RESPONSIVENESS AND PREDICTIVE VALIDITY OF THE SITTING BALANCE SCALE AND FUNCTION IN SITTING TEST IN PEOPLE WITH STROKE

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

IN THE GRADUATE SCHOOL OF THE

TEXAS WOMAN'S UNIVERSITY

SCHOOL OF PHYSICAL THERAPY

COLLEGE OF HEALTH SCIENCES

BY

JEHAD ALZYOUD, PT, MSc.

DENTON, TEXAS

MAY 2017

DEDICATION

To Almighty God, Allah, for guiding me through this project and its many phases, and for providing me with the strength, patience, and perseverance required despite challenges faced along the way.

To my loving parents, Muhammad and Nofah, whose words of inspiration and encouragement kept my motivation and enthusiasm throughout this journey.

To my wife Jomana, who has been by my side and has provided me with the unyielding support, patience, and encouragement that is so important and needed to complete a project of this magnitude and so much value to my person, I am forever grateful.

To my children, Lazaward, Adam, and Sama … the joy of my life!

ACKNOWLEDGMENTS

I would like to express my deepest gratitude for the collective efforts of many in the completion of my dissertation. It has been a challenging journey to have come so far in the achievement of this project. I can attest I have grown as an individual as a result of the experiences I have encountered, both on a personal and interpersonal level, as a result of my involvement with the patients and people who have assisted me in this project in one way or the other. I want to thank Dr. Ann Medley, committee chair, for being with me step by step during this process, for providing me with sincere guidance, and for ensuring the quality of my research. I am grateful for Dr. Mary Thompson for providing me with fundamental questions necessary to guide my research, assisting me with constructing a holistic view, as well as with her statistical expertise. I am also appreciative and thankful for Dr. Linda Csiza who has been an incredible example providing me with a positive attitude, constructive feedback, and guidance with the clinical feasibility of my study. Many thanks to Springtree Rehabilitation & Health Care Center, Broward Nursing & Rehabilitation Center, Plantation Nursing & Rehabilitation Center, Tamarac Rehabilitation & Health Center, and Unity Health & Rehabilitation Center for allowing the data to be collected at their places. My appreciation and gratefulness to Texas Woman's University School of Physical Therapy for facilitating me the opportunity to complete this project. It has been a privilege to have worked with such a great University surrounded by support and incredible mentorship.

ABSTRACT

JEHAD ALZYOUD

RESPONSIVENESS AND PREDICTIVE VALIDITY OF THE SITTING BALANCE SCALE AND FUNCTION IN SITTING TEST IN PEOPLE WITH STROKE

MAY 2017

A common impairment following stroke is impaired balance. Many survivors of stroke are non-ambulatory. Using a valid, reliable, and sensitive measurement tool is essential to identifying balance impairment accurately and making informed clinical decisions. Limited studies examined qualities of available sitting balance scales. The purpose of this study was to examine the responsiveness and the predictive validity of the Sitting Balance Scale (SBS) and Function in Sitting Test (FIST), in people in sub-acute rehabilitation settings who have had a stroke. We also aimed to establish the minimal detectable change (MDC) and minimal clinically important differences (MCID) for both scales. We recruited 40 participants with stroke who were tested upon admission and shortly before discharge. The effect size (ES) and the standardized response mean (SRM) were used as indicators of internal responsiveness. Using Pearson's correlation coefficient, the external responsiveness was tested by examining the association between the difference in scores on the SBS or FIST and the difference in scores on the Barthel Index (BI). Univariate linear regression and the receiver operating characteristic (ROC) curve were used to examine predictive validity. The MDC, 90% confident level (MDC_{90})

was calculated from the standard error of measurement, while anchor-based and distribution-based approaches were used to establish the values of MCID. Both scales demonstrated sufficient internal (ES & SRM > 1.11) and external responsiveness (r > 0.6). The SBS demonstrated better internal responsive than the FIST. Both scales were equally useful in predicting discharge placement (area under the curve > 0.81). However, the SBS demonstrated better predictive power in predicting functional level than the FIST (SBS, $R^2 = 0.53$; FIST, $R^2 = 0.43$). Both scales failed to predict length of stay. The MDC_{90} values were estimated for the SBS and the FIST to be, 2.32 and 3.9 respectively. Therefore, when a change in score between two measurement occasions exceeds 2.32 on the SBS or 3.9 on the FIST, clinicians can be 90% confident in interpreting the change as error free. We established the MCID for both scales as follows: the SBS, 5 points; the FIST, 6 points. The established MDCs and MCIDs may help clinicians to interpret the change in performance and verify treatment effects after stroke rehabilitation. The results of this study support the usefulness of two well-designed sitting balance tools in people following a stroke. Using these tools will help clinicians effectively address sitting balance during early rehabilitation phases. As supported by this study, restoring sitting balance will help to improve a patient's functional level at discharge. Patients with sufficient functional level are likely to be discharged home, rather than to long-term care.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

A stroke affects brain structures, the brain's biochemical and electrical capacities, causing symptoms such as paralysis, muscle weakness, poor coordination, visual problems, and sensory impairment that may directly or indirectly affect the patient's balance abilities. According to World Health Organization estimates, neurological disorders and their direct consequences have affected about one billion people globally (World Health Organization, 2006). Stroke, representing 55% of all neurological disorders, is a leading cause of disability and the fourth leading cause of death in the United States (Towfighi & Saver, 2011); it is a pervasive health issue in the United States, affecting 795,000 persons a year (Roger et al., 2012). By a compilation of medical bills, health care services, and time off work, stroke costs in the United States are approximately $36.5 billion every year (Roger et al., 2012).

