Floor to Stand Performance among Persons Following Stroke

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Abstract

Studies have examined floor to stand performance in varied adult populations both quantitatively and qualitatively. Despite an elevated risk of falls and inability to independently return to stand after a fall, few have examined the ability to perform floor to stand in patients recovering from stroke. The purposes of this study were to (1) identify relationships between floor to stand performance using the Timed Supine to Stand test (TSS) and physical performance measures of gait, balance and balance confidence, along with individual characteristics in persons in the subacute phase after stroke and (2) to analyze movement strategies used in the completion of the TSS. Fifty-eight adults [59.2 (13.9); 34 (58.6%) male] in the subacute phase after ischemic or hemorrhagic stroke who could stand from the floor with no more than supervision completed the TSS and physical performance assessments. The median time to complete the TSS in our sample was 13.0 (15.5) seconds. Fifty-five (94.8%) participants used an asymmetric roll strategy combined with intermediate positions to complete the TSS. TSS time was significantly correlated with physical performance tests including Timed Up and Go (TUG) test (r = .70, $p < .01$), gait velocity (r = -.67, $p < .01$), Dynamic Gait Index (r = -.52, $p < .01$), Activities-specific Balance Confidence scale (r = -.43, $p < .01$), and individual characteristics including days since stroke (r = .30, $p < .05$). Thirty-two percent of the variance in TSS time ($p < .001$) was attributed to TUG time and use of the quadruped position in the transition to stand. Findings serve to improve functional mobility assessment post stroke and to formulate effective treatment interventions to improve floor to stand performance after stroke.

Keywords: timed supine to stand, physical performance, movement pattern

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Floor to Stand Performance among Persons Following Stroke

Stroke, also known as cerebral vascular accident (CVA), is the leading cause of long-term disability, with 800,000 persons experiencing stroke each year in the United States (Benjamin et al., 2018). Falling is one of the most common complications after stroke, and occurs in all phases of recovery. It has been reported that 14-65% of those diagnosed with stroke fall at least once during their hospitalization, and 37-73% fall during the first six months after being discharged home (Batchelor, et al., , 2012). The first two months after discharge home from rehabilitation have been identified as a critical time for falls, with over 50% of falls occurring during this period (Mackintosh, et al., 2005). In addition, 30% of patients with both minor cognitive impairment and moderate-to-high levels of mobility reported at least one fall in the 12 weeks post-discharge from rehabilitation (Van der Kooi et al., 2017). Tilson et al. (2012) reported that while the primary goal of rehabilitation after stroke is to improve mobility in the presence of motor, balance, and visual-spatial deficits, fall risk can be an adverse consequence.

Many stroke survivors who experience a fall are unable to stand from the floor unassisted (Mackintosh et al., 2005; Tilson et al., 2012). Inability to stand from the floor after a fall is defined as a critical fall (Bloch, 2012); moreover, critical falls are associated with higher rates of mortality (Brito et al., 2012). The ability to rise from the floor is a significant contributor to physical independence throughout the lifespan (Vansant, 1988). Studies on strategies used to stand from the floor, time required to stand, and their correlation with other physical performance measures have been studied in healthy adult populations (Alexander, et al., 1997; Bergland & Laake, 2005; Bohannon & Lusardi, 2004; Klima et al., 2016; Moffett, et al., 2020; Ulbrich, et al., 2000; Vansant, 1998;). Results from these studies demonstrated variations in strategies used, increased time required for task completion, and an inability to complete the task in the presence of advanced age and physical impairments. Similar challenges with the task of standing from the floor have been reported in patients with neurological conditions including use of less advanced movement strategies and increased time for completion (Belt et al., 2001; Boswell, et al., 1993; Ng et al., 2015; Unrau, et al., 1994).

Despite the elevated risk for falls post-stroke, concomitant reported difficulty in standing from the floor, and potential for critical falls, little research has examined the ability to stand from the floor in this population. Ng et al. (2015) demonstrated reliability and validity of the floor transfer test for use with patients with chronic stroke, and demonstrated a correlation between this test and other physical performance measures. Movement strategies used to complete standing from the floor after stroke have not been identified or compared to healthy adult populations. Therefore, the purpose of this study is to explore the relationship of the ability to stand from the floor with other physical performance measures and to identify floor rise strategies in the early subacute phase of stroke prior to discharge from acute rehabilitation. The research questions are twofold.

1. Is the ability to stand from the floor as measured by the timed supine to stand test related to functional performance (gait performance and balance confidence), as well as individual characteristics (age, gender, body mass index) in persons in the subacute phase of stroke?
2. What are the strategies used to complete the timed supine to stand test by individuals in the early subacute phase of stroke recovery?

Establishing correlations with other standard of care physical performance measures will serve to concurrently validate the timed supine to stand test in persons with stroke and better allow physical therapists to identify patients with deficits in the ability to stand from the floor.

Identifying strategies used and the time required for task completion will assist physical therapists to better prepare patients to independently stand from the floor should a fall occur.

Literature Review

Stroke, or cerebrovascular accident (CVA) is the leading cause of long-term disability in the United States (U.S.), with 800,000 people experiencing stroke each year (Benjamin et al., 2018). While the number of deaths because of stroke has declined since 2005, there are nearly 92.1 million adults living in the U.S. with cardiovascular disease or after-effects of stroke (Benjamin et al., 2018). The associated health care and lost productivity exceeds $329.7 billion annually in the U.S. (Benjamin et al., 2018).

Stroke and Falls

The primary goal of post-stroke rehabilitation is to improve mobility given motor, balance and visual-spatial deficits. Tilson et al. (2012) warned that working toward this goal may increase the risk for falls. Falls are one of the most common complications after stroke. The fall rate is higher after stroke than in the general population of community dwelling adults at 20-57% versus 15%, respectively (Batchelor, et al., 2012). Falls are reported at all levels of recovery after stroke. Great variability and wide ranges of fall rates exist among studies reporting falls incidence post-stroke (Van der Kooi et al., 2017). For example, during hospitalization, 14-65% of people with stroke fall at least once (Batchelor et al., 2012). In the first six months after discharge from rehabilitation, 37-73% reported falls (Batchelor et al., 2012; Lim, et al., 2012). In patients at least one year after stroke, the fall rate has been reported to be 36% compared to 24% in age and gender-matched controls (Mackintosh, et al., 2005). Even 10 years following stroke, the fall rate has been reported as twice that of age and gender-matched controls, with the rate of recurrent falls also higher (Jorgensen, et al., 2002). The variability in reported incidence of falls post-stroke is thought to be related to unclear definition of a fall episode, decreased accuracy of retrospective fall reporting, variability of patient groups studied, variation in the time period in which falls were studied and variation in applied treatment protocols (Van der Kooi et al., 2017). Among all the time periods studied regarding falls post-stroke, the most critical period appears to be in the transition from the inpatient setting to the community. Van der Kooi et al. (2017) reported a 28% fall rate in patients after stroke in the 12 weeks after discharge from inpatient rehabilitation. Lim et al. (2012) reported a single fall rate of 19% and a repeated fall rate of 29% in patients after stroke within an average of 20 months after discharge from the inpatient setting. One or more falls during this time have correlated negatively with improvements in self-reported functional status as measured by the Stroke Impact Scale-16 in participants with minor cognitive deficits and moderate to high mobility scores (Van der Kooi et al., 2017) and fear of falling prevalence in participants who were ambulatory (Lim et al., 2012).

Patients after stroke are at increased risk for falls when walking or performing activities of daily living (ADL) due to the presence of stroke-related deficits including hemiparesis or hemiplegia, abnormal movement patterns, altered muscle tone, sensory changes, visual impairment, cognitive effects, emotional impact, impaired balance, and fatigue (Kelley et al., 2010). The consequences of falls impact both stroke survivors and their caregivers; moreover, many negative effects have been reported in the literature. The immediate effect could be serious injury (Kelley et al., 2010). Additionally, the stroke survivor may limit activity and participation and increase dependence on caregivers for assist in mobility and ADL tasks (Schmid & Rittman, 2009). This may increase the economic burden of informal caregiving (Joo, et al., 2017). Finally, falls can lead to increased fear of falling for both the stroke survivor and the caregiver (Kelley et al., 2010; Schmid & Rittman, 2009), which may result in further self or caregiver-imposed limitations on activity and participation.

Another concern is the issue of the critical fall. A critical fall is defined as a fall with the inability to retain upright posture, whatever the reason (Bloch, 2012). A critical fall results in increased periods of time spent on the floor, which is associated with increased mortality. Bloch (2012) reported that a critical fall nearly doubles the risk of death due to complications including the development of pressure ulcers, dehydration, hypothermia, rhabdomyolysis or renal failure. Brito et al. (2014) demonstrated support of this point with association between increased difficulty rising from the floor and higher rates of all-cause mortality among healthy older adults. This concept of the critical fall applies to patients after stroke, as many experience difficulties in rising from the floor or inability to rise from the floor unassisted after a fall. Less than half of individuals with stroke surveyed reported the ability to get up from the floor after a non-injurious fall (Tinetti, et al., 1993). This finding has been supported by more recent studies in which researchers reported on the incidence of assistance needed in getting up from the floor in patients with stroke. Mackintosh et al. (2005) reported 38% of their participants post stroke participating in a rehabilitation program and returning to live in the community needed assistance to get up after a fall in the six months after discharge from rehabilitation. In their summary article, Batchelor et al. (2012) reported 20-30% of people with stroke are unable to get up from the floor unaided after a fall. Furthermore, of the participants with stroke who participated in the Locomotor Experience Applied Post-stroke (LEAPS) trial and experienced a fall or multiple falls in the two to twelve months after stroke, 74% experienced a fall from which they could not rise independently (Tilson et al., 2012).

Floor Rise in Adult Populations

The ability of individuals to rise from the floor has been studied across the lifespan with healthy individuals and those with physical impairment. Previous studies have examined movement strategies and timed performance for rising from the floor, as well as psychometrics and correlation of floor rise tests with other physical performance measures.

There are three methods cited in the literature for analysis of movement strategies used to rise from the floor in select adult populations. Each method has added information to the pool of literature regarding movement strategies used to complete floor rise and variations in patterns used based on the parameters, correlates or diagnoses studied. The most widely adapted method of analysis of floor rise movement strategies is that of VanSant (1988). In a seminal study, VanSant (1988) described the component method of movement analysis for supine to stand in healthy young adults. The movement patterns where divided into three sections including the upper extremity, axial and the lower extremity to allow analysis at each component. Analysis of 32 participants resulted in identification of five categories of upper extremity action, four categories of lower extremity action and four categories of axial movement (VanSant, 1988). Higher frequencies of movements observed were considered more advanced movement patterns. The most advanced movement strategies identified were symmetrical push (46%) in the upper extremity, an asymmetrical squat (40.9%) in the lower extremity and symmetrical movement of the head and trunk (46.2%) for the axial component (VanSant, 1988). Twenty-one different combinations of component action across the 320 trials completed by the 32 young adult participants were identified (VanSant, 1988). This seminal work introduced the idea of variations in movement patterns both within and between participants used for rising from supine on the floor to standing (VanSant, 1988).

The method of movement analysis described by VanSant (1988) has been used in multiple studies to both examine movement patterns used in select adult populations and to identify further variations and contributors to this task (Alexander et al., 1997; Green & Williams, 1992; King & VanSant, 1995; Ulbrich et al., 2000). First, a moderate (once or twice per week) to high (daily) level of physical activity in 72 young adults age 30-39 years was noted to lead to more advanced, symmetrical movement pattern selection for standing from the floor compared to those with no or rare physical activity (Green & Williams, 1992). Furthermore, the presence of a solid ankle-foot orthosis (SAFO) in 39 young, healthy adults age 20-28 years changed the choice of movement pattern used to stand from the floor from a symmetrical pattern when no SAFO was used, to less advanced asymmetrical patterns in the upper extremity, axial and lower extremity components when either a unilateral or bilateral SAFO was present (King & VanSant, 1995). Finally, the presence of older age and physical impairment were noted to impact the selection of movement strategy to stand from the floor, the time needed and the use of intermediate positions. (Alexander et al. 1997; Ulbrich et al., 2000). Specifically, Alexander et al. (1997) reported that healthy older adults required 2.4-5.5 seconds to rise from the floor compared to healthy young adults that required 1.4-2.6 seconds, and older adult women with physical impairment who could complete the tasks required 6.4-13.2 seconds for task completion. Additionally, older adults with physical impairment more commonly required a modified starting position such as side-lying and external support such as a table to rise from the floor and reported increased difficulty in task completion due to reports of pain, weakness, and/or balance impairments (Alexander et al., 1997). Fifteen percent of older adults with a mean age of 81 years, with physical impairment were unable to complete the rising from the floor task with any type of modification or support in this study population (Alexander et al., 1997).

