All five were cleared by their PCP for continued participation in the study protocol. The study protocol was feasible and safe to implement with this sample with chronic stroke. The protocol yielded a high number of repetitions in a short, intense time period with a positive treatment effect for functional measures of LE strength and gait activity. Adding a level of fitness requirement for inclusion and/or having a more specific process to build the workload more slowly may prevent a calf strain or similar problem in a future study or in clinical application.

Implementation of the study protocol as executed in this study would be difficult to carry out with one therapist, unless minimal guarding was needed. Guarding, set-up and monitoring were performed continuously during the intervention. Progressive physical therapy intervention for gait remediation often required increased manpower.[10,24] Two[10] to three[24] personnel may be needed to provide manual cueing for limb placement[24] and guarding.[10,24] Some have reported implementation of LE CIMT using one to two therapists for three to four participants,[11] although the exact role and use of individualized guarding during the intervention were not well described. Upper extremity CIMT, on the other hand, can typically be performed with one interventionist[15] and has been implemented effectively in a group setting with two to three participants per one staff person.[42] Guarding for safety is not needed during UE CIMT part-task practice when

shaping is intensely applied. Whole task activities, in UE CIMT are selected based upon the participant's interests and abilities. Tasks could be performed in sitting, decreasing the postural demand.[15] The need for more than one staff person to implement a protocol does reduce feasibility for clinic use.[11,42] The use of an overhead harness with this LE study protocol may be sufficient to allow one therapist to set-up, implement and monitor the trials.

Providing positive reinforcement, a required element of shaping, was an essential aspect of this feasibility assessment. Praise and reporting of repetitions were planned procedures for providing positive reinforcement in this study protocol. The clicking sound of the tally counter also provided positive reinforcement. Often, the participant was so focused on the movement goal that the only noise in the room was the click of the tally counter. The audible click provided immediate positive feedback in the form of knowledge of results. Once the trial was completed, the repetitions were announced and praise provided. Most participants started setting their own goals to beat previous repetitions during trials and/or bouts. Success also provided positive reinforcement. Verbal feedback was sometimes difficult to provide during the actual trial as many variables were being monitored (participant safety, participant performance, success, set-up, time). However, the audible clicking and regular reporting of repetitions, along with cheers and high-fives contributed to a positive, energetic and fun environment. In UE CIMT the reporting of repetitions, a positive environment and encouragement to improve on personal best are critical components of shaping.[15,41] Lower extremity CIMT studies report the use of shaping, but do not elaborate.[10-11] Multiple responsibilities of the research assistants in this study, including guarding for safety, negatively impacted their ability to systematically apply positive praise during trial performance. However, the environment remained positive with systematic feedback applied through the audible tally counter.

The role of the audible clicking in the provision of positive feedback was not empirically studied or manipulated. The value of feedback from the audible click was not anticipated prior to implementation of this LE intervention protocol. All but two participants appeared to be very attentive to the clicking and would provide feedback to the research assistants if they felt they were incorrectly awarded "clicks". A search of multiple databases did not reveal any published studies regarding the use of a clicker or similar device for use in providing positive feedback or knowledge of results. Using a systematic review of six studies, Wittwer et al[33] found that synchronized walking to rhythmic auditory cueing brought short-term improvements in gait speed and stride length in patients with stroke. In these studies, the pace was set by the therapist. In this LE shaping study, the sound was made in reaction to the participant event and was tied to success. Consistent with the CIMT literature,[41] the immediate feedback from the auditory clicks and reporting of repetitions, appeared to be rewarding and motivating for most participants. It cannot be determined if the auditory clicking had any influence over the participant's pacing of the motor response. Use may have been tied to increased repetitions over the course of the intervention and/or to the positive treatment effects. Use of a tally counter could be easily implemented in a clinic setting. Further investigation the influence of the audible click on intervention outcomes, including increasing repetitions may assist with evidence-based decision-making.

The protocol used in this study clearly resulted in an increased number of repetitions over the course of the intervention days. Many researchers now emphasize the importance of repetitive, task-oriented training in bringing positive outcomes for lower limb and gait function following stroke, even in the chronic stages.[5-6,13-17,24,39] High-intensity, task-specific exercise appears to have the best potential to drive cortical reorganization following stroke; perhaps

yielding the best promise for permanent change.[13,17] Participants in this study performed a mean of 1026 (range 610 to 1647) repetitions on the last day of intervention. This varies considerably from Lang et al[34] findings for a mean number of 33.4 (±33.4) repetitions of active LE exercise, 8 (±12.3) purposeful movements, and 292 (±351.0) steps when exercise and gait (respectively) were addressed in out-patient settings for individuals status post stroke. Kimberly et al[13] subsequently found therapists provided a mean of 37.25 (± 47.52) repetitions of active lower limb activity and 185.20 (± 130.1) steps with gait training per therapy session when either was included for patients status post stroke in an acute care and rehabilitation hospitals. Use of this protocol generated a feasible method for achieving high repetitions in a one-hour therapy session.

Secondary Hypothesis

The secondary hypothesis of this study was that there would be a positive treatment effect across all levels of the ICF. Part-task, pre-gait activity yielded significant improvements on a unidimensional, functional measure of LE motor function (5xSTS)[55] and on one measure of gait function (FGA).[56-57] Five times Sit to Stand is significantly associated with knee flexor strength in individuals post stroke but is not associated with balance as tested with the Berg Balance Scale and limits of stability testing, dynamic posturography.[55] The FGA test items require postural stability[56-57]; the test is highly correlated with the Postural Assessment Scale for Stroke Patients (PASS).[56] Therefore, the treatment effects found in this study may be related to improved postural stability and lower extremity strength within our sample participants, and directly correspond with the types of pre-gait exercises performed in the study intervention.

Gait function, as measured through gait parameters of symmetry and velocity, did not show an effect. The lack of continuous gait in the intervention protocol may have influenced this

outcome. Others factors may have contributed to lack of effect. Examination of the raw data revealed that two participants (18%) had longer step lengths and one (9%) had longer stance time on the opposite limb at post-test compared to baseline (27% collectively). One participant retained the change at retention. Reporting of symmetry values does not capture those changes. Changes in gait speed were highly variable. Some participants demonstrated slower gait speeds at post and retention testing and some had improved gait speed with meaningful change at post, post and retention, or just retention. While most exercises addressed improving swing velocity through increased repetitions in a given period, some exercises were designed to slow swing time with a motor goal of increasing contralateral stance time. Some researchers have found a relationship between improved gait speed and continuous gait activities[6,8,14,24] or pre-gait activities[6,8,14] including circuit training,[69] but not when whole, continuous gait and pre-gait are combined.[8] Others have found statistically significant increases in gait speed with a home exercise program that specifically excluded continuous gait activity[24]; while others[22] did not find a statistically significant relationship between continuous gait activity (community ambulation, virtual reality, treadmill and imagery) and gait speed. The preliminary findings of this study support previous reports that part-task, pre-gait activities do not affect continuous gait parameters such as symmetry and gait speed. This study, although small, supports the results of prior findings that pre-gait activities do not improve continuous gait activities. A larger sample size is needed to better assess this outcome. A comparison between whole and part-task practice would be critical to determine this effect.

In this current study, there was no correlation between total number of repetitions performed or an increase in repetitions from early to late intervention and 5xSTS or FGA outcomes. Using a systematic review, French et al[14] found statistically significant, positive

effects with RTT in adults with stroke, for changes in walking distance, sit to stand and functional ambulation. However, no effect was found for timing of delivery relative to onset of stroke, type of training (whole, part or mixed), and larger versus smaller duration in hours of training. There was insufficient evidence in the French et al[14] review to investigate an effect from number of repetitions completed. The authors suggested that variables such as task shaping might influence the outcome of RTT.[14] In this current study, the lack of statistically significant correlation between repetitions and positive treatment effects may have been due to the small sample size. Alternatively, the positive, statistically significant effects may have resulted from the manner in which movements and motor abilities were shaped versus the number of repetitions completed. A randomized-controlled trial with both groups receiving part-task, pre-gait exercises and the experimental group receiving shaping, may provide clearer evidence for the contribution of shaping to pre-gait, part-task exercise.

Participation, as measured with the ABC[52] did not show a positive effect. This finding is consistent with many gait studies and systematic reviews examining LE function, gait, exercise, and participation.[6-8,14,22] Therefore this finding in the current study is not surprising. The ultimate goal of rehabilitation following stroke is improved participation and survivors of stroke associate impaired lower limb function with activity limitations and participation restrictions.[2,4,21] Physical therapists must continue to assess the impact of intervention on participation. Not all sources recognize the ABC as a participation measure[31]; different participation measures should be considered in a follow-up study.

Shaping

Shaping involves (1) providing immediate and frequent feedback regarding quality of movement; (2) task selection specific to movements the person has the most potential to

improve, (3) modeling, prompting and cueing to help the person understand the movement goal, and (4) systematically and incrementally increasing the difficulty of the task once the movement goal is consistently achieved.[41] This current study protocol addressed all requirements with items one and three described above. Requirement two, task selection should be guided by consideration of joint movements with the most pronounced deficits, deficits that have the greatest potential for improvement, and patient preference within the parameters of potential for improvement.[36,41] This level of detail for task selection was not fully addressed with this feasibility study protocol. Exercises were selected and modified based on knowledge of common gait deficits, observation of participant gait deficits, and assessment of participant performance of the exercise. The addition of motion analysis[26] and muscle performance testing[70] may provide additional guidance for exercise selection. The necessity of this level of detail is not known. The extra time and cost involved may not be warranted given the positive treatment effect using observation and foundational knowledge to establish motor goals.

Requirement four was addressed but quantification of the manipulation was not. If there was limited improvement after two to three intervention days, if the participant was uncomfortable, despite attempts at modification and/or if the participant did not like the exercise, the exercise was modified or abandoned. Likewise, exercises were modified when they became easy as determined through variables such as researcher observation of improved postural stability and/or ease of limb movement, reduced RPE and/or participant feedback. The primary parameter shaped was repetitions. Other parameters shaped included stepping longer, faster, slower or higher; completing the activity with eyes closed, while holding a glass of water or while standing on foam. Changes were specific to the participant's needs, abilities and interests. The decision to use upper limb support or not, was difficult as both decisions could be beneficial.

Participant input on this decision was weighted heavily; some chose a support-free environment to address balance, while other participants chose to use support in order to focus more on increasing repetitions of the activity. Other reasons for use of UE support included fear of falling, reports of fatigue, decreased strength or decreased balance. Upper extremity support helped reassure some participants and allowed participants to push themselves to reach the exercise goal. Postural demand is not specifically manipulated in UE CIMT shaping; tasks completed during UE task practice are selected within the participant's ability to maintain safe and efficient postural control.[15,41]

The manipulations used to address task difficulty (item four in shaping criteria[41]) were recorded in detailed logs for each participant (swing, stance, 1 UE support, bilateral UE support, floor surface, tactile cueing, other). However, systematic analysis of use was not performed secondary to the small sample size and reliance on numerous variables for decision-making. Finding a more systematic way in which to manipulate the exercise parameters for a given participant or group may be beneficial. Randomly allocating homogeneous participants to a group with or a group without UE support may yield data useful in clinical decision-making.

In the signature UE CIMT literature, inclusion of a transfer package combined with shaping enhances the motor capacity greater than use of a transfer package with task practice.[35] Individually, the comprehensive transfer package as described in Taub et al[35] had the greatest single effect on outcomes in UE CIMT. In this current study, the decision was made to focus solely on the application of shaping to part-task, pre-gait LE exercise. A transfer package was not utilized in order to minimize confounding variables. Use of a comprehensive transfer package that includes behavioral contracts, exercises and activities and follow-up phone calls to

assist with compliance may positively contribute to the utilization of shaping applied to LE part-task, pre-gait exercise.