Ulbrich et al. (2000) further examined this older adult population with physical impairment regarding movement strategies selected and time. They reported a hierarchy of performance within these parameters with healthy young adults completing the floor rise task in the least amount of time using the most advanced symmetric strategies and least amount of intermediate positions or supports (Ulrich et al., 2000). Older adults with physical impairment required the most time, selected the least advanced and most asymmetric movement strategies and used the highest number of intermediate positions (Ulrich et al., 2000). Healthy older adults fell in the middle of these groups for time and use of intermediate positions or supports (Ulbrich et al., 2000).

The sitting-rising test (SRT) is another method for movement analysis of the floor rise task (Brito et al., 2012). Using this method, the investigators scored participant ability to rise from the floor from zero to five, with one point subtracted for each support used for both the standing to sitting and sitting to stand task, half of a point subtracted for evaluator's perception of instability, with a total score of 0 to 10 reported. This method varied from VanSant's method since it did not have the participants move fully from supine to stand and did not use component analysis of the upper body, trunk and lower body (Brito et al., 2012). This method focused on intermediate positions described by Ulbrich et al. (2000). Using this method, Brito et al. (2012) demonstrated the impact flexibility can have on the task of rising from the floor with lower SRT scores reported for participants with lower levels of flexibility. Brito et al. (2014) later used this strategy to associate the ability of adults to rise from the floor with all-cause mortality. The authors reported that lower SRT scores were associated with higher mortality and that each unit increase in SRT score was associated with a 21% improvement in survival over an average of six years (Brito el al., 2014).

The final method found in the literature for description of floor rise was utilized by Schwickert et al. (2016) to compare movement strategies used by younger adults to that of older healthy adults. The investigators completed video analysis of recorded performance of the floor rise task for each participant to identify shared movement strategies and intermediate positions (Schwickert et al., 2016). They identified seven components of the task including lying, initiation, positioning, supporting, elevation, stabilization, standing, and walking (Schwickert et al., 2016). The investigators subsequently observed the components used and sequence of components comparing younger subjects to older subjects in the task of supine lying to standing or walking (Schwickert et al., 2016). The younger adult group moved through the seven components of the task without use of stabilization, taking only six steps to complete the task (Schwickert et al., 2016). The older adult group utilized the same seven components but used multiple additional steps of supporting and positioning (intermediate positions) between the phases of initiation and elevation, and between their first and second attempts at elevation, resulting in a total of 20 steps to complete the task (Schwickert et al., 2016). Additional differences between the groups identified lower extremity power and flexibility as possible contributors to floor rise ability and pattern used in addition to age, similar to findings previously reported by Alexander et al. (1997) and Brito et al. (2012).

In addition to further analysis of movement strategies used by adults, quantitative floor rise ability has been studied with regard to psychometrics of such assessment, including correlation with other measures of physical performance in healthy adults aged 50-90 years (Bohannon & Lusardi, 2004) and with older adults over age 60 years (Klima et al., 2016). Bohannon and Lusardi (2004) utilized VanSant's method of movement analysis to identify strategies used to stand from the floor and identified relationships between time to rise from the floor and age (r = .39, p < .005), lower body strength using five times sit to stand time (r = .64, p < .001) and balance using single leg stance time (r = -.36 and r = -.42, p < .005). Klima et al. (2016) also found similar movement patterns to those identified by VanSant using the component method of movement analysis but reported higher use of asymmetric movement patterns in the older adult population. Klima et al. (2016) also correlated the Timed Supine to Stand test (TSS) that measures time needed to rise from supine on the floor to stand, with age (r = .57, p < .001) gait speed (r = -.61, p < .001), grip strength (r = -.30, p < .05), the Timed Up and Go test (TUG) (r = .71, p < .001) and the Activities-Specific Balance Confidence (ABC) scale (r = -.51, p < .05) . The authors identified the TUG as the most significant predictor of variance (48%) in TSS time (Klima et al., 2016). One significant difference between these studies was the speed with which participants were encouraged to rise from the floor. Bohannon and Lusardi (2004) instructed participants to "rise as quickly as possible" (p. 235), while Klima et al. (2016) instructed participants to stand up at their "own speed comfortably following the go command" (p. 208).

Additional methods of floor rise assessment have been studied to determine psychometrics, including correlation to other physical performance measures, without movement analysis (Bergland & Laake, 2005; Ardali et al., 2019; Ardali et al., 2020; Moffett et al., 2020). Study populations have included healthy women over age 75 years (Bergland & Laake, 2005), community dwelling older adults aged 65-96 years (Ardali et al., 2019; Ardali et al., 2020) and community dwelling women over age 55 (Moffett et al., 2020). Bergland and Laake (2005) used the floor transfer (FT) test in which participants were asked to transfer from standing to supine on the floor and back to standing without support and in their own time. The authors reported the ability to rise from the floor using this method to be correlated with ability to climb steps higher than 20 cm (r = .79, $p < .001$), TUG (r = .72, $p < .001$) and walking outdoors (r = .67, $p < .001$) (Bergland & Laake, 2005). Ardali et al. (2019) used the FT test as well, but with a video shown to participants before performance that demonstrated safe performance of the task. Additionally, if participants were unable to complete this task without support, they were tested again under modified conditions that allowed the use of a standard armchair without armrests after watching a second video that demonstrated this task (Ardali et al., 2019). Results of the FT test were correlated with the Self-reported FT Ability Questionnaire ($r = .926$, 95% CI .869 - .980), Physical Functioning Subscale ($r = .879$, 95% CI .79 - .932), Phenotype of Physical Frailty Scale ($r = .860$, 95% CI .758 - .921) and the Short Physical Performance Battery ($r = .876$, 95% CI .785 - .930), indicating support of the floor transfer test in screening for physical disability, frailty and functional mobility among community dwelling older adults (Ardali et al., 2019). Furthermore, Ardali et al. (2020) went on to demonstrate parallel reliability between the Self-reported FT ability and FT test of .92, 95% CI (.88 - .97). In the most recent study of floor rise assessment, Moffett et al. (2020), utilized yet another method of assessment termed the Timed Up from Floor Test (TUFF). The TUFF test required participants to rise from supine on the floor to a steady standing position using any method they chose as quickly as they were safely able (Moffett et al., 2020). While a chair was placed nearby for support if needed, participants were excluded if they utilized the chair for assistance (Moffett et al., 2020). Results of the TUFF test were correlated with the Short Form-36 Physical Functioning Scale ($r = -.69$, $P < .001$), usual gait speed ($r = -.48$, $P < .001$), fast gait speed ($r = -.74$, $P < .001$) and the 30-second sit to stand test ($r = -.46$, $P < .001$) (Moffett et al., 2020).

Floor Rise in Populations with Neurological Diagnoses

Additional studies (Belt et al., 2001; Boswell, et al., 1993; Unrau, et al., 1994) investigated whether the component movement analysis described by VanSant can be applied to individuals with neurological diagnoses known to have difficulty in rising from the floor, and whether patterns used are similar to healthy participants. Boswell et al. (1993) applied these research questions to children age 4 to 7 years with spastic cerebral palsy by comparing the movement patterns of their participants to those described by VanSant (1988) with a healthy pediatric population of the same age. The authors concluded that VanSant's categories of movement established for healthy children could be used to classify movement patterns of children with cerebral palsy, albeit with some modification (Boswell et al., 1993). Children with cerebral palsy were reported to use more variability of movement, more repetition within steps, more segmented movement and more asymmetric movement patterns (Boswell et al., 1993).

Unrau et al. (1994) applied VanSant's movement descriptions for supine to stand over ten trials with fifteen adults with Down syndrome (DS), age 22-65 years. Across the 150 trials observed, 64% of the upper extremity movements, 14.6% of the axial movements and 33.8% of the lower extremity movements observed had not previously been described by VanSant (Unrau et al., 1994). Of the movement patterns observed in each component that had been previously described by VanSant, adults with DS demonstrated less developmentally advanced, asymmetric movements with more interruptions in the task and separation of the task into stages of flexing and moving to sitting, repositioning transitional movement, side-sitting to kneeling with upper extremity support and rising to standing (Unrau et al., 1994).

Belt et al. (2001) used VanSant's model of movement analysis as well with a small sample of nine participants with Prader-Willi syndrome (PWS) age 7 to 36 years and compared them to nine participants who served as age and gender matched controls. These authors were able to apply this movement analysis strategy to this patient population with minor modifications. Participants with PWS required an average of 5.4 seconds to stand from the floor compared to 2.86 seconds in age and gender matched controls (Belt et al., 2001). Additionally, those with PWS used less developmentally advanced patterns in upper extremity, lower extremity and axial components (Belt et al., 2001). Notable differences included use of more intermediate positions with four-point arm and leg contact with the floor during rising, use of arms against the legs to assist with coming to stand, increased trunk rotation and less within subject variability (Belt et al., 2001).

Limited data exist regarding floor rise in patients with stroke. Bohannon and colleagues (1995) performed a retrospective chart review of 52 patients age 36-88 years, with a median time from stroke to initial assessment of 10 days and a median length of stay in an acute rehabilitation unit of 17 days. Data were collected over a 15-month period using admission and discharge Functional Independence Measure (FIM) scores for chair to mat transfers that were also applied to floor to stand transfers (Bohannon, et al., 1995). No movement analysis was included in the study. Participants showed improvement in floor to stand transfers during their acute rehabilitation stay, with improved median FIM scores from one (dependent) to four (minimal assistance) (Bohannon et al., 1995). Floor to stand ability was correlated with chair to mat transfer ability and length of stay, but not with gender or age. The authors concluded that improvements could be made in floor to stand ability with patients whom had suffered a stroke but pointed out that improvements in this skill lagged behind improvements noted in chair to mat transfers, which improved to a median FIM score of six (modified independence) (Bohannon et al., 1995). Unfortunately, one limitation of the study included incomplete documentation that limited the ability to identify factors that predict floor to stand ability or provide reasoning for the continued need for assistance in floor to stand transfers at discharge (Bohannon et al., 1995).

More recently, Ng et al. (2015) applied the Timed Floor Transfer Test (FTT) to assess floor rise ability in 47 people with chronic stroke, without movement analysis. During the Timed Floor Transfer Test, participants moved from standing to sitting on the floor and back to standing with a chair nearby for support if needed, and at their preferred speed (Ng et al., 2015). The mean completion time for the FTT in patients with chronic stroke was 20.9 seconds. The FTT demonstrated excellent intra-rater reliability with ICC of 0.855 – 0.895, 95% CI (0.777 – 0.940), excellent inter-rater reliability with ICC of 1.000, 95% CI (1.000 – 1.000) and excellent test-retest reliability with ICC of 0.954, 95% CI (0.878 – 0.979) (Ng et al., 2015). The minimal detectable change (MDC) of FTT completion times was 7.7 seconds (Ng et al., 2015). The FTT correlated significantly with the Fugl-Meyer Assessment for the lower extremities (r = -0.419, $p \leq 0.001$), 5-times sit to stand test (r = 0.650, $p \leq 0.0001$), Berg Balance Scale (r = -0.69, $p \leq 0.0001$) and TUG (r = 0.705, $p \leq 0.0001$), but not with the Activities-Specific Balance Confidence Scale (r = -0.31, p 0.061) (Ng et al., 2015). Furthermore, an FTT completion time of 8.75 seconds differentiated the elderly adult participants from participants with stroke (Ng et al., 2015). Similar to findings of Klima et al. (2016), the TUG was the most significant correlate with quantitative floor rise ability.

Justification for the Study

Studies examining falls in patients after stroke have demonstrated a significantly increased risk for falls and an increased likelihood of inability to rise from the floor in this population. Patients after stroke have many of the factors known to correlate to increased difficulty in rising from the floor established in the literature including more advanced age

(Alexander et al., 1997; Schwickert et al., 2016); increased physical impairment (Alexander et al., 1997; Ulbrich et al., 2000); lower physical activity level (Green & Williams, 1992); presence of an AFO (King &VanSant, 1995); decreased flexibility (Brito et al., 2012; Schwickert et al., 2016); decreased lower extremity strength and balance (Bohannon & Lusardi, 2004); and slower gait speed, increased time needed for the TUG test and lower balance confidence (Klima et al., 2016). However, these correlations and predictors of variance in performance have not been established specifically in persons following stroke, except for a small sample of adults with chronic stroke as studied by Ng et al. (2015). It is not clear whether these relationships exist with persons with stroke at varied levels of recovery due to limited investigations in the literature to date. This knowledge in patients with stroke could assist therapists in predicting which patients may have difficulty with the floor rise task placing them a higher risk for a critical fall, and thus better direct interventions, education and training for these individuals during rehabilitation.

Additionally, significant research has been performed analyzing the adults' ability to rise from the floor regarding completion time and movement patterns utilized. This research has been applied to children and adults with neurological diagnoses such as cerebral palsy (Boswell et al., 1993), Down syndrome (Unrau et al., 1994) and Prader-Willi syndrome (Belt et al., 2001), but has not been completed in patients after stroke. Such research was called for by Bohannon et al. (1995) after their retrospective chart review revealed improvements in floor rise ability during acute rehabilitation. They noted an absence of specific information available to clinicians to assist in guided instruction of the floor rise task and called for future research to include descriptions of this task in patients with stroke who can successfully rise from the floor (Bohannon et al., 1995). Hofmeyer et al. (2002) demonstrated benefits of a short-term, strategy-based intervention to improve floor rise ability in older adults at risk for falls, indicating specific training could be beneficial. Perhaps this intervention could improve floor rise ability in patients after stroke once common movement patterns are more fully understood to afford focused instruction. Additionally, more than 80% of therapists surveyed did not report that they teach older patients with instability and tendency to fall how to get up from the floor (Simpson & Salkin, 1993). Perhaps increased knowledge of specific movement patterns used would increase the number of therapists willing to instruct patients post stroke in techniques to get up from the floor to better prepare their patients.

Impact on the Field of Physical Therapy

Understanding how the ability to rise from the floor is associated with other physical performance measures used as standard of care in patients after stroke supports the concurrent validity of the timed supine to stand test. Use of the timed supine to stand test in practice with patients after stroke may allow a more complete picture of the functional capacity of this patient population, allow more consistent goal setting in this area and increase use of interventions directed at improving this task.

Examining strong correlations between floor rise and other physical performance measures affords an understanding of those variables linked to floor rise ability. This may assist physical therapists in prioritizing treatment interventions associated with floor to stand performance such as lower body strength, balance training, gait training or functional task practice.

Identification of strategies used to rise from the floor in patients after stroke may assist physical therapists by providing more specific information in possible ways to train the floor rise task using guided, strategy-based functional training. Perhaps this would increase the confidence of physical therapists in getting their patients with stroke onto the floor for this specific training.

An increase in this training may reduce the risk of an inability to rise from the floor after a fall and thereby reduce the associated risk of prolonged time spent on the floor including increased mortality.

Method

Study Design

This study was a non-experimental correlational study using a cross-sectional design that examined the timed supine to stand test performance among persons in the early subacute phase of stroke. The study took place on the inpatient stroke rehabilitation unit of an acute rehabilitation facility within a larger university-based medical system in Baltimore, Maryland. Data were collected from July of 2019 until June of 2020. Prior to data collection, this study was approved by the Institutional Review Board of the University of Maryland Eastern Shore, with a reciprocal agreement with the University of Indianapolis, and approval from the research medical executive committee of the University of Maryland Rehabilitation and Orthopaedic Institute.

Participants

A convenience sample of adult patients admitted to the inpatient stroke rehabilitation unit of an acute rehabilitation facility after ischemic or hemorrhagic stroke were recruited for the study. Inclusion criteria consisted of: 1) diagnosis of ischemic or hemorrhagic cerebrovascular accident (stroke); 2) age 18 or older and 3) able to stand from the floor unassisted or with supervision. This study excluded individuals who 1) had experienced cerebellar stroke, 2) had language or cognitive deficits that precluded understanding of the study and provision of consent as recommended by the treatment team, 3) had any health conditions that prevented participation in the physical performance measures in this study including standing from the floor, and 4) persons with previous diagnosis of a chronic progressive or non-progressive neurologic condition such as Multiple Sclerosis, Parkinson's disease, Amyotrophic Lateral Sclerosis, spinal cord injury or previous stroke.

Sample size

An a priori power analysis was performed to determine the requisite sample size for the multiple regression analysis using the PASS 15.0.3 statistical program (Gastonis & Sampson, 1989). A minimum sample size of 52 participants was required to achieve 80% power to detect an effect size (f^2) of 0.20 for two independent variables using an *F* test with significance level of .05. To account for the possibility that non-parametric test would need to be used, the sample size was increased by 10%, to a goal of 57. The final sample after data collection was 58.

Data Collection

Data were collected by the primary researcher (A. D.) using a data collection form. Once completed, data were then entered into an Excel spreadsheet. All information collected for the study was congruent with physical therapy standard care provided by the inpatient rehabilitation staff regardless of this research initiative. The following data were obtained from the electronic medical record: age, body mass index, and details regarding the categorical type, lesion location and onset of stroke for each participant. The following outcome measures were collected by the primary researcher one to three days prior to discharge to home from the inpatient stroke unit: 10-meter walk test (10 MWT), Timed Up and Go (TUG) test, Activities-specific Balance Confidence (ABC) scale, Dynamic Gait Index (DGI), timed supine to stand test (TSS) and specific subsections of the Fugl-Meyer Assessment of Motor Recovery after Stroke (FMA). Subsections of the FMA for the upper extremity included reflexes (I), flexor synergy (II), extensor synergy (III), movement combining synergies (IV), movement out of synergy (V), normal reflex activity (VI), the wrist (VII), mass flexion and extension of the hand (VIII) and coordination/speed (IX). Subsections of the FMA for the lower extremity included reflex activity (I), flexor synergy (II), extensor synergy (III), movement combining synergies (IV), movement out of synergy (V), normal reflexes (VI) and coordination/speed (VII).

Operationalization of variables

For this study functional performance was operationalized by using scores from activity-based measures including the 10 MWT, TUG, DGI and TSS. Motor impairment of the upper and lower extremities at the body structure and functions level were operationalized using the FMA. Balance confidence was operationalized by using the ABC scale. Gait tests (10 MWT and TUG) and the TSS test were performed at participants' self-selected speed. Strategy to stand from the floor was defined as the movement pattern used by participants to complete the TSS.

Instruments

Timed supine to stand test

The TSS is a publicly available tool to assess a person's ability to transition from a supine position to stand position and measures the time required to rise to stand. The TSS demonstrates excellent test-retest reliability (intraclass correlation coefficient [ICC] = .94) when used with older adults for time to complete supine to stand, (Klima et al., 2016). The TSS used with other physical performance measures in older adults has been reported as a method to depict the functional profile by Klima et al. (2016). Significant correlations were found with age (r = .57, $p < .001$), gait velocity ($r = -.61$, $p < .05$), balance confidence using the ABC scale ($r = -.51$, $p < .05$), and the TUG test ($r = .71$, $p < .001$).

10-meter walk test

The 10 MWT is a publicly available tool to assess physical function using self-selected and maximal walking speeds calculated in meters per second. Gait speed is supported as a valid, reliable and sensitive measure for the assessment of functional status in a wide range of populations, including stroke (Middleton et al., 2015), and has been termed a critical vital sign (Fritz & Lusardi, 2009). Fulk and Echtermach (2008) reported appropriate test-retest reliability in patients participating in rehabilitation after stroke, ICC = .86 for all subjects combined; ICC = .97 for those who required physical assistance to walk; ICC = .80 for those able to walk without physical assistance. Correlations were identified between gait speed and ADL, $r = -.76$ (Maeda et al., 2000); the Dynamic Gait Index, $r = -.68$ in the first week of therapy and $r = -.87$ two months after therapy, $p < .001$ (Lin et al., 2010); and the TUG test, ICC = -.84 at preferred gait speed and ICC = -.91 at fast gait speed (Lin et al., 2010).

Timed Up and Go test

The TUG test is a publicly available tool that was used to assess participants' functional gait mobility. While the TUG was originally designed to detect fall risk in the frail elderly (Podsiadlo & Richardson, 1991), it has been extensively used and validated in patients with stroke. Test-retest reliability has been reported as excellent in patients with chronic stroke with ICC = .95 – .97 (Flansbjer et al., 2005; Hiengkaew et al., 2012; Ng & Hui-Chan, 2005). The TUG also has demonstrated an association with gait speed in patients with stroke, $r = -.90$, $p < .010$ (Ng & Hui-Chan, 2005). Additionally, the TUG had the greatest correlation with ability to rise from the floor in community dwelling older adults, $r = .71$, $p < .001$ (Klima et al., 2016).

Activities-specific Balance Confidence scale

The ABC scale is a publicly available, 16-item self-report measure of balance confidence while performing various activities in the home or community (Powell & Meyers, 1995). Each item is rated on a 0 to 100% rating scale, where 100% indicates higher balance confidence. The ABC scale has demonstrated excellent test-retest reliability, ICC = 0.85, 95% CI [.68, .93], for the total test (Botner et al., 2005) and excellent internal consistency, Cronbach's alpha = .94 (Salbach et al., 2006) among individuals with stroke. Correlations with the ABC tool have also been established among persons with stroke with respect to maximal gait speed, $r_s = .43$, 95% CI [.18, .63]; preferred gait speed. $r_s = .42$, 95% CI [.16, .62]; TUG test, $r_s = -.34$, 95% CI [-.07, -.56] (Salbach et al., 2006) and the Dynamic Gait Index. $r = .68$ (Jonsdottir & Cattaneo, 2007).

Dynamic Gait Index

The DGI is a publicly available gait tool that includes eight items designed to assess the participants' ability to modify their gait with added task demands including varying gait speeds, multidirectional head turns, turning, stepping over and negotiating around obstacles and stair climbing. Each item is scored on an ordinal scale of zero (poor) to three (excellent), for a possible total of 24 points. While the DGI was originally designed to predict falls in the older adult population (Shumway-Cook et al., 1997), metric support has been extrapolated for individuals with stroke. Lin et al. (2010) reported excellent test-retest reliability (ICC = .94) among persons with acute and chronic stroke. Similar findings were reported by Jonsdottir and Catteneo (2007) with excellent test-retest reliability of the DGI among persons with chronic stroke (ICC = .97). Lin et al. (2010) reported excellent construct validity of the DGI with the 10 MWT at various points during stroke recovery ($r = -.68$ during first week of physical therapy; $r =$

-.87 two months after physical therapy; *r* = -.83 five months after physical therapy). Additionally, the DGI has a robust correlation (*r* = .68) with the ABC scale (Lin et al., 2010).

Fugl-Meyer Assessment of Motor Recovery after Stroke

The FMA is a widely used, publicly available quantitative measure of motor impairment following stroke (Gladstone et al., 2002). Items included are scored on an ordinal scale of zero (cannot perform) to two (performs fully) for total possible maximum of 226 points (Fugl-Meyer et al., 1975). Instrument domains include motor function of the upper and lower extremity, sensory function, balance, joint range of motion and joint pain (Fugl-Meyer et al., 1975). Only the domain of motor function of the upper and lower extremities were included in this study.

Psychometric support has been established for the FMA in varied populations including a general rehabilitation sample, acute stroke and chronic stroke. Platz et al. (2005) reported excellent test-retest reliability in a general rehabilitation sample including 37 individuals with stroke (ICC = .97 for motor scores, ICC = .81 for sensation scores, and ICC = .95 for passive joint motion). Excellent internal consistency across administrations of the FMA at 14, 30, 90- and 180-days post-stroke has been reported, Cronbach’s alpha = .94 – .98 (Lin et al., 2004). Correlation of the FMA with gait speed is moderate, *r* = .61, at comfortable and maximal gait speeds (Nadeau at al., 1999) and moderate with Functional Independence Measure (FIM), *r* = .63 (Shelton et al., 2000).

Procedures

Screening

Prior to the initiation of the study, physical therapists and physicians on the inpatient units where the patients with stroke could be admitted (including the stroke, brain injury and complex medical units) participated in an educational session where the purpose, research questions, inclusion criteria, exclusion criteria, and procedures were disseminated.

Potential participants were identified and screened using the established inclusion and exclusion criteria by their primary physical therapist on the treating inpatient unit or attending physician working with the patient as part of their interdisciplinary treatment team. Individuals who initially met the established criteria and were willing to learn more about the study were referred to the primary researcher via phone call or email to provide the name of the potential participant.