Clinical Relevance

The application of shaping to part-task, pre-gait exercise, as applied in this study could be replicated in the clinic. Use of a tally counter, frequent positive verbal feedback and regular reporting of repetitions may provide a positive and motivating environment that could result in a high number of repetitions. Tasks designed to maximize success could be altered using a systematic, incremental and progressive approach, once the movement goal is achieved. The therapist could use his or her skills in modeling, prompting and cueing to help assure the patient understands the movement goal. These procedures do not require additional time or skill. They provide a mechanism for systematic and progressive challenge during repetitive task training. They could be easily integrated into a 45 or 60-minute session. The need for two clinic staff to maintain safety and implement the protocol may be decreased to one with the use of an overhead harness. If two staff are used, an unlicensed assistant could be trained to assist the clinician. The positive effects following a relatively short intervention period warrant consideration for clinic use.

Limitations

There were some threats to internal and statistical conclusion validity which may have contributed to a type II error include lack of homogeneity (FMA and gait speed range), and small sample size without sufficient power to detect a true difference. Post hoc power analysis using G-Power, Version 3.1.9.2 (Faul, Erdfelder, Lang, & Buchner, 2009) for the non-significant results showed that the study was underpowered to find differences for gait velocity, stance time symmetry, swing time symmetry, step length symmetry and ABC. Power ranged 13 to 64%.

Additional threats to validity included participant illness, resumption of or increased physical activity and/or change in medication after completion of the intervention period. Illness was reported and may have affected the performance of one participant (9%) at post testing and three (27%) participants at retention. Individuals who reported for testing not feeling well were given the option of rescheduling; one postponed testing for one week but was still recovering at testing. During the post to retention period, six participants (55%) resumed their prior exercise/activity routines (two were substantial consisting of approximately 45 minutes of exercise at least three times per week). Four (36%) initiated a new program consisting of approximately 10 to 20 minutes of regular exercise several times per week. Two received physical therapy, one for gait/LE exercise (9%) and one for UE exercise (9%). Participants were required to refrain from physical therapy and were discouraged from completing formal, home exercise during the study intervention period. Participants were not encouraged or discouraged from participation in regular exercise and/or physical therapy during the post to retention period; that was considered overreaching and perhaps unethical. One participant (9%) had a change in BP medication to lower BP during the intervention period. One participant (9%), at post testing, had a change in medication to address spasticity. During the post to retention period, one participant (9%) was taken off medications for BP and diabetes and one (9%) had a change in medication for headache management.

Future research is warranted using a larger sample size, control group and/or blind assessors. Manipulation of additional variables such as UE support, continuous gait and a transfer package may yield clinically important data. The protocol lends itself to easy manipulation of variables and could be used to systematically examine which variable has the most significant impact on which domain(s) of the ICF.

Participant comments throughout the study were very positive. Comments have not been reported because a formal methodology to capture and analyze the comments was not implemented. Use of an additional or different outcome measure assessing participation and/or use of a focus group, may increase the richness of information regarding the study protocol and outcome from the participant perspective. A mixed-method design with a control group and additional participation-level measures may yield additional helpful information that will further guide clinical decision-making. Lengthening the duration of the protocol beyond a two-week time-period, with less visits per week may improve attendance.

Conclusion

This study offers a protocol that is feasible to implement (safe, tolerable, manageable) in most physical therapy clinic settings where two individuals are available to provide assistance. An overhead harness may provide sufficient (and perhaps superior) guarding and decrease personnel required to one. The protocol yields a high number of repetitions that can easily be counted. The counting with an audible tally counter and reporting of counts appears to provide positive reinforcement for the activity. Analysis of variables related to the secondary hypotheses suggest that participants continued to improve following completion of the two-week intervention, as evidenced by the improved scores on retention testing for 5xSTS, ABC, FGA and gait speed, with 5xSTS and FGA reaching a positive, significant difference from baseline to retention.

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Table 1. Participant General Characteristics

Variables	**All Participants N = 11**
Age (years), M (SD)	61.2 (10.4)
Time post stroke (months), Mdn (IQR)	18.0 (10.0)
Fugl-Meyer Lower Extremity Score, M (SD)	26.6 (4.3)
Side of hemiparesis, *N* (%)	
Left	7.0 (63.6)
Type of stroke, *N* (%)	
Ischemic	5.0 (45.5)
Hemorrhagic	1.0 (9.1)
Brainstem	1.0 (9.1)
Do not know	4.0 (36.4)
Gender, *N* (%)	
Male	6.0 (54.5)
Marital Status, *N* (%)	
Married	9.0 (81.8)
Widowed	1.0 (9.1)
Single/never married	1.0 (9.1)
Race/ethnicity, *N* (%)	
White	10.0 (90.9)
Hispanic/Latino	1.0 (9.1)

Table 2. Primary Hypothesis: Feasibility Benchmarks and Outcomes (*N* = 11)

Measure	**Benchmark**	**Outcome N (%)**	**Benchmark Met**
Study process			
Attendance, N (%)[a]	80% attend 10/10 intervention days	7.0 (63.6)	No
Completion rate[a]	80% complete the intervention	11.0 (100.0)	Yes
Study protocol			
Emergency medical calls, N (%)[b]	0% emergency medical calls	0.0 (100.0)	Yes
Falls, N (%)[b]	0% falls	0.0 (100.0)	Yes
Tolerance of trial length, N (%)[a]	80% complete 30 second trials	10.0 (90.9)	Yes
Increase in repetitions[a]	15% increase from days 1-3 (mean) to final day	11.0 (100.0)	Yes
Study management			
Study personnel, N (%)[b]	80% require two or fewer assistants for safety, process	11.0 (100.0)	Yes

[a] intervention only
[b] baseline , post-, and retention-testing and intervention

Table 3. Comparison of Outcome Measures Over Time (*N* = 11)

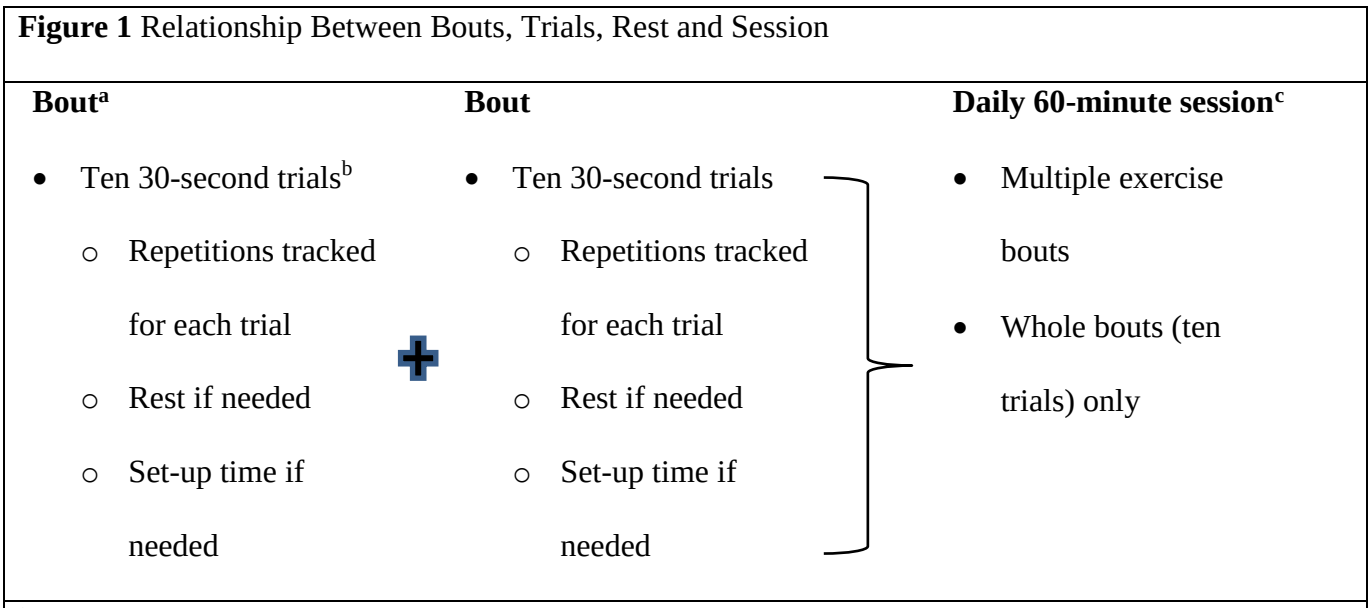
Variables	Baseline *M* (*SD*)	Post-test *M* (*SD*)	Retention *M* (*SD*)	*P*
5xSTS, sec*	15.15 (8.44)	11.61 (8.12)	12.68 (6.15)	< .01
ABC, %	69.00 (20.72)	71.82 (24.17)	72.73 (22.87)	.29
FGA	11.73 (3.69)	12.82 (3.46)	14.36 (4.78)	< .01
Gait Speed, m/s	0.61 (0.23)	0.59 (0.24)	0.64 (0.25)	.26
Stance Time Ratio	0.86 (0.07)	0.85 (0.10)	0.84 (0.10)	.32
Swing Time Ratio*	1.43 (0.58)	1.60 (0.10)	1.58 (0.90)	.35
Step Length Ratio*	1.01 (0.70)	1.00 (0.41)	1.05 (0.44)	.34

* Median (IQR) reported

5xSTS = Five times sit to stand; ABC = Activities Specific Balance Confidence Scale;

FGA = Functional Gait Assessment

Figure 1 Relationship Between Bouts, Trials, Rest and Session



[a] Each bout was one exercise

[b] Each exercise was performed for ten 30-second trials, with rest between trials if needed; set-up time between trials also added time to the bout, depending upon the nature of the exercise

[c] Multiple bouts were completed in a 60 minute session

Note: Mandatory 5-minute rest between bouts for the first three days was weaned as sufficient endurance was demonstrated.

Appendix A: Fugl-Meyer Motor Function – Lower Extremity

TEST	ITEM	SCORE	SCORING CRITERIA
I. Reflex Activity	Achilles		0 – No reflexes can be elicited 2- Reflex activity can be elicited
	Patellar		
II. Flexor synergy (in supine)	Hip flexion		0-Cannot be performed at all 1-Performed partially 2- Performed faultlessly
	Knee flexion		
	Ankle dorsiflexion		
III. Extensor synergy (in sidelying)	Hip extension		0-Cannot be performed at all 1-Performed partially 2- Performed faultlessly
	Adduction		
	Knee extension		
	Ankle plantar flexion		
IV. Movement combining synergies (sitting: knees free of chair)	Knee flexion beyond 90°		0-No active motion 1-From slightly extended position, knee can be flexed, but not beyond 90° 2-Knee flexion beyond 90°
	Ankle dorsiflexion		0-No active flexion 1-Incomplete active flexion 2-Normal dorsiflexion
V. Movement out of synergy (Standing, hip at 0°)	Knee flexion		0-Knee cannot flex without hip flexion 1-Knee begins flexion without hip flexion, but does not reach 90°m or hip flexes during motion 2-Full motion
	Ankle dorsiflexion		0-No active motion 1-Incomplete active motion 2-Normal motion
VI. Normal reflexes (sitting)	Knee flexors, patellar, Achilles (This item is only tested if the patient achieves maximum score on all previous items. If person has not achieved full score to this point, enter 0)		0-At least 2 of the 3 phasic reflexes are markedly hyperactive 1-One reflex is markedly hyperactive, or at least 2 are lively 2-No more than one reflex is lively and none are hyperactive
VII. Coordination/speed – sitting; Heel to opposite knee (5 repetitions in rapid succession)	Tremor		0-Marked tremor 1-Slight tremor 2-No tremor
	Dysmetria		0-Pronounced or unsystematic dysmetria 1-Slight or systematic dysmetria 2-No dysmetria
	Speed		0-Activity is more than 6 seconds longer than unaffected side 1-Activity is 2-5.9 second longer than unaffected side 2-Less than 2 second difference
TOTAL LOWER EXTREMITY TOTAL			**MAXIMUM = 34**

Appendix B: Five Times Sit to Stand

From Rehabmeasures.org

Five times sit to stand

Test Administration:

1. Patient sits with arms folded across chest and with their back against the chair. With patients who have had a stroke, it is permissible to have the impaired arm at the side or in a sling
2. Use a standard chair with arms (keep testing chair consistent for each retest). Chair heights recorded in literature vary, generally 43-45 cm
3. Ensure that the chair is not secured (i.e. against the wall or mat)
4. *Patient Instructions: "I want you to stand up and sit down 5 times as quickly as you can when I say 'Go'."*
    - Instruct to stand fully between repetitions of the test and not to touch the back of the chair during each repetition.
    - It is OK if the patient does touch the back of the chair, but it is not recommended
5. Timing begins at "Go" and ends when the buttocks touches the chair after the 5th repetition.
6. Provide one practice trial before measurements are recorded. If you are concerned that the patient may fatigue with a practice trial, it is OK to demonstrate to the patient and have the patient do two repetitions to ensure they understand the instructions
7. Inability to complete five repetitions without assistance or use of upper extremity support indicates failure of test. (Any modifications should be documented)
8. Try NOT to talk to the patient during the test (may decrease patient's speed)
9. Document speed and assist level (CGA, supervision, Mod I, or I) in the PT Standing Balance Section

Appendix C: Functional Gait Assessment

Requirements: A marked 6-m (20-ft) walkway that is marked with a 30.48-cm (12-in) width.

_____1. GAIT LEVEL SURFACE Instructions: *Walk at your normal speed from here to the next mark (6 m [20 ft]).* Grading: Mark the highest category that applies. (3) Normal—Walks 6 m (20 ft) in less than 5.5 seconds, no assistive devices, good speed, no evidence for imbalance, normal gait pattern, deviates no more than 15.24 cm (6 in) outside of the 30.48-cm (12-in) walkway width. (2) Mild impairment—Walks 6 m (20 ft) in less than 7 seconds but greater than 5.5 seconds, uses assistive device, slower speed, mild gait deviations, or deviates 15.24–25.4 cm (6–10 in) outside of the 30.48-cm (12-in) walkway width. (1) Moderate impairment—Walks 6 m (20 ft), slow speed, abnormal gait pattern, evidence for imbalance, or deviates 25.4–38.1 cm (10–15 in) outside of the 30.48-cm (12-in) walkway width. Requires more than 7 seconds to ambulate 6 m (20 ft). (0) Severe impairment—Cannot walk 6 m (20 ft) without assistance, severe gait deviations or imbalance, deviates greater than 38.1 cm (15 in) outside of the 30.48-cm (12-in) walkway width or reaches and touches the wall.	**_____4. GAIT WITH VERTICAL HEAD TURNS** Instructions: *Walk from here to the next mark (6 m [20 ft]). Begin walking at your normal pace. Keep walking straight; after 3 steps, tip your head up and keep walking straight while looking up. After 3 more steps, tip your head down, keep walking straight while looking down. Continue alternating looking up and down every 3 steps until you have completed 2 repetitions in each direction.* Grading: Mark the highest category that applies. (3) Normal—Performs head turns with no change in gait. Deviates no more than 15.24 cm (6 in) outside 30.48-cm (12-in) walkway width. (2) Mild impairment—Performs task with slight change in gait velocity (eg, minor disruption to smooth gait path), deviates 15.24–25.4 cm (6–10 in) outside 30.48-cm (12-in) walkway width or uses assistive device. (1) Moderate impairment—Performs task with moderate change in gait velocity, slows down, deviates 25.4–38.1 cm (10–15 in) outside 30.48-cm (12-in) walkway width but recovers, can continue to walk. (0) Severe impairment—Performs task with severe disruption of gait (eg, staggers 38.1 cm [15 in] outside 30.48-cm (12-in) walkway width, loses balance, stops, reaches for wall).
_____2. CHANGE IN GAIT SPEED Instructions: *Begin walking at your normal pace (for 1.5 m [5 ft]). When I tell you "go," walk as fast as you can (for 1.5 m [5 ft]). When I tell you "slow," walk as slowly as you can (for 1.5 m [5 ft]).* Grading: Mark the highest category that applies. (3) Normal—Able to smoothly change walking speed without loss of balance or gait deviation. Shows a significant difference in walking speeds between normal, fast, and slow speeds. Deviates no more than 15.24 cm (6 in) outside of the 30.48-cm (12-in) walkway width. (2) Mild impairment—Is able to change speed but demonstrates mild gait deviations, deviates 15.24–25.4 cm (6–10 in) outside of the 30.48-cm (12-in) walkway width, or no gait deviations but unable to achieve a significant change in velocity, or uses an assistive device. (1) Moderate impairment—Makes only minor adjustments to walking speed, or accomplishes a change in speed with significant gait deviations, deviates 25.4–38.1 cm (10–15 in) outside the 30.48-cm (12-in) walkway width, or changes speed but loses balance but is able to recover and continue walking. (0) Severe impairment—Cannot change speeds, deviates greater than 38.1 cm (15 in) outside 30.48-cm (12-in) walkway width, or loses balance and has to reach for wall or be caught.	**_____5. GAIT AND PIVOT TURN** Instructions: *Begin with walking at your normal pace. When I tell you, "turn and stop," turn as quickly as you can to face the opposite direction and stop.* Grading: Mark the highest category that applies. (3) Normal—Pivot turns safely within 3 seconds and stops quickly with no loss of balance. (2) Mild impairment—Pivot turns safely in _3 seconds and stops with no loss of balance, or pivot turns safely within 3 seconds and stops with mild imbalance, requires small steps to catch balance. (1) Moderate impairment—Turns slowly, requires verbal cueing, or requires several small steps to catch balance following turn and stop. (0) Severe impairment—Cannot turn safely, requires assistance to turn and stop.
_____3. GAIT WITH HORIZONTAL HEAD TURNS Instructions: *Walk from here to the next mark 6 m (20 ft) away. Begin walking at your normal pace. Keep walking straight; after 3 steps, turn your head to the right and keep walking straight while looking to the right. After 3 more steps, turn your head to the left and keep walking straight while looking left. Continue alternating looking right and left every 3 steps until you have completed 2 repetitions in each direction.* Grading: Mark the highest category that applies. (3) Normal—Performs head turns smoothly with no change in gait.	Instructions: *Begin walking at your normal speed. When you come to the shoe box, step over it, not around it, and keep walking.* Grading: Mark the highest category that applies. (3) Normal—Is able to step over 2 stacked shoe boxes taped together (22.86 cm [9 in] total height) without changing gait speed; no evidence of imbalance. (2) Mild impairment—Is able to step over one shoe box (11.43 cm [4.5 in] total height) without changing gait speed; no evidence

Deviates no more than 15.24 cm (6 in) outside 30.48-cm (12-in) walkway width. (2) Mild impairment—Performs head turns smoothly with slight change in gait velocity (eg, minor disruption to smooth gait path), deviates 15.24–25.4 cm (6–10 in) outside 30.48-cm (12-in) walkway width, or uses an assistive device. (1) Moderate impairment—Performs head turns with moderate change in gait velocity, slows down, deviates 25.4–38.1 cm (10–15 in) outside 30.48-cm (12-in) walkway width but recovers, can continue to walk. (0) Severe impairment—Performs task with severe disruption of gait (eg, staggers 38.1 cm [15 in] outside 30.48-cm (12-in) walkway width, loses balance, stops, or reaches for wall).	of imbalance. (1) Moderate impairment—Is able to step over one shoe box (11.43 cm [4.5 in] total height) but must slow down and adjust steps to clear box safely. May require verbal cueing. (0) Severe impairment—Cannot perform without assistance.
_____**7. GAIT WITH NARROW BASE OF SUPPORT** Instructions: *Walk on the floor with arms folded across the chest, feet* *aligned heel to toe in tandem for a distance of 3.6 m [12 ft]. The number of steps taken in a straight line are counted for a maximum of 10 steps.* Grading: Mark the highest category that applies. (3) Normal—Is able to ambulate for 10 steps heel to toe with no staggering. (2) Mild impairment—Ambulates 7–9 steps. (1) Moderate impairment—Ambulates 4–7 steps. (0) Severe impairment—Ambulates less than 4 steps heel to toe or cannot perform without assistance.	_____**9. AMBULATING BACKWARDS** Instructions: *Walk backwards until I tell you to stop.* Grading: Mark the highest category that applies. (3) Normal—Walks 6 m (20 ft), no assistive devices, good speed, no evidence for imbalance, normal gait pattern, deviates no more than 15.24 cm (6 in) outside 30.48-cm (12-in) walkway width. (2) Mild impairment—Walks 6 m (20 ft), uses assistive device, slower speed, mild gait deviations, deviates 15.24–25.4 cm (6–10 in) outside 30.48-cm (12-in) walkway width. (1) Moderate impairment—Walks 6 m (20 ft), slow speed, abnormal gait pattern, evidence for imbalance, deviates 25.4–38.1 cm (10–15 in) outside 30.48-cm (12-in) walkway width. (0) Severe impairment—Cannot walk 6 m (20 ft) without assistance, severe gait deviations or imbalance, deviates greater than 38.1 cm (15 in) outside 30.48-cm (12-in) walkway width or will not attempt task.
_____**8. GAIT WITH EYES CLOSED** Instructions: *Walk at your normal speed from here to the next mark (6 m [20 ft]) with your eyes closed.* Grading: Mark the highest category that applies. (3) Normal—Walks 6 m (20 ft), no assistive devices, good speed, no evidence of imbalance, normal gait pattern, deviates no more than 15.24 cm (6 in) outside 30.48-cm (12-in) walkway width. Ambulates 6 m (20 ft) in less than 7 seconds. (2) Mild impairment—Walks 6 m (20 ft), uses assistive device, slower speed, mild gait deviations, deviates 15.24–25.4 cm (6–10 in) outside 30.48-cm (12-in) walkway width. Ambulates 6 m (20 ft) in less than 9 seconds but greater than 7 seconds. (1) Moderate impairment—Walks 6 m (20 ft), slow speed, abnormal gait pattern, evidence for imbalance, deviates 25.4–38.1cm (10–15 in) outside 30.48-cm (12-in) walkway width. Requires more than 9 seconds to ambulate 6 m (20 ft). (0) Severe impairment—Cannot walk 6 m (20 ft) without assistance, severe gait deviations or imbalance, deviates greater than 38.1 cm (15 in) outside 30.48-cm (12-in) walkway width or will not attempt task.	_____**10. STEPS** Instructions: *Walk up these stairs as you would at home (ie, using the rail* *if necessary). At the top turn around and walk down.* Grading: Mark the highest category that applies. (3) Normal—Alternating feet, no rail. (2) Mild impairment—Alternating feet, must use rail. (1) Moderate impairment—Two feet to a stair; must use rail. (0) Severe impairment—Cannot do safely.
	TOTAL SCORE: _____ MAXIMUM SCORE 30

Appendix D: Activities Specific Balance Confidence Scale

Script: For each of the following, please indicate your level of confidence in doing the activities without losing your balance or becoming unsteady by choosing one of the percentage points on the scale from 0% to 100%. **If you do not currently do the activities in question, try and imagine how confident you would be if you had to do these activities. If you normally use a walking aid to do the activities or hold onto someone, rate your confidence as if you were using these supports.** If you have questions about answering any of these things, please ask the administrator.