Recruitment

For those who met established criteria, the primary researcher met with the potential participant on the inpatient unit, at bedside, or in a private area of the physical therapy gym, and introduced and described the study and answered questions. After this meeting, if the participant was interested in study participation, the formal informed consent process was then completed or scheduled over the following two days.

Informed consent

All participants who met the established criteria met with the primary researcher to provide informed consent. This meeting occurred at the participant's bedside or a private area on the unit prior to the onset of formal testing. Information reviewed during the informed consent process included the purpose of the study, research questions, possible risks and benefits, study procedure including all testing and data collection from the electronic medical record, participant rights including freedom to discontinue participation, methods for privacy and confidentiality and contact information of appropriate individuals to address questions or concerns as needed.

Participants were provided the opportunity to ask questions during this meeting and afforded the opportunity to further consider their participation as needed prior to signing informed consent.

Data collection

The primary researcher established preliminary reliability on physical performance measures including the TUG, 10 MWT, TSS, DGI and FMA to ensure testing accuracy. Testing to establish reliability was completed with five persons after stroke on the outpatient unit. Each test was scored by the primary researcher when performed and was simultaneously video recorded. After two to three days the primary researcher re-scored each test using the recorded performance until the desired reliability was achieved. Preliminary intratester reliability was established with all outcome measures, and ICC statistics for each test were > .98.

Upon completion of the informed consent process, a review of the electronic medical record was completed by the primary researcher to obtain information including age, most recent body mass index, and details regarding type, lesion location and date of stroke for each participant. Physical performance measure data was collected by the primary researcher using a data collection form (Appendix 1).

Testing

The primary researcher conducted the following physical performance testing one to three days prior to discharge home from the inpatient rehabilitation unit**.** Testing was completed in the physical therapy gym of the inpatient rehabilitation unit; moreover, the below testing order was utilized for each participant to ensure consistency among participants regarding any possible testing-related fatigue. All testing was completed in a single session.

Timed supine to stand test. A standardized protocol for this test has not been established. For this study, participants performed the TSS on a carpet square measuring 82.75

inches in length, 58.75 inches in width and 0.3 inches in thickness. Participants were instructed to stand up at their self-selected, comfortable speed, following the "go" command. Timing began at the command of "go" and stopped when the participant had achieved a stable standing position without compensatory movement or postural sway (Klima et al., 2016). A standard chair with arms that was 18" in height from seat to floor was available laterally to assist if needed. Participants could wear an AFO if needed. Compensatory steps prior to stable stance were counted and recorded. This task was video recorded using a Go Pro HERO6 camera set upon a tripod and positioned off the corner of the carpet square, opposite the chair provided.

10-meter walk test. Strategies reported by Steffen and Seney (2008) and Watson (2002) were utilized to improve consistency of testing for this population of participants with a neurologic condition. Participants negotiated a 10-meter walking path with 2-meters allotted at the start of the path for acceleration, 2-meters allotted at the end of the path for deceleration, and the 6-meters marked in the center of the path as the only distance timed. Distance increments were marked on the floor with tape lines. Each participant completed two trials at their self-selected speed. The scores for the two trials were averaged. Instructions to the participants for the self-selected trials were to "walk at your own comfortable walking pace and stop at the far mark". Any needed assistive device or bracing needed for ambulation were used during this test and documented.

Timed Up and Go test. The procedure established by Podsiadlo and Richardson (1991) were utilized for the TUG. Participants started with their back resting on the backrest in a standard chair (seat height 46 cm) with arms resting on the armrests (height 67 cm). Any assistive device used for walking was placed within arm's reach. Additional devices used for walking were used if necessary. Participants began at the command of "go" by standing up, ambulating along a three-meter path to a taped line on the floor, turning around at the line, walking back to the chair and sitting down. Participants were instructed to use a comfortable and safe walking speed. Timing was completed using a stopwatch, beginning at the command of “go” and ceasing when the participant’s buttocks touched the seat of the chair.

Dynamic Gait Index. The original version, eight-item test as established by Shumway-Cook and Woollacott (1995) was utilized for completion of the DGI (Appendix 2). All eight items were administered as described on the original, publicly available scoring sheet, including specific instructions to participants for each item. The test was completed along a designated 6.1-meter (20 foot) walkway, used a shoebox for the stepping over task, two identical cones for the obstacle negotiation task and a set of four practice steps for the stair climbing task.

Activities-Specific Balance Confidence scale. The ABC (Appendix 3) was completed via personal interview with each participant. An enlarged version of the visual analogue scale was utilized throughout the interview. Instructions established by Powell and Meyers (1995) were provided verbally to each participant at the start of the interview and repeated as needed throughout the interview process. Per established instructions, participants were asked to indicate their level of confidence in doing each of the 16 activities included on this scale without losing their balance or becoming unsteady. Each of the 16 items were read aloud to each participant. The confidence level was indicated by selection of a percentage using the provided visual analogue scale from 0-100%. If the participant had not yet done an included activity, they were asked to imagine how confident they would be if they had to complete the task. Scoring was completed per the procedure established by Powell and Meyers (1995).

Fugl-Meyer Assessment of Motor Recovery after Stroke. The original version of the FMA (Appendix 4) as established by Fugl-Meyer et al. (1975) was administered with all participants. Both the upper (FMA-UE) and lower (FMA-LE) assessments were completed using the standardized procedure established by Sullivan et al. (2011) for clinical practice and clinical trials.

Data Management and Analysis

Each participant was assigned a unique study identification number (1-58) at the time of informed consent completion. This study identification number was matched to the participant's name using a log sheet until all data were collected and entered into a Microsoft Excel spreadsheet. Once all data were entered into the spreadsheet, the log sheet was destroyed. Data management included reviewing data sheets for accuracy and completeness, and periodic data range checks. Descriptive statistics were performed on the entire sample. Nominal data were reported as frequencies and percentages, ordinal data and non-normally distributed interval and ratio data as medians and interquartile range (IQR), and normally distributed interval and ratio data as means and standard deviations.

To answer the first research question regarding the relationship between functional performance (gait performance and balance confidence) and the ability to stand from the floor as measured with the timed supine to stand test in participants in the early subacute phase of CVA, a Pearson correlation or nonparametric Spearman rho correlation, depending on whether the data are normally distributed, were used to examine physical performance variable relationships. To address individual characteristics associated with supine to stand ability as measured with the supine to stand test, demographic characteristics were compared using a Fisher's exact test or Pearson chi-square test for nominal data, Mann-Whitney *U* test for ordinal or non-normally distributed interval and ratio data, and independent *t* test for normally distributed interval and ratio data. Significant correlates and demographic variables were entered into a multiple regression model to identify predictive determinants of the dependent variable, timed supine to stand performance. Model summaries were analyzed for coefficient of determination contributions and collinearity diagnostics.

To address our second research question regarding strategies used to complete the timed supine to stand test in participants in the early subacute phase of stroke, qualitative descriptions of motor patterns strategized to stand were developed by review of video recorded performance of the TSS. Overall motor patterns were categorized into patterns A, B or C,
then subclassified into upper extremity, axial and lower extremity components as described by VanSant (1988). Per VanSant's (1988) description, pattern A includes symmetrical push of the upper extremities, symmetrical axial movement and symmetrical squat with the lower extremities; pattern B varies from this in the lower extremity component only with use of asymmetrical squat; and pattern C varies more greatly and includes asymmetric push and reach of the upper extremity, partial rotation of the axial component and half kneel with the lower extremities. These three components were analyzed through the three phases of supine to stand identified in an older adult population by Bohannon and Lusardi (2004) including initiation, transitional weight transfer and rising to upright. Within the initiation phase, information was recorded regarding whether the participant led with the upper extremity, lower extremity or head and trunk, and to which direction the initial movement occurred. During the transitional weight transfer, use of patterns described by Bohannon and Lusardi (2004) were recorded including asymmetrical side sit to half knee pivot, quadruped push up or sit up and roll over. During the rise to upright phase, additional information was recorded and included: initiating lower extremity beginning the task, use of a chair for support, affected or unaffected upper extremity use, transitional chair sitting prior to stand, and the number of compensatory steps taken to

achieve stable stance. Furthermore, use of intermediate positions described by Ulbrich et al. (2000) were recorded. These included sit, crouch, sidelying, tuck, half-tuck, kneel, half-kneel, quadruped and bearwalk patterns (Ulbrich et al., 2000). Additional descriptive details recorded included use of an AFO, the side of hemiparesis and the initial chair position. Data were categorized by the above classification schemes and descriptive frequency percentages were calculated.

Preliminary intrarater reliability was established for pattern classification and methods used in previous studies of supine to stand performance (Belt et al., 2001; Bohannon & Lusardi, 2004; King &VanSant, 1995; Klima et al., 2016). Five randomly selected TSS trials were analyzed and classified by the primary researcher. After an interval of two days, these trials were reclassified by the same researcher. The Kappa statistic was calculated for nominal motor patterns employed to stand, with consistency agreement exceeding .98 for all sub-classification schemes.

Data were analyzed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY). Normality of data were determined using the Shapiro-Wilk test, all comparisons were two-tailed, and a significance level of less than .05 was considered statistically significant.

Results

Characteristics of the Sample

Fifty-eight participants [mean age 59.22 (13.89) years] were included in the study. Over half (58.6%) the sample was male (Table 1). Major reasons for exclusion included previous history of stroke and physical assistance during the floor rise task. Demographic features included a mean body mass index (BMI) of 30.2 (6.83) kg/m^2. The mean number of days since participants' stroke, when tested, was 19.4 (9.2) days. Vascular events included ischemic

(86.2%), hemorrhagic (6.9%) or combination (6.9%) strokes. Fugl-Meyer motor scores were 49.5 (9.3) for the upper extremity subsection and 31.0 (6.0) for the lower extremity subsection.

Physical Performance Measures

The median time needed to complete the TSS was 13.0 seconds (15.5) for the entire sample; a Shapiro-Wilks analysis identified a non-normal distribution of the measure. Means and standard deviations are reported for normally distributed variables, including physical performance measures, and are noted in Table 2. The nonparametric Kruskal-Wallis analysis noted no significant difference in TSS (p=.32) among participants with left [15.3s (9.7)], right [27.7s (29.8)], and bilateral lesions [13.3s (8.7)]; however, magnitude differences were large between cohorts. Forty-one participants (70.7%) required the use of a chair to complete the TSS measure. Seventeen participants (29.3%) used an assistive device in ambulation. A Chi-Square test of independence determined a significant interaction; participants who used an ambulatory assistive device were more likely to use the chair to rise during the TSS Test ($x^2(1) = 10.0$, $p = .001$). Twenty-six participants utilized a quadruped maneuver; participants who employed this strategy were significantly older (64.7 vs. 54.8 years; $p = .02$) and demonstrated higher Fugl-Meyer upper extremity scores ($p=.006$).

Bivariate Correlations and Multivariate Analysis

Spearman's rho correlations (Munro, 2000) noted that TSS performance had a low positive association with number of days since stroke ($r = .30$; $p < .05$) and low negative correlation with the ABC ($r = -.43$, $p < .01$); in addition, a moderate negative relationship with both gait velocity ($r = -.67$, $p < .01$) and the DGI ($r = -.52$, $p < .01$) was demonstrated. There was a strong positive association between TSS and TUG ($r = .70$, $p < .01$) performance. Age and

BMI were not significant correlates (*r* = .22 and .25, p > .05, respectively). Bivariate demographic and performance correlations are noted in Table 3

A multiple linear regression analysis (Table 4) demonstrated that the TUG and use of the quadruped position predicted 32% of the variance in TSS completion time (F (2,55) = 14.7; p < .001). Positive variable beta weights are noted in Table 4. Exploratory gait and balance confidence independent variables (including gait velocity, the DGI and ABC) were entered into the regression with no significant contributions to the model. In addition, Pearson product moment correlations between gait variables were high (r = .80 to - .85; p < .001) and yielded collinear constructs.

Movement Component Analysis

Frequency analysis of movement patterns utilized are noted in Table 5. Fifty-five (94.8%) participants utilized Pattern C for the transition from supine on the floor to steady stand, as described by VanSant in the movement component analysis (1988). Two (3.4%) participants utilized Pattern B, and one (1.7%) demonstrated Pattern A. In the extended component analysis, twenty (34.4%) participants utilized an upper extremity pattern (VanSant, 1988); furthermore, 16 participants (27.6%) employed the upper extremity push and reach to asymmetrical push pattern. Axial patterns were identified in 44 (75.8%) participants, with 30 (51.7%) demonstrating the frequent full rotation abdomen up transition. Only ten (17.2%) participants demonstrated a lower extremity pattern; seven (12.1%) participants used the half kneel technique (Table 5).

Movement strategy pair combinations as described by Bohannon and Lusardi (2004) in healthy older adults were identified (Table 5). Eight (13.8%) utilized an asymmetrical side sit to half knee pivot, technique, while nine (15.5%) employed a quadruped push-up maneuver. Three subjects (5.2%) demonstrated the sit up and roll over combination.

Intermediate Positions, Hemiplegic Extremity Use, and Compensatory Steps

Finally, movement patterns were analyzed according to those intermediate positions described by Ulbrich and colleagues (2000) in older adults (Table 5). Most commonly, participants utilized a half kneel position (43, 74.1%). Of these, 22 (51.2%) utilized the hemiparetic lower extremity as the lead leg to transition to stand. This was followed by the following patterns: tuck (40, 68.9%), kneel (29, 50.0%), quadruped (26, 44.8%), sit (20, 34.5%), bearwalk (14, 24.1%), sidelying (11, 18.9%), half tuck (10, 17.2%) and crouch (7, 12.1%) transitions.

Additional analyses examined use of the involved extremities to rise to stand. Of those participants using the tuck position, 14 (35.0%) used the hemiparetic lower extremity to stand. In the half tuck position, five (50.0%) used their hemiparetic lower extremity as the lead limb for the maneuver. Forty-one (70.7%) participants strategized with upper extremity use to rise to stand. Within this group, 27 (65.9%) used their involved or hemiparetic upper extremity to assist in rising from supine to stand. Forty-one (81.0%) participants took compensatory steps at terminal stance; moreover, the mean number of compensatory steps was 2.4 (1.9). Although weak, there was a significant association between TSS time and number of compensatory steps taken (r=.29; p=.03).

Discussion

The purpose of this study was to examine floor to stand ability both quantitatively and qualitatively among persons in the early subacute phase of stroke recovery, prior to discharge home from acute rehabilitation. Specifically, the aim was to examine the relationship of floor to stand time using the TSS with other physical performance measures and demographic characteristics of our participants, and to identify movement patterns commonly used to complete the floor to stand task.

Timed Supine to Stand

While multiple methods of quantitative floor to stand assessment have been reported in the literature, the TSS as described by Klima et al. (2016) was selected for this study. The procedure for the TSS most closely simulated recovery after a fall by timing only supine to stand at one's comfortable pace and with upper extremity support available. Similar testing procedures of preferred speed and with upper extremity support were used by Alexander et al (1997) and Ulbrich et al (2000) in studies with older adults that included a subset of participants with physical impairment. In the only other study examining floor to stand completion in persons with stroke, Ng et al (2015) used a timed floor transfer test (FTT) that included timing the standing to sitting on the floor maneuver and subsequent return to standing. Although participants completed this test at preferred speed and with chair assist as necessary, this procedure is dissimilar to what may be needed to return to stand after a fall. Our test-retest reliability for the TSS was excellent (ICC > .98), and commensurate with coefficients previously cited (ICC = .94). Consistent with Klima et al. (2016), the TSS measure demonstrated concurrent validity with other physical performance and balance confidence outcomes commonly used among patients after stroke including the TUG, gait velocity, DGI and ABC.

Our results demonstrate that the TSS is feasible for patients after first ischemic or hemorrhagic stroke, in the early subacute phase of recovery, who were able to complete floor to stand with no more than supervision. All participants were able to complete the TSS and required a median time of 13.0 (15.5) seconds to complete the task. This time is longer than means reported by Alexander et al. (1997) and Ulbrich et al. (2000) for healthy older adults (5.5

seconds), Bohannon and Lusardi (2004) for healthy adults age 50-90 (4.1 seconds), Klima et al. (2016) for community dwelling older adults (8.0 seconds), and Moffett et al. (2020) for community dwelling women over age 55 (5.8 seconds). However, our median time was shorter than the mean time needed for older female participants with physical impairment (17.1 seconds) reported by Alexander et al. (1997) and Ulbrich et al. (2000). The longer time required by participants in the Ulbrich analysis (2000) may be explained by age, as the mean age was 81 years, compared to 59.2 years in this study. Other discrepant times reported for floor to stand may be explained by differences in samples tested (gender, age and inclusion/exclusion criteria), procedures used (availability of external support, start position and number of trials) and instructions provided (preferred versus maximal speed).

Bivariate Correlations and Multivariate Analysis

Our finding of a significant relationship between floor to stand time and the TUG (r = .70) has been reported by others examining similar relationships in varied adult populations including Bergland and Laake (2005) (r = .72), Ng et al. (2015) (r = .71) and Klima et al. (2016) (r = .71). Furthermore, Klima et al. (2016) reported that TUG performance predicted 48% of the variance in TSS time in healthy community dwelling older adults. In our study, multiple linear regression analysis demonstrated that TUG performance predicted 28% of the variance in TSS performance, and the use of the quadruped position increased the coefficient of determination to 32%. Similar findings have been noted between floor to stand completion and other tasks requiring antigravity muscle activation for rising to stand such as standing from a chair (Bohannon & Lusardi, 2004; Moffett et al., 2020) and climbing steps (Bergland & Laake, 2005). Select physical impairments present in our participants post stroke including lower extremity weakness, decreased coordination and decreased balance plausibly contributed to the relationship between TUG and floor to stand (Ng et al., 2020) and the use of quadruped could be due to compensation by maintaining both upper and lower body contact with the floor (Ulbrich et al., 2000). While age was not significantly correlated with TSS time as in previous studies (Alexander et al., 1997; Ulbrich et al., 2000; Bohannon & Lusardi, 2004; Klima et al, 2016), those who used the quadruped position were significantly older ($p < .001$). Ulbrich et al. (2000) noted that older adults with physical impairment were more likely to use such intermediate positions. Furthermore, those who employed the use of quadruped in the sequence used to return to stand had higher scores on FMA-UE ($p = .006$). This indicates that in older adults after stroke, when upper extremity function is present on the involved side, it is often utilized to maintain stability for the transition to stand.

The relationship between TSS and gait velocity continues to validate gait velocity as a measure of physical function post stroke, and as a critical vital sign as indicated by Fritz and Lusardi (2009). Our moderate relationship ($r = -.67$) is similar to that reported by Klima et al. (2016) ($r = -.61$) for community dwelling older adults, and slightly higher than the low-level correlation reported by Moffett et al. (2020) ($r = -.48$) for community dwelling women over age 55. Those who completed floor to stand more slowly demonstrated both decreased gait velocity and increased time to complete the TUG.

The strength of the relationship between the ABC and TSS ($r = -.43$) was less significant than that reported by Klima et al. (2016) ($r = -.51$) for community dwelling older adults. This is not unexpected as our participants had not yet discharged to the community from inpatient rehabilitation after first stroke. In many cases our participants were asked to imagine how they would feel about balance confidence in community situations that they had not yet encountered while completing the ABC. This could explain the lower mean ABC score reported in our study

(69.2), compared to that reported by Ng et al. (2015) (77.5) who studied a sample of patients after chronic stroke living in the community. Nevertheless, our results indicate that those who took longer to complete floor to stand have lower confidence in their ability to complete household and community mobility tasks.

We are aware of no other study which has compared TSS performance with DGI performance. The DGI was selected as a measure of balance for our study due to the allowance of an assistive device if needed. This proved necessary for 17 (29.3%) of our study participants. The moderate relationship (r = -.52) between TSS and DGI indicates that those who required more time to complete floor to stand demonstrated poorer dynamic gait ability. Further, participants who used an assistive device for gait performance were more likely to use the chair to complete floor to stand.

Although BMI has been described as a contributor to floor rise ability in prior studies (Ulbrich et al., 2000; Ardali et al., 2020), our results did not show this relationship. This is similar to the group of community dwelling older adults studied by Klima, et al. (2016). While the active community dwelling older adult sample studied by Klima et al (2016) had a relatively low overall BMI, 32.8% of our sample was overweight, and 44.8% were obese (Centers for Disease Control and Prevention, 2020). This is similar to the sample of participants studied by Ardali et al. (2020) in which 76.5% of those dependent in floor to stand were described as overweight. Ulbrich et al. (2000) also reported that BMI was significantly higher in the subset of older adults with physical impairment who required more time and use of intermediate positions to move from supine to stand. While the amount of elevated BMI was similar to these studies, the difference in TSS time based on this factor did not reach significance (r = .25). This may be explained by insufficient power to detect significance of BMI as a contributor to TSS performance in this study.

In our study, greater number of days post stroke was associated with increased TSS time. Greater number of days between stroke and testing could indicate more severe stroke with associated longer acute hospital stay prior to inpatient rehabilitation. Greater severity of stroke may have also contributed to a greater number of days between stroke and testing needed to achieve the supervision level required for inclusion in this study. Furthermore, if participants were newly able to perform floor to stand task with only supervision, they may have been more cautious in their performance without assistance thus increasing the time needed for TSS completion

Movement Component Analysis

To our knowledge, this is the first detailed analysis of movement strategies used by participants recovering from stroke to complete the floor to standing task. In the only other study of floor to stand ability in patients after stroke completed by Ng et al. (2015), movement analysis was not included. While we were able to classify all 58 of our participants' overall movement pattern as either A, B or C according to VanSant's method of component movement analysis (1988), fewer upper extremity, axial and lower extremity component patterns noted could be classified according to her descriptions. Of those upper extremity, lower extremity and axial components that fit into VanSant's classifications (1988), most included asymmetrical patterns indicating less developmentally advanced movements. These findings are similar to previous studies of participants with neurologic diagnoses including studies of patients with CP (Boswell et al., 1993), Down's Syndrome (Unrau et al., 1994) and Prader-Willi Syndrome (Belt et al., 2001). In each of these studies, authors concluded that VanSant's method of component movement analysis could be utilized to describe movement, but less developmentally advanced movement strategies required expansion to capture all movement strategies observed. Thus, we expanded our classification system to include pair combinations described by Bohannon and Lusardi (2004) and intermediate positions described by Ulbrich et al. (2000) to comprehensively capture and calculate frequencies of all movement strategies identified on movement analysis, and allow further investigation of involvement of the hemiparetic upper and lower extremity.

In our sample, most overall movement patterns could be classified as movement pattern C defined by VanSant which included a form of asymmetrical push and reach with the upper extremity, partial rotation of the axial component and an asymmetrical pattern with lower extremities. This is commensurate with Klima et al. (2016) who identified pattern C as the most common pattern used by older community dwelling adults. Twenty (34.5%) of our participants used a pair combination described by Bohannon and Lusardi (2004) with the most used being quadruped push up. Calculating the frequency of each intermediate position as a group proved more challenging, as many participants used more than one in series in their effort to achieve stand. The sequence of intermediate positions to move from supine to stand had some common themes, but largely varied between participants. Common themes included moving from supine through sidelying, sitting or tuck; progressing next through quadruped, kneeling, half-kneeling, or a combination of these; then transition to stand, often utilizing the chair for external support. This variability in performance is supported by the seminal work of VanSant (1988) who first proposed the concept that movement patterns for floor to stand can vary both within and between individuals. These finding are further reinforced by Ulbrich et al. (2000) who found the use of intermediate positions to be associated with older age and the presence of physical impairment, both of which were present in our sample of participants.

Several of the most common intermediate positions used included the half kneel, tuck and quadruped positions. These, along with the nearby chair, were used frequently to assist with the transition to stand. Of those who used the half-kneel and tuck positions, 51% and 35% used their hemiparetic lower extremity as the lead leg for transition to stand, respectively. Twenty-six used the quadruped position, which allowed bilateral upper and lower extremity use, for which the hemiparetic extremity(s) were utilized. Those who utilized the quadruped position demonstrated significantly higher FMA-UE scores (p = .006) indicating a greater amount of upper extremity motor recovery. Additionally, 66% of those who used the chair for transition to stand did so with the support of their affected upper extremity, either in isolation or in combination with the less involved arm. The large percentage of participants using their involved upper and lower extremities might be explained by relatively high upper and lower extremity motor Fugl-Meyer scores in our study population. Our mean FMA-UE score was 49 of 56 and the mean FMA-LE score was 31 of 34, indicating higher level of motor recovery post stroke in our sample.

Finally, while the differences in TSS times between participants with right, left and bilateral involvement were not statistically significant, the large magnitude of differences between these cohorts warrants further discussion. Those after right brain lesions, with left sided involvement required more time to complete the TSS. These differences in times may be explained by variability in the type and severity of deficits post stroke linked to lesion laterality (Mutha et al., 2012). Further investigation with a large sample regarding lesion laterality as a possible contributor to floor to stand performance is warranted.