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
No Confidence **Completely Confident**

How confident are you that you will not lose your balance or become unsteady when you…	
1. Walk around the house?	%
2. Walk up or down stairs?	%
3. Bend over and pick up a slipper from the front of a closet floor?	%
4. Reach for a small can off a shelf at eye level?	%
5. Stand on your tiptoes and reach for something above your head?	%
6. Sweep the floor?	%
7. Walk outside of the house to a parked car in the driveway?	%
8. Stand on a chair and reach for something?	%
9. Get in or out of a car?	%
10. Walk across the parking lot to the mall?	%
11. Walk up or down a ramp?	%
12. Walk in a crowded mall where people rapidly walk past you?	%
13. Are bumped into by people as you walk through the mall?	%
14. Step onto or off of an escalator while you are holding onto a rail?	%
15. Step onto or off of an escalator while holding onto parcels such that you cannot hold onto the railing?	%
16. Walk outside on a wet or slippery sidewalk?	%
Mean	**%**

Appendix E: Participant: Eligibility and General Information Form

Date of Initial Contact with Co-Investigator:_____

[ ] phone intake [ ] in-person intake

[ ] AFO [ ] no AFO

[ ] fall history _____

Eligibility Determination: (Check all that apply)

- ☐ lives in community
- ☐ at least 6-months post stroke
- ☐ has only experienced one stroke
- ☐ between the ages of 21-80
- ☐ able to walk with or without the use of an assistive device and/or orthosis
- ☐ requires no more than occasional minimal assistance for balance
- ☐ reports LE coordination/strength/control problems
- ☐ currently not receiving physical therapy services
- ☐ no co-morbidities or pre-existing cardiovascular conditions that would prohibit gait training and exercise
- ☐ no pre-existing neurological or current musculoskeletal conditions that would limit gait ability separate from the effects of stroke
- ☐ no complications from other health conditions that could influence walking
- ☐ able to follow at least three-step verbal instructions
- ☐ available for the entire period of the study
- ☐ able to travel to and from research measurement and intervention sessions
- ☐ medically stable with a physician release stating approval to enter an exercise program

Eligible for study? (Y/N)_____ Date Eligibility determined: _____

General Participant Information

Name: _____

Address:_____

Home phone: _____Cell phone:_____

Emergency Contact (Name/phone):_____

Physician Name/phone:_____

Participant Number:_____

Appendix F: Demographics

Demographics – Pre-Test only

Date of birth: ☐☐/☐☐/☐☐ Age: _____ Gender: ☐ Male ☐ Female

What is your current **marital status**?

☐ Married ☐ Member of an unmarried couple ☐ Single and never been married

☐ Widowed ☐ Divorced ☐ Separated

Which single **race** group best describes you?

☐ Black/African American ☐ Asian American ☐ Native American Indian/Alaskan ☐ Other

☐ White ☐ Hispanic/Latino ☐ Native Hawaiian/Pacific Islander ☐ no answer

Stroke Characteristics – Pre-Test only

Diagnosis of Stroke: ☐ Yes ☐ No ☐ Do not remember

Date of stroke: Month _____ Year_____

Time since stroke: ☐ <1 year ☐ 2-5 years ☐ 5-10 years ☐ >10 years

How old were you when you had your stroke? _____ years

Are you weaker because of your stroke? ☐ Yes ☐ No

☐ Right hemiparesis ☐ Left hemiparesis

Dominant hand: Right ☐ Left ☐

Type of stroke: ☐ Ischemic ☐ Hemorrhagic ☐ Brainstem ☐ Do not remember

What therapies did you have after your stroke? OT / PT / ST / RT / Psych (circle) Other:_____

What other health conditions have you been diagnosed with?_____
_____
_____

Have you had any surgeries in the past? If so, what?_____
_____
_____

Did you fall when or shortly after you had the stroke? ☐ Yes ☐ No ☐ Do not remember

Have you fallen **since** your stroke? ☐ Yes ☐ No ☐ Do not remember

If 'Yes,' how often? ☐ Daily ☐ Weekly ☐ Monthly ☐ Just once ☐ Other_____

Were you injured? ☐ Yes ☐ No ☐ Do not remember

Do you currently exercise? ☐ Yes ☐ No

If 'Yes," what type of exercise(s)?_____
_____
_____

Names and dosages of current medications:

Medication name	Daily dose	Purpose
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		

Any recent changes in medications? ☐ Yes ☐ No ☐ Do not remember/know

If so, please explain: _____

_____

_____

Appendix G: Test Tracking

Tracking for pre/post/retention testing **Participant #_____**
pre-test date: _____ intervention: _____
post-test date: _____ retention test date: _____

Item	**Pre-testing**	**Post-testing**	**retention**
informed consent (pre-testing only)			
issued copy			
discussed what to wear			
polar HR monitor			
demographics			
vital signs			
____ BP ____ HR ____ RR ____O2 sat (pre) ____ BP ____ HR ____ RR ____O2 sat (post) ____ BP ____ HR ____ RR ____O2 sat (retention)			
confirm dates for intervention and post-intervention testing			
set date for retention testing			
Indicate order of testing			
____ ABC			
____ spatiotemporal gait parameters			
____ Fugl-Meyer			
____5x sit to stand			
____FGA			
____ 6MWT RPE: ____ (pre) ____ (post) ____ (retention)			
____ Post-intervention survey			
____ retention-testing interview			
Notes: (record any helpful information here including confirm no PT during intervention; f/u on exercise during intervention and PT and/or ex following intervention – be specific as possible with dates, frequency, duration, intensity)			

Appendix H: Intervention Log Sheet

Participant #_____ **Date:_____**

<table>
<tr><th colspan="5">END OF DAY SUMMARY</th></tr>
<tr><th>Exertion Ratings</th><th>Total Time on Task</th><th>Total Reps</th><th colspan="2">Total Reps Involving:</th></tr>
<tr><td>_____ RPE Minimum Rating

_____ RPE Maximum Rating

Initial resting:
HR | | RR | |
O_2 sat | | BP | |
Post resting:
HR | | RR | |
O_2 sat | | BP | |</td><td>

# of ex completed:</td><td>____ Bilateral stance (parallel or stride)

____ Affected stance limb

____ affected swing limb

____ alternating</td><td>____ 1 or ____ 2 UE support

____ speed goal (↑ or ↓)

____ distance goal (↑ or ↓)

____ holding object (affected, unaffected, bilateral)</td><td>____ reaching to goal

____ eyes open ____ eyes closed

____ head turns

____ standing on foam</td></tr>
<tr><td colspan="5">Notes:</td></tr>
</table>

<table>
<tr><th colspan="5">Shaping Exercise # Brief Description:</th></tr>
<tr><th>Exertion Ratings</th><th>Total Time on Task</th><th>Total Reps</th><th colspan="2">Total Reps Involving:
(circle specifics)</th></tr>
<tr><td>_____ RPE Minimum Rating

_____ RPE Maximum Rating

HR/BP/RR (prn):</td><td></td><td>____ Bilateral stance (parallel or stride)

____ Affected stance limb

____ affected swing limb

____ alternating</td><td>____ BUE

____ affected or unaffected UE support for stability

____ speed goal (↑ ↓ variable)

____ distance goal (↑ ↓ variable)

____ holding object (affected, unaffected, bilateral)</td><td>____ reaching to goal (↑ ↓ → ← ↗ ↖ ↘ ↙ or multi)

____ eyes open ____ eyes closed

____ head turns (↑ ↓ → ← ↗ ↖ ↘ ↙ multi)

____ standing on foam</td></tr>
<tr><td colspan="5">Notes:</td></tr>
</table>

Appendix I: Trial Tracking

Participant # _____ Date:_____

Time start: _____ Time end ex: _____ Time end rest: _____

Ex #	RPE 1	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10	RPE 2	Task Time	other

Notes:

Appendix J: Study Flyer

Research Participants with Stroke Needed for Exercise Study

We are testing the effects of an exercise program on ability to stand for longer periods of time, and improve strength, balance, walking ability, and confidence in performing walking tasks.

This research study will help us to design better rehabilitation interventions for people who have had a stroke.

Gannon University
Doctor of Physical Therapy Program

University of Indianapolis
Krannert School of Physical Therapy

CONTACT INFORMATION

Beth Gustafson, PT, MSEd
814-871-7709
gustafso006@gannon.edu
Gannon University
Physical Therapy Program, MS60
109 University Square
Erie, PA 16541

We are looking for people who:

• Have had their stroke for at least 6 months	• Live at home (not in a nursing home)
• Are between the ages of 21-80	• Are able to follow test instructions and communicate needs
• Have only had one stroke	• Have no other conditions that affect walking
• Are able to walk with or without a walker or cane and/or brace, it is ok if they need a little help	• Are able to travel to and from research measurement and training sessions
• Have some problems with leg movement and coordination (in leg affected by stroke)	• Are available for the entire period of the study
• Are not currently in physical therapy	• Can obtain physician clearance

What to expect:

If you are enrolled in this study, you will take part in an exercise program on the campus of Gannon University. During each training session you will complete exercises in standing such as stepping forward, backward, up and over items. Exercises will be made harder or easier by adding in activities such as head turns and may be performed with eyes open or eyes closed. All exercises will be supervised by a physical therapist and guarded by an assistant. The training sessions will take place for 60 minutes, 5 days/week for 2 weeks in a row. Tests performed before and after the exercise will measure your walking ability, your coordination, your endurance, and your confidence in performing walking tasks. A 1-hour measurement session will take place the week before and after the training period and at 3 to 4 months following the training. At the conclusion of the training, you will also be asked to answer some questions regarding your interest in the exercise program. All measurements will take place on the Gannon University campus. The total time commitment is about 5 months.

Study approval:

This study has been approved by the Institutional Review Boards from both Gannon University and the University of Indianapolis. We will respect your confidentiality and will not use your name if the findings of this study are published.

Appendix K: Initial Contact Script

First: Introduce self and describe the study:

"Thank you for contacting us about our study. I am Beth Gustafson. I am on faculty here at the Gannon University in the Doctor of Physical Therapy Program. I am a co-Investigator for the study you are calling about. The purpose of this study is to examine the feasibility of an exercise program for people who have had a stroke. I will also be measuring differences in standing tolerance, strength, balance, walking ability, and confidence in performing walking tasks.

All of the testing and exercises will be performed at Gannon University under the supervision of a physical therapist and student physical therapists. Exercises will include standing and stepping activities. These activities will be gradually increased in difficulty.

It will include a total of 10 treatment sessions over a period of 2 weeks in 60 minute sessions. Participants will be able to sit and rest as needed. Also, as part of the research, we will conduct 3 testing sessions here on the campus of the Gannon University, during the weeks immediately before and after the 2-week training period and then again 3 to 4 months after the training period. Each testing session will take about 1 hour."

"Do you have any questions?"

Second: After answering questions, ask the potential participant if interested in determining if eligible to participate in the study

"Are you interested in determining if you are eligible to participate in our study?"

Third: Determine eligibility using Eligibility and Contact Information Form

Fourth:

A. If the potential participant meets all of the eligibility requirements, then ask if interested in learning more about the study.
   "You are eligible to participate in the study. Would you like to learn more about the study?"
B. I am sorry, but at this time you are not eligible to participate in the study for the following reason(s) _____. Are you interested in being contacted in the future for other studies?

Fifth: If the potential participant is eligible and interested in learning more about the study, then invite them to meet with the primary investigator and student researchers at Gannon University to go over the informed consent form, answer any other questions and to further determine eligibility based on observation of gait (must have obvious gait impairment). Schedule a time to meet with the potential participant at this time and fill in contact information on the eligibility form.

"I would like to invite you to meet with me and some of the student co-investigators to go over the informed consent form, answer any other questions you might have about the study and to further determine your eligibility for the study through an informal observation of your walking. With your permission, we will then seek medical clearance from your physician. Can we set up a time to meet?"

**At any time if the potential participant is not interested in hearing more about the study or does not meet the eligibility requirements, then the contact is terminated.