Study Limitations

The study was a correlational study with a cross-sectional design. While relationships were demonstrated between floor to stand using the TSS and other physical performance measures and individual characteristics, causal interpretations cannot be made. While our study was powered sufficiently to analyze two independent variables during multiple regression, more variables may have reached significance or contributed further to variance in TSS completion time with a larger sample size that allowed inclusion of additional variables into the model.

The cross-sectional design and convenience sampling limit generalizability of results beyond patients in the early subacute phase of stroke recovery with similar functional levels. Our inclusion criteria biased our sample to patients who had achieved a high enough level of recovery during inpatient admission at the acute rehabilitation level of care to complete the floor to stand maneuver with no more than supervision. Furthermore, this requirement also likely contributed to the high levels of motor recovery noted in our sample as indicated by means reported on FMA-UE (49/56) and FMA-LE (31/34), further limiting generalizability to patients after stroke with lower levels of motor recovery in their involved upper and lower extremities. Our exclusion criteria excluded those with cerebellar stroke and prior stroke, which were the main reasons for exclusion during the screening phase of our study, after referral by the treatment team. Many of these excluded patients with history of cerebellar or prior stroke could complete the floor to stand task with no more than supervision.

Each participant completed only one trial of the TSS to avoid fatigue. While this allowed us to analyze movement pattern variation between subjects to identify patterns, it did not allow within subject analysis of variable movement patterns used for floor to stand completion, which had been described previously by VanSant (1988).

Finally, an education session was held prior to starting data collection to facilitate referrals to our study from the treatment team. Therapists making referrals were instructed not to vary their practice in any way with patients referred to this study. Because it was a treatment activity implemented as part of their usual care, some participants had practiced floor to stand with instruction in technique prior to participation in the testing session for this study. This instruction and practice may have changed their self-selected movement patterns as suggested by Hofmeyer et al. (2002) who demonstrated benefits of a short-term, strategy-based intervention to improve floor rise ability in older adults at risk for falls.

Future Study

Further studies assessing floor to stand in patients after stroke are warranted. Future studies could involve larger sample sizes to allow further exploration of various contributors to floor to stand performance. Participants with prior stroke and with cerebellar lesions should be included, as should participants in all stages of recovery post stroke to allow further generalization of results. Inclusion of lower level patients or avoiding criteria for level of function would allow study of those patients at higher risk of needing assistance after a fall. Stratification based on Fugl-Meyer motor scores and/or Functional Independence Measure (FIM) scores may allow comparison of between group differences. Timing and movement analysis of floor to stand could include more than one trial per participant post stroke to allow analysis of within subject movement variability. Further studies to establish psychometric properties of the TSS such as means per stage of recovery, cut scores predictive of falls and/or levels of independence with TSS, minimal detectable change and minimal clinically important differences would also be useful for incorporation of this tool into the toolboxes of physical therapists assessing functional mobility of patients post stroke. Interventional studies to assess response of training of patients after stroke in floor to stand performance using the TSS to assess change in time needed and movement analysis to capture data regarding changes in movement strategies over time could support incorporation of this task into rehabilitation programs.

Conclusion

The median time to complete floor to stand in patients in the early subacute phase post stroke is 13.0 (15.5) seconds. This is related to a cluster of physical performance measures used in the assessment of mobility of patients after stroke including TUG, gait velocity, DGI and ABC. Timed Up and Go performance is the single most predictive physical performance measure of floor to stand performance. The use of an assistive device for gait tasks indicates the need for chair use in the transition from floor to stand. Patients in this stage of recovery most commonly use an asymmetric roll strategy to complete floor to stand and most use several intermediate positions that allow the ability to keep more contact with a supporting surface throughout the maneuver. The most common intermediate positions used include half-kneel, tuck, kneeling and quadruped. Many patients self-select the use of the hemiparetic upper and/or lower extremity during floor to stand and should be encouraged to do so. Incorporation of the involved upper and lower extremities and training of intermediate positions in part to whole task practice may assist in earlier achievement of the ability to complete the floor to stand task. This may mitigate fear of falling and lower the risk of mortality due to critical fall in the transition to home post discharge. Over time, as motor recovery, strength, balance, and balance confidence develop, training in more developmentally advanced patterns of floor to stand may be possible.

As noted previously, Simpson and Salkin (1993) reported that more than 80% of therapists surveyed did not report that they teach older patients with instability and tendency to fall how to get up from the floor. One reason for this was proposed by Bohannon et al. (1995) who noted an absence of specific information available to clinicians to assist in guided instruction of the floor rise task for patients after stroke. This study serves to provide knowledge of the relationships between floor to stand and commonly used physical performance measures, median time for completion of the TSS, and knowledge of movement patterns used by patients in the early subacute phase of recovery after stroke. This knowledge can empower evaluating physical therapists to determine who may struggle with floor to stand and to formulate a treatment plan with specific coaching, treatment interventions and progression over time to improve performance in floor to stand after stroke.

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Table 1

Participant Sociodemographic and Physical Performance Characteristics

Participant Demographic and Performance Profile	Total Sample (N = 58)
Age (years)	59.2 (13.9) [a]
Gender (%)	
Male	34 (58.6)
BMI (kg/m^2)	30.2 (6.8) [a]
Stroke Type (%)	
Infarct	50 (86.2)
Hemorrhage	4 (6.9)
Combination	4 (6.9)
Side of Stroke (%)	
Right	24 (41.4)
Left	27 (46.6)
Bilateral	7 (12.1)
Days Since Stroke (#)	19.4 (9.9)
FMA–Upper Extremity (Max 56)	49.5 (9.3) [b]
FMA-Lower Extremity (Max 34)	31.0 (6.0) [b]
Ambulation with assistive device (%)	
No	41 (70.7)
Yes	17 (29.3)
Rolling walker	8 (13.8)
Quad cane	5 (8.6)
Straight cane	4 (6.9)
Use of ankle-foot orthosis (%)	
Yes	5 (8.6)
Use of chair to rise during TSS (%)	
Yes	41 (70.7)
Use of Quadruped Position to Rise (%)	
Yes	26 (44.8)

Note. Data reported as frequency (%) unless otherwise indicated. [a] Reported as mean (SD). [b] Reported and median (interquartile range).

Table 2

Physical Performance Measures

Performance Profile	Total Sample (N = 58)
TSS (seconds)	13.0 (15.5) [a]
Left lesion CVA	15.3 (9.3)
Right lesion CVA	27.7 (29.8)
Bilateral lesion CVA	13.3 (9.7)
Gait velocity (m/s)	0.80 (0.34)
TUG (seconds)	19.0 (10.4)
DGI total score (out of 24)	17 (5.0)
ABC Score (%)	69.2 (18.4)

Note. Values are reported as mean (SD) unless otherwise indicated. [a] Reported as median (interquartile range).

Table 3

Bivariate Correlations with Timed Supine to Stand Performance

Variable	TSS
Age	.22
BMI	.25
Days Since Stroke	.30*
TUG	.70**
Gait Velocity	-.67**
DGI	-.52**
ABC	-.43**
Compensatory Steps	.28*

Note. N = 58 for all correlation. Spearman's rank correlation coefficients * $p < .05$, ** $p < .01$

Table 4

Predictive Determinants of the Timed Supine to Stand Test

Independent Variable	B	SE B	*β*	*t*	*p*
Timed Up and Go	1.2	.23	.59	5.3	.001
Quadruped	9.9	4.7	.24	2.1	.040

Note. N = 58 for regression. Adjusted R^2 = .324. P < .001.

Table 5

Movement Pattern Analysis during the Timed Supine to Stand Test

Pattern Variable	Total Sample (N = 58)
Initiation	
Lead with upper extremity	22 (37.9)
Lead with lower extremity	16 (27.6)
Lead with head and trunk	20 (34.5)
Initial movement direction	
Right	25 (43.1)
With right side involvement	9 (15.5)
Left	28 (48.3)
With left side involvement	10 (17.2)
Forward	5 (8.6)
Pattern and Squat Symmetry	
Pattern A	1 (1.7)
Pattern B	2 (3.4)
Pattern C	55 (94.8)
UE pattern identified	20 (34.4)
Push and reach to asymmetrical push	16 (27.6)
Push and reach	2 (3.4)
Symmetrical push to push and reach	2 (3.4)
Axial pattern identified	44 (75.8)
Full rotation abdomen up	30 (51.7)
Partial rotation	6 (10.3)
Symmetrical interrupted by rotation	5 (8.6)
Symmetrical	3 (5.2)
LE pattern identified	10 (17.2)
Half kneel	7 (12.1)
Asymmetrical squat	2 (3.4)
Symmetrical squat	1 (1.7)

Pair Combinations	
Asymmetrical side sit to ½ knee pivot	8 (13.8)
Quadruped push up	9 (15.5)
Sit up and roll over	3 (5.2)
Intermediate Positions	
Sit	20 (34.5)
Crouch	7 (12.1)
Sidelying	11 (18.9)
Right	5 (8.6)
With ride side involvement	2 (3.4)
Left	6 (10.3)
With left side involvement	3 (5.2)
Tuck	40 (68.9)
Right	15 (25.9)
With ride side involvement	6 (10.3)
Left	25 (43.1)
With left side involvement	8 (13.8)
Half tuck	10 (17.2)
Right	5 (8.6)
With right side involvement	3 (5.2)
Left	5 (5.8)
With left side involvement	2 (3.4)
Kneel	29 (50.0)
Half kneel	43 (74.1)
Right	18 (31.0)
With right side involvement	10 (17.2)
Left	25 (43.1)
With left side involvement	12 (20.7)
Quadruped	26 (44.8)
Bearwalk	14 (24.1)

Transition to Stand	
Lead leg	
Right	27 (46.6)
Left	30 (51.7)
Equal	1 (1.7)
Chair used to rise	41 (70.7)
Upper extremity used to rise	
Right	10 (17.2)
With right side involvement	2 (3.4)
Left	7 (12.1)
With left side involvement	1 (1.7)
Bilateral	24 (41.3)
With right side involvement	13 (22.4)
With left side involvement	10 (17.2)
Bilateral involvement	1 (1.7)
Participants who took compensatory steps	47 (81.0)
Mean number of compensatory steps	2.4 (1.9)[a]

Note. Values reported as frequency (percentage) unless otherwise indicated. [a] reported as the mean and standard deviation.

Appendix 1

Data Collection Form

Study ID Number	Age	BMI	Categorical Type of Stroke	Location of Stroke	Stroke Onset Date	TSS	10 MWT	TUG	ABC Scale	FMA - UE/LE
1										
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52										

Appendix 2

Dynamic Gait Index (original 8-item test)

<u>Description:</u>

Developed to assess the likelihood of falling in older adults. Designed to test eight facets of gait.

<u>Equipment needed:</u> Box (Shoebox), Cones (2), Stairs, 20’ walkway, 15” wide

<u>Completion:</u>

<u>Time:</u> 15 minutes

<u>Scoring:</u> A four-point ordinal scale, ranging from 0-3. “0” indicates the lowest level of function and “3” the highest level of function.

Total Score = 24

<u>Interpretation:</u> **< 19/24 = predictive of falls risk in community dwelling elderly**

1. Gait level surface _____

Instructions: Walk at your normal speed from here to the next mark (20’)

Grading: Mark the lowest category that applies.

(3) Normal: Walks 20’, no assistive devices, good sped, no evidence for imbalance, normal gait pattern

(2) Mild Impairment: Walks 20’, uses assistive devices, slower speed, mild gait deviations.

(1) Moderate Impairment: Walks 20’, slow speed, abnormal gait pattern, evidence for imbalance.

(0) Severe Impairment: Cannot walk 20’ without assistance, severe gait deviations or imbalance.

2. Change in gait speed _____

Instructions: Begin walking at your normal pace (for 5'), when I tell you "go," walk as fast as you can (for 5'). When I tell you "slow," walk as slowly as you can (for 5').

Grading: Mark the lowest 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.

(2) Mild Impairment: Is able to change speed but demonstrates mild gait deviations, or not 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, or changes speed but has significant gait deviations, or changes speed but loses balance but is able to recover and continue walking.

(0) Severe Impairment: Cannot change speeds, or loses balance and has to reach for wall or be caught.

3. Gait with horizontal head turns _____

Instructions: Begin walking at your normal pace. When I tell you to "look right," keep walking straight, but turn your head to the right. Keep looking to the right until I tell you, "look left," then keep walking straight and turn your head to the left. Keep your head to the left until I tell you "look straight,“ then keep walking straight, but return your head to the center.

Grading: Mark the lowest category that applies.

(3) Normal: Performs head turns smoothly with no change in gait.

(2) Mild Impairment: Performs head turns smoothly with slight change in gait velocity, i.e., minor disruption to smooth gait path or uses walking aid.

(1) Moderate Impairment: Performs head turns with moderate change in gait velocity, slows down, staggers but recovers, can continue to walk.

(0) Severe Impairment: Performs task with severe disruption of gait, i.e., staggers outside 15” path, loses balance, stops, reaches for wall.

4. Gait with vertical head turns _____

Instructions: Begin walking at your normal pace. When I tell you to “look up,” keep walking straight, but tip your head up. Keep looking up until I tell you, “look down,” then keep walking straight and tip your head down. Keep your head down until I tell you “look straight,“ then keep walking straight, but return your head to the center.

Grading: Mark the lowest category that applies.

(3) Normal: Performs head turns smoothly with no change in gait.

(2) Mild Impairment: Performs head turns smoothly with slight change in gait velocity, i.e., minor disruption to smooth gait path or uses walking aid.

(1) Moderate Impairment: Performs head turns with moderate change in gait velocity, slows down, staggers but recovers, can continue to walk.

(0) Severe Impairment: Performs task with severe disruption of gait, i.e., staggers outside 15” path, loses balance, stops, reaches for wall.

5. Gait and pivot turn _____

Instructions: Begin 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 lowest 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.

(1) Moderate Impairment: Turns slowly, requires verbal cueing, requires several small steps to catch balance following turn and stop.

(0) Severe Impairment: Cannot turn safely, requires assistance to turn and stop.

6. Step over obstacle ____

Instructions: Begin walking at your normal speed. When you come to the shoebox, step over it, not around it, and keep walking.

Grading: Mark the lowest category that applies.

(3) Normal: Is able to step over the box without changing gait speed, no evidence of imbalance.

(2) Mild Impairment: Is able to step over box, but must slow down and adjust steps to clear box safely.

(1) Moderate Impairment: Is able to step over box but must stop, then step over. May require verbal cueing.

(0) Severe Impairment: Cannot perform without assistance.

7. Step around obstacles _____

Instructions: Begin walking at normal speed. When you come to the first cone (about 6' away), walk around the right side of it. When you come to the second cone (6' past first cone), walk around it to the left.

Grading: Mark the lowest category that applies.

(3) Normal: Is able to walk around cones safely without changing gait speed; no evidence of imbalance.

(2) Mild Impairment: Is able to step around both cones, but must slow down and adjust steps to clear cones.

(1) Moderate Impairment: Is able to clear cones but must significantly slow, speed to accomplish task, or requires verbal cueing.

(0) Severe Impairment: Unable to clear cones, walks into one or both cones, or requires physical assistance.

8. Steps _____

Instructions: Walk up these stairs as you would at home, i.e., using the railing if necessary. At the top, turn around and walk down.

Grading: Mark the lowest 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: ___ / 24

Appendix 3

The Activities-specific Balance Confidence (ABC) Scale

For each of the following activities, please indicate your level of self-confidence by choosing a corresponding number from the following rating scale:

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…

…walk around the house? ____%

…walk up or down stairs? ____%

…bend over and pick up a slipper from the front of a closet floor ____%

…reach for a small can off a shelf at eye level? ____%

…stand on your tiptoes and reach for something above your head? ____%

…stand on a chair and reach for something? ____%

…sweep the floor? ____%

…walk outside the house to a car parked in the driveway? ____%

…get into or out of a car? ____%

…walk across a parking lot to the mall? ____%

…walk up or down a ramp? ____%

…walk in a crowded mall where people rapidly walk past you? ____%

…are bumped into by people as you walk through the mall?____%

… step onto or off an escalator while you are holding onto a railing? ____%

… step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing? ____%

…walk outside on icy sidewalks? ____%

Appendix 4

Fugl-Meyer Assessment of Motor Recovery after Stroke

Date: ________________________ Participant number:_______________

Motor Function – Upper Extremity			
TEST	**ITEM**	**SCORE**	**SCORING CRITERIA**
I. Reflexes	Biceps		0 – No reflexes can be elicited 2- Reflex activity can be elicited
	Triceps		
II. Flexor synergy	Elevation		0-Cannot be performed at all 1-Performed partially 2- Performed faultlessly
	Shoulder retraction		
	Abduction (at least 90°)		
	External Rotation		
	Elbow Flexion		
	Forearm supination		
III. Extensor synergy	Shoulder add/internal rotation		0-Cannot be performed at all 1-Performed partially 2- Performed faultlessly
	Elbow extension		
	Forearm pronation		
IV. Movement combining synergies	Hand to lumbar spine		0-No specific action performed 1-Abduction or elbow flexion occurs in later phase of motion 2- Performed faultlessly
	Shoulder flexion to 90° and elbow at 0°		0-Arm is immediately abducted, or elbow flexes at start of motion 1-Abduction or elbow flexion occurs in later phase of motion 2- Performed faultlessly
	Pronation/supination of forearm with elbow at 90° & shoulder at 0°		0-Correct position of shoulder and elbow cannot be attained, and/or pronation or supination cannot be performed at all. 1-Active pronation or supination can be performed even within a limited range of motion, and at the same time the should and elbow are correctly positioned 2-Complete pronation or supination with correct positions at elbow and shoulder
V. Movement out of synergy	Shoulder abduction of 90°, elbow to 0°, and forearm pronated		0-Initial elbow flexion occurs or any deviation from pronated forearm occurs 1-Motion can be performed partly, or if during motion, elbow is flexed, or forearm cannot be kept in position 2- Performed faultlessly
	Shoulder flexion 90° -180°, elbow at 0°, and forearm in mid-position		0-Initial flexion of elbow or shoulder abduction occurs 1-Elbow flexion or shoulder abduction occurs during shoulder flexion 2- Performed faultlessly
	Pronation/supination of the forearm, elbow at 0° and shoulder between 30° -90° of flexion		0-Supination and pronation cannot be performed at all, or elbow and shoulder positions cannot be attained 1-Elbow and shoulder are properly positioned and pronation and supination performed in a limited range 2- Performed faultlessly
VI. Normal reflex activity	Biceps and/or finger flexors and biceps (This item is only tested if the patient achieves a maximum score on all previous UE items. If the person has not achieved a full score to this point, enter 0)		0-At least 2 of the 3 phasic reflexes are markedly 1-One reflex is markedly hyperactive, or at least 2 reflexes are lively 2-No more than one reflex is lively and none are hyperactive

Date: __________ Participant number: ______________

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° 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 6 seconds or more longer than unaffected side 1-Activity is 2.0-5.9 seconds longer than unaffected side 2-Less than 2 seconds difference
TOTAL LOWER EXTREMITY TOTAL			**MAXIMUM = 34**

Appendix 5

Informed Consent Document

Identification of Project:

Floor to Stand Performance among Persons Following Stroke

Statement of Age of Participant:

I state that I am 18 years of age or older, in good health, and wish to participate in a program of research being conducted by Dr. Dennis Klima, Dr. Amanda Leonard, Dr. Stephanie Combs-Miller and Angela Davis at University of Maryland Rehabilitation and Orthopedic Institute in conjunction with University of Maryland Eastern Shore and University of Indianapolis.

Purpose:

The purpose of this research is to study getting up from the floor among persons who have had a stroke in conjunction with walking speed, walking performance, balance, balance confidence, movement, age, body weight and type, location and date of stroke.

Procedures:

The procedures will involve data collected from my electronic medical record including age, body weight and type, location and date of my stroke.

The procedures will also include six parts, in which the following will be tested in one session:

1. Timed floor to stand (video recorded)
2. Walking speed (10-meter walk test)
3. Walking performance (Timed Up & Go test)
4. Balance (Dynamic Gait Index)
5. Balance confidence (Activities-Specific Balance Confidence scale)
6. Movement of my affected arm and leg (Fugl-Meyer Assessment)

Confidentiality:

All information collected in this study is confidential, and my name will not be identified at any time.

Benefits:

I understand that this study is not designed to help me personally, but that the investigators hope to learn more about physical performance and rising from the floor.

Freedom to Withdraw from and Ask Questions:

I understand that I am free to ask questions and to withdraw from participation at any time without penalty.

Where Medical Care is Available:

In the event of physical injury resulting from participation in this study, I understand that immediate medical treatment is available at University of Maryland Rehabilitation and Orthopedic Institute. However, I understand that the University of Maryland Rehabilitation and Orthopedic Institute, University of Maryland Eastern Shore and University of Indianapolis does not provide any medical or hospitalization insurance coverage for participants in the research study, nor will these institutions provide any compensation for any injury sustained as a result of participation in this research study except as required by law.

Conclusion:

You are making a decision whether or not you will participate in this study. If you sign the consent form, you are agreeing to participate based on your reading and understanding of this form. If you have any questions regarding this study, please ask one of the investigators, or call Dr. Dennis Klima at 410-651-6354. If you have questions regarding your rights as a research participant, please contact the Chair of the University of Maryland Eastern Shore Institutional Review Board, Dr. Clayton Faubion, by calling 410-651-6379.

Names:

Principle Investigator: Dr. Dennis Klima, PT, MS, Ph.D, GCS, NCS

Co-Investigators: Dr. Stephanie Combs-Miller, PT, Ph.D, NCS

Dr. Amanda Leonard, PT, DScPT, NCS

Student Investigator: Angela Davis, PT, MHS, NCS

Address:

University of Maryland Eastern Shore
Department of Physical Therapy
Hazel Hall, 2nd Floor
Princess Anne, MD, 21853
Phone: 410-651-6301

University of Maryland Rehabilitation
and Orthopedic Institute
2200 Kernan Drive
Baltimore, MD 21207
Phone: 410-448-2500

Signature of Participant: ________________________________ **Date:** __________

Signature of Witness: ___________________________________ **Date:** __________

Appendix 6

IRB Approval Documents

UNIVERSITY *of* MARYLAND
EASTERN SHORE

UNIVERSITY OF MARYLAND EASTERN SHORE
Institutional Review Board

Hazel Hall, Suite 1062
Princess Anne, Maryland 21853-1299

VOICE: **(410) 651-6262**
FAX: **(410) 651-6736**

Date: May 13, 2019

To: Dr. Dennis Klima, Department of Physical Therapy
From: Clayton Faubion, Ph.D., Chair, UMES IRB

RE: Protocol #2019-011– "Floor to Stand Performance among Persons Following Stroke"

I am writing to confirm that the UMES protocol mentioned above has been reviewed by the UMES Institutional Review Board and deemed Expedited. The UMES IRB approval for this study expires May 12, ,2020.

Please be advised that any and all information recorded in your study must be kept confidential and no changes to the study protocol can be made without additional review and prior approval by the UMES IRB.

If you have any questions or concerns you can contact me at (410) 651-6379 or cwfaubion@umes.edu.

UNIVERSITY of INDIANAPOLIS.

Human Research Protections Program (HRPP)
1400 East Hanna Avenue
Health Pavilion
Indianapolis, IN 46227

(317) 781-5774
http://irb.uindy.edu
hrpp@uindy.edu

Institutional Review Board (IRB) Reliance/Authorization Agreement

Institution/Organization Providing IRB Review (IRB of Record):

Name: University of Maryland Eastern Shore
Federalwide Assurance (FWA) #:

Institution/Organization Relying on the IRB of Record (Relying IRB):

Name: University of Indianapolis
Federalwide Assurance (FWA) #: 00027197

Terms of Agreement

1. Scope: The Officials signing below agree that the Relying IRB may rely on the IRB of Record in accordance with the terms and conditions set forth in this Agreement for review and continuing oversight of human subject research described below **(select the applicable scope of review)**:

   ( ) A. This Reliance Agreement applies to ALL Relying IRB human subject research

   (X) B. This Reliance Agreement pertains to the following research/studies:

   (1) Title of Research Study: Floor to Stand Performance among Persons Following Stroke

   Name(s) of Relying IRB institution's investigator: Stephanie Combs-Miller, PT, PhD, NCS
   Name(s) of IRB of Record Institution's investigator: Dennis Klima, PT, MS, PhD, GCS, NCS

2. FWA & Review in Accordance with FWA: **IRB of Record** will maintain a current, approved FWA with OHRP for the duration of this Agreement. **IRB of Record** will notify the **Relying IRB** immediately when its FWA is terminated or expires.