Appendix L: Informed Consent

Date: _____

Dear Participant,

You are invited to enter a research study. The title of the study is ***Lower extremity shaping exercises for community dwelling adults with chronic stroke: a feasibility study***. The study is conducted by a physical therapist at Gannon University, Beth Gustafson. The purpose is to test the feasibility of a leg exercise program for people who have had a stroke. This program will address strength, coordination, balance and walking. We will also look at your confidence in performing walking tasks. You may find benefits in these areas from participation. Your participation will help us gain a better understanding of exercise following stroke. We will seek your opinion on the benefits of and interest in the exercise program. Physical or mental risks from participating are no greater than would be found in a typical physical therapy session. If you have an unknown medical condition, the exercise could become problematic. You will be monitored closely for signs of trouble. All of the exercises will be performed in standing. You will be able to rest in sitting. It is possible you may initially be sore or tired. This should go away over the course of the exercise program. The procedures used are standard research procedures, not experimental ones.

Your physician will need to sign a letter of medical clearance for you to participate. Your pulse, blood pressure, breathing, and effort will be monitored. You will be asked to slow down or stop if you show any signs of trouble. If it is determined that the exercise is not safe for you, you will be withdrawn from the study. You will be referred back to your physician. No provision will be made for financial payments or other forms of compensation (such as lost wages, medical cost reimbursement, lost time or discomfort) with respect to injuries as a result of this study.

If you are found to be eligible you will continue with pre-testing. There will be three testing sessions. One will occur the week before the exercise program. One will occur the week after the exercise program. One will occur three to four months after the exercise program. Each will take about an hour. The exercise program will run daily for two weeks in a row. The sessions will take about an hour and a half.

Your performance and the test results will be recorded in several ways. We will use electronic means, paper, video and audio to record results. An individual file will be created to carefully store your testing results. Please see the summary at the end of this letter for information on how all of this data will be stored.

All tests and observations obtained by the researchers will remain confidential. You may be testing or exercising with others who are participating in the study. The researchers cannot monitor or control what other participants share. However, each is encouraged to be respectful of each other. Some of the tests or exercises may occur when other students, faculty or visitors are in the area. It is expected that the volume of this kind of traffic will be low. The researchers will be very careful to make sure your private information, including test results are not shared with others. It is possible others will hear you receive feedback such as “good job” or “you completed 10 yesterday”. If you prefer to test or exercise in a private area, you may let the researcher know. You may request this at any time.

Your participation is voluntary. You may end your participation at any time without penalty.

If you have questions about the research or experience any discomfort or injury from participation, contact Beth Gustafson, PT, MSEd at (814) 871-7709.

If you have questions about your rights as a research participant, contact Dr. Ryan Leonard, Chairperson, Gannon University Institutional Review Board at (814) 871-5875 or Greg E. Manship, IRB Coordinator & Human Protections Administrator, University of Indianapolis, Fountain Square Center, A313, 901 South Shelby Street, Indianapolis, IN, 46203. 317/781-5774 (Office) 317/791-5945 (Fax)

You will be given a copy of this form to keep.

I volunteer to participate in this study. I have had the opportunity to ask questions.

Participant name (print) _____

Participant signature _____ Date _____

Witness signature _____ Date _____

☐ Check here to see the results when the study is over.

Document storage

- Electronic files (includes video): hard drive: folder with secure password; jump drive file with secure password locked in file cabinet in Co-Investigator Gustafson locked office
- Paper files: locked in file cabinet in Co-Investigator Gustafson locked office
- All paper documents will be kept for 3 years following publication and will be shredded after this time point.

Using language that is understandable and appropriate, I have discussed this research with the above participant.

Researcher signature _____Date _____

Note: font decreased by 1 to accommodate proposal margins

Appendix M: Medical Release Form

Physician's Approval Statement

Patient:_____ Date of Birth: _____

I release my patient named above to participate in the study entitled "Lower extremity shaping exercises for community dwelling adults with chronic stroke: a feasibility study. "

I understand that my patient will be participate in 10 exercise sessions over 2 weeks for 60 minutes of standing and stepping exercises per session. Participants will work with moderate intensity (Rate of Perceived Exertion (RPE) 11-14) during the training. Vital signs will be monitored. During each session standing and stepping exercises will be modified to progressively challenge the participant in gait-related activities. For example, one exercise may consist of repetitively stepping and a progression may be stepping with a head turn or stepping with eyes closed. Testing will take place one week before (pre-test), one week after (post-test), and 3 to 4-months after (retention) the intervention period. Gait velocity, limb symmetry, endurance, quality of gait pattern, gait with functional tasks and confidence in completing walking tasks will be measured during all testing sessions. A follow-up interview will also occur. The interventions and testing sessions will be carried out at Gannon University by trained physical therapy students and faculty.

Physician's name (please print) _____

Physician's signature: _____Date:_____

Please return signed form to:

Beth Gustafson, PT, MSEd (Co-Investigator)
Assistant Professor
Gannon University
Doctor of Physical Therapy Program, MS60
109 University Square
Erie, PA 16451
Or fax to: (814) 871-5548

I agree to allow the research team to obtain approval from my physician to participate in study, "Lower extremity shaping exercises for community dwelling adults with chronic stroke: a feasibility study".

Participant's Signature: _____ Date: _____

Participant Date of Birth: _____

Physician name:_____Phone:_____

Note: font and spacing decreased to accommodate proposal margins

Appendix N: Table of Contents for Bank of Exercises

See separate document for exercises

Appendix O: Study Personnel Training

Research assistant name: _____ Date: _____

Research assistant orientation and exercise intolerance/emergency management training for research study: *Lower extremity shaping exercises for community dwelling adults with chronic stroke: a feasibility study.*

- ☐ CPR certification, Professional Rescuer or higher
  - ☐ expiration date:
- ☐ First Aid certification
  - ☐ expiration date:
- ☐ Review signs/symptoms of exercise intolerance
  - ☐ shortness of breath/labored breathing
  - ☐ diffuse diaphoresis
  - ☐ change in color (pale, red, blue)
  - ☐ appears anxious
  - ☐ chest, shoulder, arm or jaw pain
  - ☐ muscle cramping
- ☐ Walk to AED locations (in Morosky Academic Center prior to September, in the Human Performance Lab during September)
- ☐ Review protocol for managing intolerance
  - ☐ slow down
  - ☐ stop and sit
  - ☐ monitor HR, BP, RR, signs/symptoms, RPE
  - ☐ rest until vital signs, signs/symptoms return to pre-intervention levels
  - ☐ proceed back into exercise with exercise previously tolerated, if signs/symptoms or intolerance have cleared and participant desires to continue
  - ☐ If this occurs more than twice during the entire study period for an individual, a review of the participant's data will occur and a discussion with the physician will ensue
- ☐ Emergency management procedures
  - ☐ Shout out for help
  - ☐ any researchers present in the area assist participants they are working with into a safe sitting position, preferably out of site of the person in distress if this will not add time to response time and respond to call for help
  - ☐ Provide First Aid or CPR (initiate rescue breaths and send someone for AED and help)
    - Call Gannon University Campus Police at 871-7777 (posted in all rooms)
    - or call 911

- if possible, send someone to the 10th street entrance (Morosky, before September) or the 6th street entrance (Human Performance Lab, September on) to flag emergency personnel
- Review participant right to ask for private testing or intervention room (may require rescheduling)
- Review participant right to end session
- copy of emergency procedures given to research assistant

Orientation and training provided by:

_____

(signature)
Beth Gustafson, PT, MSEd
Assistant Professor
Doctor of Physical Therapy Program

Appendix N: Table of Contents for Bank of Shaping Exercises

Four Square	Bilateral
Activity Description	Stand in center of four square; step with less affected first, more affected second
Parameters to Shape	Sequence of stepping (L, L, R, R or L, R, L, R, etc…) predictable or random sequence Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Return to start or stay in boxes EO/EC
Potential Feedback Parameters	Repetitions per 30 or 45 second trial Time in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Adaptable, coordinated movement between limbs
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Weight shifts	bilateral
Activity Description	Use as a guide for progression, maintain one activity for trial but can alter trials within the set; emphasize area of challenge [ ] BUE >> less affected UE >> more affected UE >> no BUE support (start with the least amount of support needed) [ ] lateral [ ] A/P [ ] diagonal [ ] oval [ ] figure 8
Parameters to Shape	Range of movement QOM (symmetry, hip and trunk extension)
Potential Feedback Parameters	Range of movement (you hit these three quadrants really well…try to emphasize this one next time; keep trying for this one, I know it is tough) "quietness" of stance/relaxed upper body and limbs QOM: hip and trunk extension; symmetry of weight; weight on more affected; knee control
Movements Emphasized	Ankle strategy • hip extension • trunk extension • knee control (use wedge if needed) • ankle control – static dynamic
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Heel and toe rocks	Bilateral, level surface, EO/EC
Activity Description	Shift weight from toes to heals; can add reach to target to facilitate weight shift if needed; start with EO, progress to EC
Parameters to Shape	Position of limbs (stride, symmetrical) Excursion Speed – movement to metronome EC
Potential Feedback Parameters	Seconds in synch with metronome QOM: hip and trunk extension; symmetry of weight; weight on more affected; knee control
Movements Emphasized	• A/P ankle strategy • hip extension • trunk extension • knee control (stand on wedge if needed to help control hyperextension) • concentric hip flexion/knee extension • dorsiflexion /plantar flexion
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Heel and toe rocks	Bilateral, foam, EO/EC
Activity Description	Stand on foam; shift weight from toes to heals; can add reach to target to facilitate weight shift if needed, start with EO, progress to EC
Parameters to Shape	Position of limbs (stride, symmetrical) Excursion Speed – movement to metronome EC Foam compliance
Potential Feedback Parameters	Seconds in synch with metronome QOM: hip and trunk extension; symmetry of weight; weight on more affected; knee control
Movements Emphasized	• A/P ankle strategy • hip extension • trunk extension • knee control (stand on wedge if needed to help control hyperextension) • concentric hip flexion/knee extension • dorsiflexion /plantar flexion
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Heel and toe rocks	Bilateral, foam, holding a glass of water
Activity Description	Stand on foam and hold a glass of water; shift weight from toes to heals; can add reach to target to facilitate weight shift if needed, start with EO, progress to EC
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Position of limbs (stride, symmetrical) Excursion Speed – movement to metronome EC Foam compliance
Potential Feedback Parameters	Seconds in synch with metronome control over water QOM: hip and trunk extension; symmetry of weight; weight on more affected; knee control
Movements Emphasized	• A/P ankle strategy • hip extension • trunk extension • knee control (stand on wedge if needed to help control hyperextension) • concentric hip flexion/knee extension • dorsiflexion /plantar flexion
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Stance, more affected, **level surface**
Activity Description	Step with less affected limb to target, maintain A hip extension throughout; start in stride stance progress to bilateral
Parameters to Shape	Distance to target (measure from stance heel) FWB to heel touch Starting position of stepping limb (trailing, bilateral, other) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Stance, more affected, **EC**
Activity Description	Step with less affected limb to target, EC, maintain A hip extension throughout; start in stride stance progress to bilateral
Parameters to Shape	Distance to target (measure from stance heel) FWB to heel touch Starting position of stepping limb (trailing, bilateral, other) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Stance, more affected**; stand on foam**
Activity Description	Stand on foam; step with less affected limb to target, maintain A hip extension throughout; start in stride stance progress to bilateral
Parameters to Shape	Distance to target (measure from stance heel) FWB to heel touch Starting position of stepping limb (trailing, bilateral, other) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Stance, more affected**; head turns**
Activity Description	Step with less affected limb to target while simultaneously looking to specific direction (Left, right, up, down, diagonal right, diagonal left, random), maintain A hip extension throughout; start in stride stance progress to bilateral (must have practiced to target first)
Parameters to Shape	Distance to target (measure from stance heel) FWB to heel touch Starting position of stepping limb (trailing, bilateral, other) Predictable or random head turn direction Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Direction of turning Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Stance, more affected**; reach for object**
Activity Description	Step with less affected limb towards target while reaching for an object, maintain A hip extension throughout; start in stride stance progress to bilateral
Parameters to Shape	Distance to target (measure from stance heel) FWB to toe touch on landing Starting position of stepping limb (trailing, bilateral, other) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome number of times object reached Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Direction of reaching Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Stance, more affected**; holding cup of water**
Activity Description	Step with less affected while holding a glass of water, return to start, maintain A hip extension throughout
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Distance to target (measure from stance heel) FWB to heel touch Starting position of stepping limb (trailing, bilateral) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome control over water Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Swing, more affected**, level surface**
Activity Description	Step to target with more affected, return to start; start in asymmetrical stance and progress to symmetrical (start in easier position)
Parameters to Shape	Distance to target (measure from stance heel) FWB to heel touch Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved step length Improved hip flexion Improved heel contact
Movements Emphasized	Stepping limb • Hip flexion (minimize pelvic elevation if possible) • land with heel first or foot flat (determine if possible in AFO) • "relaxed" stable trunk
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Swing, more affected**, EC**
Activity Description	Step to target with more affected, EC, return to start; start in asymmetrical stance and progress to symmetrical (start in easier position)
Parameters to Shape	Distance to target (measure from stance heel) FWB to heel touch Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved step length Improved hip flexion Improved heel contact
Movements Emphasized	Stepping limb • Hip flexion (minimize pelvic elevation if possible) • land with heel first or foot flat (determine if possible in AFO) • “relaxed” stable trunk
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Swing, more affected**; stand on foam**
Activity Description	Stand on foam less affected; step to target with more affected, return to start; start in asymmetrical stance and progress to symmetrical (start in easier position)
Parameters to Shape	Distance to target (measure from stance heel) FWB to heel touch Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved step length Improved hip flexion Improved heel contact
Movements Emphasized	Stepping limb • Hip flexion (minimize pelvic elevation if possible) • land with heel first or foot flat (determine if possible in AFO) • “relaxed” stable trunk
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Swing, more affected**; head turns**
Activity Description	Step with more affected onto step while simultaneously looking to specific direction (Left, right, up, down, diagonal right, diagonal left, random), return to start
Parameters to Shape	Distance to target (measure from stance heel) FWB to heel touch Predictable or random head turn direction Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed) Better balance with head turns
Movements Emphasized	Stepping limb • Hip flexion (minimize pelvic elevation if possible) • land with heel first or foot flat (determine if possible in AFO) • “relaxed” stable trunk
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Swing, more affected**; reach for object**
Activity Description	Step to target with more affected onto step while simultaneously reaching for an object (Left, right, up, down, diagonal right, diagonal left, random), return to start, maintain A hip extension throughout
Parameters to Shape	Distance to target (measure from stance heel) FWB to heel touch Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial Repetitions in sync with metronome number of times object reached Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stepping limb • Hip flexion (minimize pelvic elevation if possible) • land with heel first or foot flat (determine if possible in AFO) • "relaxed" stable trunk
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Direction of reaching Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Big Steps	Swing, more affected**; holding cup of water**
Activity Description	Step with more affected to target while holding a glass of water, return to start
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Distance to target (measure from stance heel) FWB to heel touch Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved control of water Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stepping limb • Hip flexion (minimize pelvic elevation if possible) • land with heel first or foot flat (determine if possible in AFO) • "relaxed" stable trunk
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Good 'Ole strengthening ex	Bilateral, alternating limbs
Activity Description	Alternate limbs for any or all of the following exercises (one trial per exercise) [ ] knee bends [ ] toe rises [ ] heel rises [ ] hamstring curls [ ] marching in place [ ] hip abduction (left/right alternating) [ ] hip extension (left/right alternating)
Parameters to Shape	Reps per trial Total reps per set Continuous metronome pace across all trials Seconds in pace with metronome per trial QOM
Potential Feedback Parameters	Seconds in synch with metronome QOM: hip and trunk extension; symmetry of weight; weight on more affected; knee control
Movements Emphasized	• depends upon movement but general goal is trunk and hip stability with superimposed movement (static/dynamic controlled mobility)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