   The review and continuing oversight of the research performed by the **IRB of Record** included under this Agreement will meet the human subject protection requirements of **Relying IRB's** OHRP-approved FWA. **Relying IRB** will, as needed, inform the **IRB of Record** of changes to or expiration of the FWA. **IRB of Record** agrees to conduct review of research according to all applicable regulations and laws, including initial review, continuing review, review of modifications to previously approved research, review of Unanticipated Problems Involving Risks to Subjects or Others (UPIRTSOs), and review of non-compliance.

3. IRB Member Training: **IRB of Record** agrees to maintain a program for education and training in human subject research for IRB personnel.

4. Accreditation Status (as applicable): **IRB of Record** agrees to notify **Relying IRB** when the accreditation status of the human research protection program changes.

5. Informed Consent: **IRB of Record** agrees to review and approve the informed consent process and document(s), including review of any site-specific modifications.

6. Conflict of Interest: **IRB of Record** agrees to provide **Relying IRB** with information related to any significant financial interests of which the IRB becomes aware.

7. Organizational Conflict of Interest: **Relying IRB** agrees to disclose to the **IRB of Record** any organizational conflict(s) of interest, as well as an applicable conflict management plan. **IRB of Record** agrees to review and approve the management plan prior to approving the study.

8. Investigator Qualifications: **Relying IRB** is responsible for educating and training its investigators to perform research involving human subjects covered by this Agreement. The **IRB of Record** agrees to validate credentials/qualifications of investigator(s) for the conduct of human subject research.

9. IRB approval: **IRB of Record** agrees to ensure investigators obtain official certification of IRB approval before the initiation of this research/study.

10. Public Health Service (PHS) Research: **IRB of Record** agrees to conduct, when applicable, a conflict of interest review pursuant to PHS regulations on Promoting Objectivity in Research, 42 CFR 50, Subpart F.

11. Credentialing: **IRB of Record** agrees to maintain appropriate institution-specific required credentialing of staff.

12. Contract Review: **IRB of Record** agrees to ensure that contracts between sponsors and investigators include the following terms:

    (a) Who will provide care and who is responsible to pay for it;

    (b) Obligate the Sponsor to promptly report to the investigator(s) or organization conducting the research any findings of study monitors that could affect the safety of participants or influence the conduct of the study;

    (c) Obligate the Sponsor to send routine and urgent data and safety monitoring reports to the investigators or organization conducting the research;

(d) Obligate the Sponsor to notify the investigator(s) or organization conducting the research of any study results after the study has ended that could directly affect participant safety and specify a time frame after closure of the study during which the Sponsor will communicate such findings.

13. HIPAA: **IRB of Record** will perform any determinations required by the Health Insurance Portability and Accountability Act of 1996 (HIPAA) and its regulations with respect to the research included under this Agreement, including determinations related to waivers of authorization for use and disclosure for research of subjects' Protected Health Information (PHI) as defined in the HIPAA regulations. **IRB of Record** will also provide a form of authorization for use and disclosure of PHI where such authorization is required.

14. Concurrent Review: **Relying IRB** reserves the right at any time to assert its jurisdiction over the review of any research/study included under this Agreement and conduct review of the research/study by its own IRB. **Relying IRB** must notify in writing the Study PI and the **IRB of Record** when **Relying IRB** decides to assert jurisdiction. In this event, the more stringent requirements of the two IRBs' reviews will govern. **Relying IRB** acknowledges and agrees that it MAY NOT administratively overrule the **IRB of Record's** disapproval of any research/study reviewed concordant with this Agreement.

15. IRB Independence & Local Research Context: This Agreement does not require the **IRB of Record** to allow representatives of **Relying IRB** to attend its meetings or otherwise accept comments or influence from **Relying IRB** representatives in the review of an included study, except to the extent necessary or requested to ensure sufficient knowledge of the local research context.

    Relying IRB will notify the **IRB of Record** in writing of any local laws, regulations, policies, or other standards imposing requirements on **Relying IRB** with respect to any study included under this Agreement.

16. IRB Correspondence & Meeting Minutes: The **IRB of Record** will notify in writing appropriate officials at **Relying IRB** and the responsible **Relying IRB** investigator of its decision to approve or disapprove any research/study accepted for review under this Agreement or of modifications required to secure approval of the research/study, as well as of subsequent IRB-reviewed and approved changes in the conduct of the research/study. Relevant minutes of the **IRB of Record's** meetings will be made available to **Relying IRB** upon written request.

17. IRB Authority: **Relying IRB** will accept the decisions and requirements of the **IRB of Record** with respect to the research study conducted under this Agreement. **Relying IRB** will also ensure that its investigator cooperates in the **IRB of Record's** continuing review process with all other requirements of the **IRB of Record**.

18. Compliance Responsibilities of Relying Entity and Its Investigators: **Relying IRB** remains responsible for:

(a) Compliance with all applicable federal, state and local statutes, regulations, guidelines and rules that govern human research protections;

(b) Compliance with institutional policies and procedures;

(c) Ensuring that **Relying IRB** investigators and all research/study team members comply with the determinations of the **IRB of Record.**

The **IRB of Record** will, upon **Relying IRB's** request, provide to **Relying IRB** and its investigators copies of the **IRB of Record's** policies, procedures, and documents referenced herein. Nothing herein shall be interpreted to prevent **Relying IRB** or its investigators from complying with any policy or procedure of **Relying IRB** applicable to the covered research; however, to the extent there is a conflict between such policy or procedure and the applicable policies and procedures of the **IRB of Record**, the parties will work together to ensure that the more stringent requirements of the conflicting policy or procedure will govern.

19. Reporting of Information on Noncompliance and Subject Safety: **Relying IRB** will promptly report to the **IRB of Record** any noncompliance by **Relying IRB** or its investigators with the determinations, documents, laws, policies, and procedures identified above in Part 18 pertaining to the research study conducted under this Agreement of which **Relying IRB** is aware. **Relying IRB** will also ensure that its investigators report immediately to the **IRB of Record** any injuries to subjects or unanticipated problems involving risks to subjects or others in the research study conducted under this Agreement of which the investigators are aware. Furthermore, **Relying IRB** will ensure that its investigators submit in a timely manner to the **IRB of Record** all proposed modifications in research/study activity/ies; such changes shall not be initiated without the **IRB of Record's** review and approval except where necessary to eliminate apparent immediate hazards to the subjects.

20. Notification of Information on Noncompliance, Suspension/Termination, and Subject Safety Determined/Discovered by IRB: The **IRB of Record** will, in writing, notify **Relying IRB** of the following findings/determinations:

(a) Serious or continuing non-compliance by **Relying IRB** or **Relying IRB**'s investigators;

(b) Any suspension or termination of IRB approval; and

(c) Injuries to subjects or unanticipated problems involving risks to subjects or others.

This includes, as appropriate, notifying **Relying IRB** about information from internal and external reports and complaints determined, discovered, or learned by the **IRB of Record** in connection with the conduct of the study by **Relying IRB**, or in connection with the conduct of the study by another site if such discovery or determination regarding the other sites affects the conduct of the study at other sites.

21. Participant Complaints: **Relying IRB** will promptly report to the **IRB of Record** any **Relying IRB** participant complaints in connection with the research/study activity(ies) conducted under this Agreement of which **Relying IRB** is aware. In turn, the **IRB of Record** will, in writing, notify **Relying IRB** of any participant complaints received from participants at the **Relying IRB** site. In the event that there is not a consensus about how to address the complaint, the parties will work together to ensure that the more stringent requirements of the conflicting policy or procedure will govern.

22. Cooperation in Investigations and Corrective Actions: **Relying IRB** will cooperate and ensure that its investigators cooperate with the **IRB of Record** or any government authority that conducts an inquiry into research compliance involving research/studies conducted under this Agreement. Such cooperation will include, but is not limited to, providing research records and related information, meeting with **IRB of Record** research representatives upon request, permitting reasonable on-site audits of **Relying IRB's** facilities, and helping to carry out remedial action if reasonably indicated. Such remedial action may include termination of participation by **Relying IRB** or its investigators in designated research activities. **Relying IRB** may also take further action where appropriate to deter and remedy such deficiencies; however, to the extent there is a conflict between remedial actions sought to be taken by the parties, the more stringent of the remedial actions shall apply.

23. Recordkeeping: **Relying IRB** will instruct its investigators to retain for at least three years after completion of the research and longer if required by law records of all human subjects research and related activities conducted under this Agreement. Upon request, **Relying IRB** shall provide a copy of such records to the **IRB of Record** and other legally authorized entities.

24. Term: This Agreement shall become effective on the last date signed below and shall continue until completion of the research as determined by the **IRB of Record,** provided that the parties' FWAs remain current and in good standing and provided that the Agreement is not earlier terminated as provided below.

25. Termination: Either the **IRB of Record** or **Relying IRB** may terminate this Agreement (i) without cause upon thirty (30) days prior written notice to the other or (ii) upon fourteen (14) days prior written notice to the other in the event of a breach by the other that is not remedied to the reasonable satisfaction of the non-breaching party within said fourteen (14)-day notice period. In the event that **Relying IRB's** FWA is threatened, terminated, or expires, the **IRB of Record** may immediately terminate this Agreement.

26. Effect of Expiration or Termination & Survival of Terms: In the event of any termination of this Agreement, the parties will work together to determine the effect of such termination on any research being conducted under the Agreement at the time of termination.

    Parts 16, 17, 18, 19, 23, 24 & 25 of this Agreement will survive any expiration or termination of the Agreement.

27. Notices: All communications, reports and notices required under this Agreement shall be delivered by hand, by facsimile, email or by first-class mail, postage prepaid and addressed as follows:

IRB of Record

Name: University of Maryland Eastern Shore

Address: Hazel Hall, Suite 1062 Princess Anne, MD 21853-1299

Email: cwfaubion@umes.edu

Telephone: 410-651-6262

Relying IRB

Name: Ellen Miller, PhD, PT – can be signed by Yvonne Wakeford, PhD. Director HRPP

Address: 1400 East Hanna Avenue, Health Pavilion, Room 250, Indianapolis, IN 46227

Email: emiller@uindy.edu

Telephone: (317) 791-5932

28. Miscellaneous: This Agreement may be amended only by a written agreement signed by authorized representatives of all parties. If any provision of this Agreement shall be held to be invalid, illegal, or unenforceable, the validity, legality and enforceability of the remaining provisions of this Agreement shall not be affected thereby. The failure of a party to insist upon the strict performance of any of the terms of this Agreement shall not be construed to be a waiver or relinquishment of any of the terms of the Agreement or of the whole Agreement. All the titles and headings contained in the Agreement are inserted only as a matter of convenience and reference and do not define, limit, extend, or describe the scope of this Agreement or the intent of any of its provisions. This Agreement is not assignable in whole or in part, and any attempt to do so shall be void.

This Agreement will be kept on file at each institution/entity and provided to OHRP upon request.

EXECUTED BY AUTHORIZED SIGNATORY OFFICIALS

Date: 5-20-19

Name: Dr. Heidi M. Anderson

Institutional Title: President

Date: 5-21-19

Name: Yvonne Wakeford, PhD for Ellen Miller, PhD, PT

HRPP Director for Associate Provost

UNIVERSITY OF MARYLAND EASTERN SHORE
Institutional Review Board

DATE May 28, 2020

TO Dr. Yvonne Wakeford, Director, Human Research Protection Program
University of Indianapolis
1400 E. Hanna Avenue
Indianapolis, Indiana 46227

FROM Jennifer C. Bobenko, Ph.D., Professor of Biochemistry
Chairperson, UMES Institutional Review Board
Jennifer C Bobenko

VIA Dennis Klima, PT, MS, PhD, DPT, GCS, NCS
Associate Professor
Co-Chairperson, Institutional Review Board
Department of Physical Therapy
University of Maryland Eastern Shore
Princess Anne MD 21853
dwklima@umes.edu; Phone: 410-651-6354

RE Floor to stand performance among persons following stroke: Protocol 2019-011
Angela Davis, PT

Your request for a three-month extension of protocol 2019-011 is approved. This extension is granted to allow time to test one remaining subject. The testing of this subject is required to meet statistical power.

University of Maryland Eastern Shore
Department of Natural Sciences **EMAIL: JLHearne@umes.edu**
1 Backbone Road **VMAIL: 443.614.9226 (cell)**
Princess Anne, Maryland 21853-1299 **: 410.651.7945 (office)**