lunge to dots	Stance, more affected
Activity Description	Bilateral stance; use colored discs for targets; step into lunge on colored disc
Parameters to Shape	Position of dots Number of dots Predictable or unpredictable sequence of stepping pattern Starting position of stepping limb (bilateral, trailing) Return to start or move to dots
Potential Feedback Parameters	Number of discs used Repetitions per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

lunge to dots	Stance, more affected**; stand on foam**
Activity Description	Bilateral stance; use colored discs for targets; step into lunge on colored disc
Parameters to Shape	Position of dots Number of dots Predictable or unpredictable sequence of stepping pattern Starting position of stepping limb (bilateral, trailing) Return to start or move to dots
Potential Feedback Parameters	Number of discs used Repetitions per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

lunges to dots	Stance, more affected**; holding cup of water**
Activity Description	Bilateral stance; use colored discs for targets; step into lunge on colored disc
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Position of dots Number of dots Predictable or unpredictable sequence of stepping pattern Starting position of stepping limb (bilateral, trailing) Return to start or move to dots
Potential Feedback Parameters	Number of discs used Repetitions per 30 or 45 second trial Repetitions in sync with metronome control over water Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (avoid hyperextension, emphasize flexion) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

lunges to dots	Stance, more affected; holding cup of water AND standing on foam
Activity Description	Bilateral stance; stand on foam; use colored discs for targets; step into lunge on colored disc
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Position of dots Number of dots Predictable or unpredictable sequence of stepping pattern Starting position of stepping limb (bilateral, trailing) Return to start or move to dots
Potential Feedback Parameters	Number of discs used Repetitions per 30 or 45 second trial Repetitions in sync with metronome control over water Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (avoid hyperextension, emphasize flexion) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

lunge to dots	Swing, more affected, **level surface**
Activity Description	Bilateral stance; use colored discs for targets; step into lunge on colored disc
Parameters to Shape	Position of dots Number of dots Predictable or unpredictable sequence of stepping pattern Starting position of stepping limb (bilateral, trailing) Return to start or move to dots
Potential Feedback Parameters	Number of discs used Repetitions per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed) Improved landing on forward foot
Movements Emphasized	Swing limb • Hip flexion (goal: from trailing limb position) • Initial contact • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

lunge to dots	Swing, more affected; stand on foam
Activity Description	Bilateral stance; stand on foam; use colored discs for targets; step into lunge on colored disc
Parameters to Shape	Position of dots Number of dots Predictable or unpredictable sequence of stepping pattern Starting position of stepping limb (bilateral, trailing) Return to start or move to dots
Potential Feedback Parameters	Number of discs used Repetitions per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed) Improved landing on forward foot
Movements Emphasized	Swing limb • Hip flexion (goal: from trailing limb position) • Initial contact • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

lunges to dots	Swing, more affected; holding cup of water
Activity Description	Bilateral stance; use colored discs for targets; step into lunge on colored disc
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Position of dots Number of dots Predictable or unpredictable sequence of stepping pattern Starting position of stepping limb (bilateral, trailing) Return to start or move to dots
Potential Feedback Parameters	Number of discs used Repetitions per 30 or 45 second trial Repetitions in sync with metronome control over water Improved hip extension (standing straight) Improved speed Improved control (slower speed) Improved landing on forward foot
Movements Emphasized	Swing limb • Hip flexion (goal: from trailing limb position) • Initial contact • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

lunges to dots	Swing, more affected; holding cup of water AND standing on foam
Activity Description	Bilateral stance; use colored discs for targets; step into lunge on colored disc
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Position of dots Number of dots Predictable or unpredictable sequence of stepping pattern Starting position of stepping limb (bilateral, trailing) Return to start or move to dots
Potential Feedback Parameters	Number of discs used Repetitions per 30 or 45 second trial Repetitions in sync with metronome control over water Improved hip extension (standing straight) Improved speed Improved control (slower speed) Improved landing on forward foot
Movements Emphasized	Swing limb • Hip flexion (goal: from trailing limb position) • Initial contact • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Toe Touch Steps	Stance, more affected, **level surface**
Activity Description	Place unaffected onto step, return to start, maintain A hip extension throughout
Parameters to Shape	Distance to step (measure from stance heel) Height of step (4.25", 6.25", _____) Toe touch to FWB Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved height Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Toe Touch Steps	Stance, more affected**; stand on foam**
Activity Description	Stand on foam, place unaffected onto step, return to start, maintain A hip extension throughout
Parameters to Shape	Distance to step (measure from stance heel) Height of step (4.25", 6.25", _____) Toe touch to FWB Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved height Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Toe Touch Steps	Stance, more affected**; head turns**
Activity Description	Place unaffected onto step while simultaneously looking to specific direction (Left, right, up, down, diagonal right, diagonal left, random), return to start, maintain A hip extension throughout
Parameters to Shape	Distance to step (measure from stance heel) Height of step (4.25", 6.25", _____) Toe touch to FWB Predictable or random head turn direction Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved height Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed) Better balance with head turns
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Direction of turning Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Toe Touch Steps	Stance, more affected**; reach for object**
Activity Description	Place unaffected onto step while simultaneously reaching for an object (Left, right, up, down, diagonal right, diagonal left, random), return to start, maintain A hip extension throughout
Parameters to Shape	Distance to step (measure from stance heel) Height of step (4.25", 6.25", _____) Toe touch to FWB Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial Repetitions in sync with metronome number of times object reached Improved height Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Direction of reaching Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Toe Touch Steps	Stance, more affected**; holding cup of water**
Activity Description	Place unaffected onto step, return to start, maintain A hip extension throughout
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Distance to step (measure from stance heel) Height of step (4.25", 6.25", _____) Toe touch to FWB Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome control over water Improved height Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Toe Touch Steps	Swing, more affected**, level surface**
Activity Description	Place more affected limb onto step, return to start
Parameters to Shape	Distance to step (measure from stance heel) Height of step (foam mat, 4.25", 6.25", _____) Toe touch to FWB Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved height Improved step length Improved hip flexion Improved landing on foot
Movements Emphasized	Stepping limb • Hip flexion (minimize pelvic elevation if possible) • land with heel first or foot flat (determine if possible in AFO) • "relaxed" stable trunk
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Toe Touch Steps	Swing, more affected**; stand on foam**
Activity Description	Less affected stand on foam; place more affected limb onto step, return to start
Parameters to Shape	Distance to step (measure from stance heel) Height of step (foam mat, 4.25", 6.25", _____) Toe touch to FWB Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved height Improved step length Improved hip flexion Improved landing on foot
Movements Emphasized	Stepping limb • Hip flexion (minimize pelvic elevation if possible) • land with heel first or foot flat (determine if possible in AFO) • "relaxed" stable trunk
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Toe Touch Steps	Swing, more affected**; head turns**
Activity Description	Place more affected onto step while simultaneously looking to specific direction (Left, right, up, down, diagonal right, diagonal left, random), return to start
Parameters to Shape	Distance to step (measure from stance heel) Height of step (foam mat, 4.25", 6.25", _____) Toe touch to FWB Starting position of stepping limb (bilateral, trailing) Predictable or random head turn direction Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome Improved height Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed) Better balance with head turns
Movements Emphasized	Stepping limb • Hip flexion (minimize pelvic elevation if possible) • land with heel first or foot flat (determine if possible in AFO) • "relaxed" stable trunk
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Toe Touch Steps	Swing, more affected**; reach for object**
Activity Description	Place more affected onto step while simultaneously reaching for an object (Left, right, up, down, diagonal right, diagonal left, random), return to start, maintain A hip extension throughout
Parameters to Shape	Distance to step (measure from stance heel) Height of step (4.25", 6.25", _____) Toe touch to FWB Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial Repetitions in sync with metronome number of times object reached Improved height Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stepping limb • Hip flexion (minimize pelvic elevation if possible) • land with heel first or foot flat (determine if possible in AFO) • "relaxed" stable trunk
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Direction of reaching Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Toe Touch Steps	Swing, more affected**; holding cup of water**
Activity Description	Place more affected onto step, return to start
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Distance to step (measure from stance heel) Height of step (foam mat, 4.25", 6.25", _____) Toe touch to FWB Starting position of stepping limb (bilateral, trailing) Self-paced repetitions Slow repetitions (45, 30, 15 bpm) Fast repetitions (60, 75, 100 bpm) Static hold time (up to 45 seconds)
Potential Feedback Parameters	Repetitions per 30 or 45 second trial repetitions in sync with metronome control over water Improved height Improved step length Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stepping limb • Hip flexion (minimize pelvic elevation if possible) • land with heel first or foot flat (determine if possible in AFO) • "relaxed" stable trunk
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Squish the pom pom	Stance, more affected
Activity Description	Roll a pom pom within reach of less affected LE; individual "squishes" pom pom
Parameters to Shape	Size of pom pom Predictable placement of pom pom to promote weight shift over stance limb • forward, lateral, backward, diagonal, cross midline Random placement of pom pom Speed of delivery/repetitions per trial
Potential Feedback Parameters	Number of pom poms squished Control of stance limb Improved hip extension (standing straight) Improved speed
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Squish the pom pom	Stance, more affected, stand on foam (or wedge)
Activity Description	Stance limb on foam, roll a pom pom within reach of less affected LE; individual "squishes" pom pom
Parameters to Shape	Size of pom pom Predictable placement of pom pom to promote weight shift over stance limb • forward, lateral, backward, diagonal, cross midline Random placement of pom pom Speed of delivery/repetitions per trial
Potential Feedback Parameters	Number of pom poms squished Control of stance limb Improved hip extension (standing straight) Improved speed
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Squish the pom pom	Stance, more affected, hold cup of water
Activity Description	Hold a glass of water, roll a pom pom within reach of less affected LE; individual "squishes" pom pom
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Size of pom pom Predictable placement of pom pom to promote weight shift over stance limb • forward, lateral, backward, diagonal, cross midline Random placement of pom pom Speed of delivery/repetitions per trial
Potential Feedback Parameters	Number of pom poms squished control over water Control of stance limb Improved hip extension (standing straight) Improved speed
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Squish the pom pom	Stance, more affected, stand on foam, hold cup of water
Activity Description	Stance limb on foam, hold a glass of water, roll a pom pom within reach of less affected LE; individual "squishes" pom pom
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Size of pom pom Predictable placement of pom pom to promote weight shift over stance limb • forward, lateral, backward, diagonal, cross midline Random placement of pom pom Speed of delivery/repetitions per trial
Potential Feedback Parameters	Number of pom poms squished control over water Control of stance limb Improved hip extension (standing straight) Improved speed
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Squish the pom pom	Swing, more affected, level surface
Activity Description	roll a pom pom within reach of more affected LE; individual "squishes" pom pom
Parameters to Shape	Size of pom pom Predictable placement of pom pom to promote "reaching" with swing limb • forward, lateral, backward, diagonal, cross midline Random placement of pom pom Speed of delivery/repetitions per trial
Potential Feedback Parameters	Number of pom poms squished Quality of initial contact Limb extension to reach pom pom Limb coordination to reach pom pom Improved speed
Movements Emphasized	Swing limb • Hip flexion • adaptive response: flexion, abduction, extension, adduction • limb extension • stable, quick, spontaneous foot contact
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Squish the pom pom	Swing, more affected, stand on foam
Activity Description	Stand on foam, less affected, roll a pom pom within reach of more affected LE; individual "squishes" pom pom
Parameters to Shape	Size of pom pom Predictable placement of pom pom to promote "reaching" with swing limb • forward, lateral, backward, diagonal, cross midline Random placement of pom pom Speed of delivery/repetitions per trial
Potential Feedback Parameters	Number of pom poms squished Quality of initial contact Limb extension to reach pom pom Limb coordination to reach pom pom Improved speed
Movements Emphasized	Swing limb • Hip flexion • adaptive response: flexion, abduction, extension, adduction • limb extension • stable, quick, spontaneous foot contact
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Squish the pom pom	Swing, more affected, hold cup of water
Activity Description	Hold a cup of water; roll a pom pom within reach of more affected LE; individual "squishes" pom pom
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Size of pom pom Predictable placement of pom pom to promote "reaching" with swing limb • forward, lateral, backward, diagonal, cross midline Random placement of pom pom Speed of delivery/repetitions per trial
Potential Feedback Parameters	Number of pom poms squished Quality of initial contact control over water Limb extension to reach pom pom Limb coordination to reach pom pom Improved speed
Movements Emphasized	Swing limb • Hip flexion • adaptive response: flexion, abduction, extension, adduction • limb extension • stable, quick, spontaneous foot contact
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Squish the pom pom	Swing, more affected, stand on foam, hold cup of water
Activity Description	Stand on foam, less affected; hold a cup of water; roll a pom pom within reach of more affected LE; individual "squishes" pom pom
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Size of pom pom Predictable placement of pom pom to promote "reaching" with swing limb • forward, lateral, backward, diagonal, cross midline Random placement of pom pom Speed of delivery/repetitions per trial
Potential Feedback Parameters	Number of pom poms squished Quality of initial contact control over water Limb extension to reach pom pom Limb coordination to reach pom pom Improved speed
Movements Emphasized	Swing limb • Hip flexion • adaptive response: flexion, abduction, extension, adduction • limb extension • stable, quick, spontaneous foot contact
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the golf ball, SB	Stance, more affected
Activity Description	Kick a golf ball to a target, less affected limb
Parameters to Shape	Use with a SB or without Stationary ball or rolled ball Distance of target Width of target Position of target Limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Stability in stance limb and trunk
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the golf ball, SB	Stance, more affected, stand on foam (or wedge)
Activity Description	Stand on foam; kick a golf ball to a target, less affected limb
Parameters to Shape	Use with a SB or without Stationary ball or rolled ball Distance of target Width of target Position of target Limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Stability in stance limb and trunk
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the golf ball, SB	Stance, more affected, hold cup of water
Activity Description	Hold a glass of water; Kick a golf ball to a target, less affected limb
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Use with a SB or without Stationary ball or rolled ball Distance of target Width of target Position of target Limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Control over water Stability in stance limb and trunk
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the golf ball, SB	Stance, more affected, stand on foam, hold cup of water
Activity Description	Stand on foam, hold a glass of water; kick a golf ball to a target, less affected limb
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Use with a SB or without Stationary ball or rolled ball Distance of target Width of target Position of target Limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Control of water Stability in stance limb and trunk
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the golf ball, SB	Swing, more affected
Activity Description	Kick a golf ball to a target, more affected limb
Parameters to Shape	Use with a SB or without Stationary ball or rolled ball Distance of target Width of target Position of target Limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Control of ankle/use of foot and ankle to strike ball
Movements Emphasized	Swing limb • Knee flexion • eccentric knee extension • concentric hip flexion/knee extension • dorsiflexion • low-limb clearance
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the golf ball, SB	Swing, more affected, stand on foam
Activity Description	Stand on foam; kick a golf ball to a target, more affected limb
Parameters to Shape	Use with a SB or without Stationary ball or rolled ball Distance of target Width of target Position of target Limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Control of ankle/use of foot and ankle to strike ball
Movements Emphasized	Swing limb • Knee flexion • eccentric knee extension • concentric hip flexion/knee extension • dorsiflexion • low-limb clearance
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the golf ball, SB	Swing, more affected, hold cup of water
Activity Description	hold a glass of water; kick a golf ball to a target, more affected limb
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Use with a SB or without Stationary ball or rolled ball Distance of target Width of target Position of target Limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Control of water Control of ankle/use of foot and ankle to strike ball
Movements Emphasized	Swing limb • Knee flexion • eccentric knee extension • concentric hip flexion/knee extension • dorsiflexion • low-limb clearance
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the golf ball, SB	Swing, more affected, stand on foam, hold cup of water
Activity Description	Stand on foam; hold a glass of water; kick a golf ball to a target, more affected limb
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Use with a SB or without Stationary ball or rolled ball Distance of target Width of target Position of target Limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Control of water Control of ankle/use of foot and ankle to strike ball
Movements Emphasized	Swing limb • Knee flexion • eccentric knee extension • concentric hip flexion/knee extension • dorsiflexion • low-limb clearance
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the disc	Stance, more affected
Activity Description	Kick a disc to a target, less affected limb
Parameters to Shape	Size of disc (Frisbee, floor protector, large button, small button) Distance of target Width of target Position of target/limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Size of disc Stability in stance limb and trunk
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the disc	Stance, more affected, stand on foam (or wedge)
Activity Description	Stand on foam, more affected; kick a disc to a target, less affected limb
Parameters to Shape	Size of disc (Frisbee, floor protector, large button, small button) Distance of target Width of target Position of target/limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Size of disc Stability in stance limb and trunk
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the disc	Stance, more affected, hold cup of water
Activity Description	Hold a glass of water, kick a disc to a target, less affected limb
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Size of disc (Frisbee, floor protector, large button, small button) Distance of target Width of target Position of target/limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit control over water Distance achieved Path of object Size of disc Stability in stance limb and trunk
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the disc	Stance, more affected, stand on foam, hold cup of water
Activity Description	Stand on foam, more affected; hold a glass of water, kick a disc to a target, less affected limb
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Size of disc (Frisbee, floor protector, large button, small button) Distance of target Width of target Position of target/limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit control over water Distance achieved Path of object Size of disc Stability in stance limb and trunk
Movements Emphasized	Stance limb • Hip extension • forward, lateral, posterior progression • knee control (avoid hyperextension, emphasize flexion) • ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the disc	Swing, more affected
Activity Description	kick a disc to a target, more affected limb
Parameters to Shape	Size of disc (Frisbee, floor protector, large button, small button) Distance of target Width of target Position of target/limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Size of disc Stability in stance limb and trunk
Movements Emphasized	Swing limb • Knee flexion • eccentric knee extension • concentric hip flexion/knee extension • dorsiflexion • low-limb clearance
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the disc	Swing, more affected, stand on foam
Activity Description	Stand on foam (less affected) kick a disc to a target, more affected limb
Parameters to Shape	Size of disc (Frisbee, floor protector, large button, small button) Distance of target Width of target Position of target/limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved Path of object Size of disc Stability in stance limb and trunk
Movements Emphasized	Swing limb • Knee flexion • eccentric knee extension • concentric hip flexion/knee extension • dorsiflexion • low-limb clearance
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the disc	Swing, more affected, hold cup of water
Activity Description	Hold cup of water, kick a disc to a target, more affected limb
Parameters to Shape	Size of disc (Frisbee, floor protector, large button, small button) Distance of target Width of target Position of target/limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit Distance achieved control over water Path of object Size of disc Stability in stance limb and trunk
Movements Emphasized	Swing limb • Knee flexion • eccentric knee extension • concentric hip flexion/knee extension • dorsiflexion • low-limb clearance
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Kick the disc	Swing, more affected, stand on foam, hold cup of water
Activity Description	Stand on foam less affected, hold a cup of water, kick a disc to a target, more affected limb
Parameters to Shape	Size of disc (Frisbee, floor protector, large button, small button) Distance of target Width of target Position of target/limb starting position (neutral, trailing, terminal stance)
Potential Feedback Parameters	# times target hit control over water Distance achieved Path of object Size of disc Stability in stance limb and trunk
Movements Emphasized	Swing limb • Knee flexion • eccentric knee extension • concentric hip flexion/knee extension • dorsiflexion • low-limb clearance
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Don't squish the birdie	Stance, more affected
Activity Description	Place birdies or birdies and cones around the moving limb; touch birdie or cone with heel or toe
Parameters to Shape	Position of birdies/cones Birdies only or birdies and cones Number of birdies/cones Pattern of birdies and cones (repetitive, random) Starting position of stepping limb (bilateral, trailing) Return to start or move to birdies/cones
Potential Feedback Parameters	Number of objects used Number of "hits" without "squishes" Repetitions per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Don't squish the birdie	Stance, more affected**; stand on foam**
Activity Description	Stand on foam with more affected; place birdies or birdies and cones around the moving limb; touch birdie or cone with heel or toe
Parameters to Shape	Position of birdies/cones Birdies only or birdies and cones Number of birdies/cones Pattern of birdies and cones (repetitive, random) Starting position of stepping limb (bilateral, trailing) Return to start or move to birdies/cones
Potential Feedback Parameters	Number of objects used Number of "hits" without "squishes" Repetitions per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Don't squish the birdie	Stance, more affected**; holding cup of water**
Activity Description	Hold a glass of water; Place birdies or birdies and cones around the moving limb; touch birdie or cone with heel or toe
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Position of birdies/cones Birdies only or birdies and cones Number of birdies/cones Pattern of birdies and cones (repetitive, random) Starting position of stepping limb (bilateral, trailing) Return to start or move to birdies/cones
Potential Feedback Parameters	Number of objects used Number of "hits" without "squishes" Control over water Repetitions per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (avoid hyperextension, emphasize flexion) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Don't squish the birdie	Stance, more affected; holding cup of water AND standing on foam
Activity Description	Hold a glass of water and standing on foam; Place birdies or birdies and cones around the moving limb; touch birdie or cone with heel or toe
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Position of birdies/cones Birdies only or birdies and cones Number of birdies/cones Pattern of birdies and cones (repetitive, random) Starting position of stepping limb (bilateral, trailing) Return to start or move to birdies/cones
Potential Feedback Parameters	Number of objects used Number of "hits" without "squishes" Control over water Repetitions per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (avoid hyperextension, emphasize flexion) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Don't squish the birdie	Swing, more affected, **level surface**
Activity Description	place birdies or birdies and cones around the moving limb; touch birdie or cone with heel or toe
Parameters to Shape	Position of birdies/cones Birdies only or birdies and cones Number of birdies/cones Tap with heel or toe (predictable or random) Pattern of birdies and cones (repetitive, random) Starting position of stepping limb (bilateral, trailing) Return to start or move to birdies/cones
Potential Feedback Parameters	Number of objects used Number of "hits" without "squishes" Repetitions per 30 or 45 second trial Repetitions in sync with metronome Quality of contact (heel/toe) Improved speed Improved control (slower speed)
Movements Emphasized	Swing limb • Hip flexion (goal: from trailing limb position) • Initial contact • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Don't squish the birdie	Swing, more affected; stand on foam
Activity Description	Stand on foam; place birdies or birdies and cones around the moving limb; touch birdie or cone with heel or toe
Parameters to Shape	Position of birdies/cones Birdies only or birdies and cones Number of birdies/cones Tap with heel or toe (predictable or random) Pattern of birdies and cones (repetitive, random) Starting position of stepping limb (bilateral, trailing) Return to start or move to birdies/cones
Potential Feedback Parameters	Number of objects used Number of "hits" without "squishes" Repetitions per 30 or 45 second trial Repetitions in sync with metronome Quality of contact (heel/toe) Improved speed Improved control (slower speed)
Movements Emphasized	Swing limb • Hip flexion (goal: from trailing limb position) • Initial contact • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Don't squish the birdie	Swing, more affected; holding cup of water
Activity Description	place birdies or birdies and cones around the moving limb; touch birdie or cone with heel or toe
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Position of birdies/cones Birdies only or birdies and cones Number of birdies/cones Tap with heel or toe (predictable or random) Pattern of birdies and cones (repetitive, random) Starting position of stepping limb (bilateral, trailing) Return to start or move to birdies/cones
Potential Feedback Parameters	Number of objects used Number of "hits" without "squishes" Control over water Repetitions per 30 or 45 second trial Repetitions in sync with metronome Quality of contact (heel/toe) Improved speed Improved control (slower speed)
Movements Emphasized	Swing limb • Hip flexion (goal: from trailing limb position) • Initial contact • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Don't squish the birdie	Swing, more affected; holding cup of water AND standing on foam
Activity Description	place birdies or birdies and cones around the moving limb; touch birdie or cone with heel or toe
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Position of birdies/cones Birdies only or birdies and cones Number of birdies/cones Tap with heel or toe (predictable or random) Pattern of birdies and cones (repetitive, random) Starting position of stepping limb (bilateral, trailing) Return to start or move to birdies/cones
Potential Feedback Parameters	Number of objects used Number of "hits" without "squishes" Control over water Repetitions per 30 or 45 second trial Repetitions in sync with metronome Quality of contact (heel/toe) Improved speed Improved control (slower speed)
Movements Emphasized	Swing limb • Hip flexion (goal: from trailing limb position) • Initial contact • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Auto steps	Bilateral
Activity Description	Use theraband to encourage ankle strategy; release theraband slightly with unpredictable timing to promote stepping response
Parameters to Shape	Predictability of release Direction of sway Amount of sway EO/EC
Potential Feedback Parameters	Successful catches without assist per 30 or 45 second trial Stability of limbs Stability of trunk
Movements Emphasized	• Automatic postural reactions • Ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Flamingo on kick ball	Stance, more affected
Activity Description	Less affected on kick ball
Parameters to Shape	Hold foot on ball Roll ball A/P with foot on it Roll ball lateral with foot on it Roll ball in circle (switch directions each trial) with foot on it Roll ball with foot on it, respond to random direction
Potential Feedback Parameters	Time foot on ball per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Flamingo on kick ball	Stance, more affected**; stand on foam**
Activity Description	Stand on foam, Less affected on kick ball
Parameters to Shape	Hold foot on ball Roll ball A/P with foot on it Roll ball lateral with foot on it Roll ball in circle (switch directions each trial) with foot on it Roll ball with foot on it, respond to random direction
Potential Feedback Parameters	Time foot on ball per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Flamingo on kick ball	Stance, more affected**; EC**
Activity Description	Less affected on kick ball, EC
Parameters to Shape	Hold foot on ball Roll ball A/P with foot on it Roll ball lateral with foot on it Roll ball in circle (switch directions each trial) with foot on it Roll ball with foot on it, respond to random direction
Potential Feedback Parameters	Time foot on ball per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Flamingo on kick ball	Stance, more affected**; reach for object**
Activity Description	Less affected on kick ball, reach for object
Parameters to Shape	Hold foot on ball Roll ball A/P with foot on it Roll ball lateral with foot on it Roll ball in circle (switch directions each trial) with foot on it Roll ball with foot on it, respond to random direction
Potential Feedback Parameters	Time foot on ball per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (use wedge to help control hyperextension if necessary) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Flamingo on kick ball	Stance, more affected**; holding cup of water**
Activity Description	Hold cup of water; Less affected on kick ball
Parameters to Shape	Type of container holding water and/or amount of water (less or more open/full) Hold foot on ball Roll ball A/P with foot on it Roll ball lateral with foot on it Roll ball in circle (switch directions each trial) with foot on it Roll ball with foot on it, respond to random direction
Potential Feedback Parameters	Time foot on ball per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Control of water Improved control (slower speed)
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (avoid hyperextension, emphasize flexion) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Flamingo on kick ball	Stance, more affected; head turns
Activity Description	Less affected on kick ball, while simultaneously looking to specific direction (Left, right, up, down, diagonal right, diagonal left, random)
Parameters to Shape	Hold foot on ball Roll ball A/P with foot on it Roll ball lateral with foot on it Roll ball in circle (switch directions each trial) with foot on it Roll ball with foot on it, respond to random direction
Potential Feedback Parameters	Time foot on ball per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Control of water Improved control (slower speed) Balance with head turns
Movements Emphasized	Stance limb • Hip extension • forward progression • knee control (avoid hyperextension, emphasize flexion) • ankle stability/ankle strategy
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Flamingo on kick ball	Swing, more affected, **level surface**
Activity Description	More affected on kick ball
Parameters to Shape	Hold foot on ball Roll ball A/P with foot on it Roll ball lateral with foot on it Roll ball in circle (switch directions each trial) with foot on it Roll ball with foot on it, respond to random direction
Potential Feedback Parameters	Time foot on ball per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Swing limb • coordination of swing limb, light and moveable • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Flamingo on kick ball	Swing, more affected, **EC**
Activity Description	More affected on kick ball, EC
Parameters to Shape	Hold foot on ball Roll ball A/P with foot on it Roll ball lateral with foot on it Roll ball in circle (switch directions each trial) with foot on it Roll ball with foot on it, respond to random direction
Potential Feedback Parameters	Time foot on ball per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Swing limb • coordination of swing limb, light and moveable • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Flamingo on kick ball	Swing, more affected, **reach for object**
Activity Description	more affected on kick ball, reach for object
Parameters to Shape	Position of object Hold foot on ball Roll ball A/P with foot on it Roll ball lateral with foot on it Roll ball in circle (switch directions each trial) with foot on it Roll ball with foot on it, respond to random direction
Potential Feedback Parameters	Time foot on ball per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Swing limb • coordination of swing limb, light and moveable • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Flamingo on kick ball	Swing, more affected; stand on foam
Activity Description	Stand on foam, more affected on kick ball
Parameters to Shape	Hold foot on ball Roll ball A/P with foot on it Roll ball lateral with foot on it Roll ball in circle (switch directions each trial) with foot on it Roll ball with foot on it, respond to random direction
Potential Feedback Parameters	Time foot on ball per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Swing limb • coordination of swing limb, light and moveable • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Flamingo on kick ball	Swing, more affected; head turns
Activity Description	more affected on kick ball, while simultaneously looking to specific direction (Left, right, up, down, diagonal right, diagonal left, random)
Parameters to Shape	Hold foot on ball Roll ball A/P with foot on it Roll ball lateral with foot on it Roll ball in circle (switch directions each trial) with foot on it Roll ball with foot on it, respond to random direction
Potential Feedback Parameters	Time foot on ball per 30 or 45 second trial Repetitions in sync with metronome Improved hip extension (standing straight) Improved speed Improved control (slower speed)
Movements Emphasized	Swing limb • coordination of swing limb, light and moveable • Adaptive limb response (hip abduction, hip extension, hip adduction)
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Repetitions per trail (record for each of 10 trials) Seconds per trail in which beat was maintained (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Stand on one leg	Stance stability, more and less affected
Activity Description	Stand on one leg progression [ ] less affected leg first, using UE support if needed [ ] allow standing rest between trials to "shake-out" limb [ ] BUE >> less affected UE >> more affected UE >> no BUE support (start with the least amount of support needed) [ ] Once 25 – 30 seconds is achieved per trial, add in EC or foam [ ] follow same progression with more affected LE
Parameters to Shape	Stance limb Maximum hold per trial Total seconds per set QOM
Potential Feedback Parameters	Maximum hold time Adding seconds to total…that is good "quietness" of stance/relaxed upper body and limbs QOM: hip and trunk extension; symmetry of weight; weight on more affected; knee control
Movements Emphasized	Stance limb • hip extension • trunk extension • knee control (use wedge if needed) • ankle control – static dynamic
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done

Dips	stance
Activity Description	Stand on stool, lower limb NWB limb to ground, return to stool, repeat Alternate sides per trial; allow standing rest in any position within trial as needed
Parameters to Shape	Reps per trial L/R reps Total reps per set Range of movement (control with stool height, use two side by side if necessary to have just a small difference) QOM (symmetry, hip and trunk extension)
Potential Feedback Parameters	Number of reps/trial Decreasing rest time within trial effort "quietness" of stance/relaxed upper body and limbs QOM: hip and trunk extension; symmetry of weight; weight on more affected; knee control
Movements Emphasized	strengthening • hip extension • knee extension • concentric/eccentric gastroc • trunk extension • knee control
Recorded Results	Before (minimum) and after (maximum) RPE HR max from HR monitor Shaping parameter Two, one or no UE assist Trial time (30 or 45 seconds) Successes per trial (record for each of 10 trials) In notes: indicate if AFO was worn; recommendations for continuing or progressing or modifying the activity; any signs of intolerance and what was done