A common impairment following stroke is impaired balance. Balance is defined as the ability to maintain the position within the limits of stability or base of support (Shumway-Cook, Anson, & Haller, 1988). Balance can be maintained through coordination of three sensory input systems (vestibular, somatosensory, and visual), integration of sensory input, and a healthy motor system (musculoskeletal system) that is able to act according to the plan developed during central processing. Regardless of the

stroke site, balance components are likely vulnerable, leaving individuals at risk of losing important functions or facing dangerous consequences (e.g., falls). Studies have shown that falls interfere with functional recovery and limit individuals' activities of daily living (ADL) (Krishchiunas & Savitskas, 2004; Nyberg & Gustafson, 1997). Assessment of balance is needed before clinicians can establish an effective plan of care for patients, particularly those with neurological disorders.

Clinically, several scales have been designed to detect balance impairment by testing activities for which balance is a necessary component. These clinical tools assess patients' impairments or functional limitations, tracking their changes over time, and predict optimal levels of function that might be reached. Using a valid, reliable, and sensitive measurement tool is essential to accurately identify balance impairment and to make informed clinical decisions. Several tools have been used to measure balance specifically. The majority of available tools assess balance in the standing position. However, in many cases, survivors of stroke are non-ambulatory, which makes these tools less useful. This need for more useful tools led researchers to develop mechanisms to assess balance in a sitting position.

Statement of the Problem

People who have suffered a stroke make up a large portion of the overall population of rehabilitation clients. Decreased sitting balance is common following a stroke (Morgan, 1994). Good sitting balance is essential for most functional activities and a key element for functional recovery after stroke (Amusat, 2009; Tsang & Mak, 2004). Poor sitting balance will likely lead to a discharge to a long term care setting rather than

home. Restoring sitting balance following stroke is a primary goal during the early stages of rehabilitation (Nieuwboer, Feys, Weerdt, Nuyens, & Corte, 1995). Therefore, assessing patients' sitting balance is important clinical practice.

The available sitting balance scales are relatively new, and only a few studies have been conducted to investigate their psychometric properties. Two recently developed sitting balance assessments are the Sitting Balance Scale (SBS) and the Function In Sitting Scale (FIST). To date, limited studies have examined the responsiveness and predictive validity of the SBS and FIST. One study examined the responsiveness and the minimally clinically importance difference (MCID) of the FIST in inpatient rehabilitation settings across a wide variety of diagnoses (Gorman, Harro, Platko, & Greenwald, 2014). However, the predictive validity of both scales; and the responsiveness, minimal detectable change (MDC) and the MCID of the SBS have not been established. This study is the first to investigate clinically important features of two well-designed, reliable, and easy to administer sitting balance scales in individuals who have suffered a stroke. Unlike Gorman's study, the current study focused exclusively on patients with stroke and was conducted in post-acute rehabilitation facilities where major therapy impact occurs. Tracking true changes in patients' abilities throughout the rehabilitation program is vital for clinicians, patients, and patients' families. Determining the responsiveness and calculating the MDC and MCID may help clinicians provide the most effective intervention and decrease patients' risk of falling. Furthermore, all parties are interested in discussing the potential functional outcome and the level of independence a patient might reach. Such outcomes may be predicted by looking at

earlier performance on other measures. In this study, the ability of the two sitting balance scales to predict level of independence and functional mobility was examined.

Purpose of the Study

The primary purpose of the study was to examine responsiveness and predictive validity of scores on two sitting balance scales, the SBS and FIST, in people receiving rehabilitation in skilled nursing facilities who have had a stroke. In addition, the MDC and MCID of the two scales were estimated as a second purpose.

Research Questions

The following research questions were addressed in this study:

1. What is the ability of the SBS and FIST to detect change over time for individuals in a post-acute rehabilitation setting following a stroke?
2. Will admission scores on the SBS or FIST predict functional level as measured by the Functional Independence Measure (FIM) at the time of discharge in individuals in a post-acute rehabilitation setting following a stroke?
3. Will admission scores on the SBS or FIST predict the length of stay in post-acute rehabilitation sittings following a stroke?
4. Will admission scores on the SBS or FIST predict discharge placement following post-acute rehabilitation following a stroke?
5. What are the MDC and MCID of the SBS and FIST for individuals in a post-acute rehabilitation setting in people with stroke?

Operational Definitions

For the purpose of this study, the following terms were defined:

1. Sitting balance is the ability to maintain upright stability while performing activities in seated position.
2. Functional mobility is the way people move around in the environment to participate in the activities of daily living and move to different places as measured by the FIM (Forhan & Gill, 2013).
3. Level of independence is the extent of independence from any physical or verbal help regardless of the underlying causes (Collin, Wade, Davies, & Horne, 1988).

Assumption and Limitations

Assumptions

The following assumptions were made for the purpose of this study:

1. Each participant was appropriately diagnosed with stroke.
2. All participants were tested within 72 hours of their admission to the facility and within 48 hours of their discharge from the rehabilitation program.
3. Participants in the study represent the population of stroke in their functional limitation and balance impairment.
4. Participants performed at their maximum ability to obtain the maximum possible score on each test.
5. The Mini Mental Status Examination, Functional Independence Measure, Timed Up and Go, and Barthel Index effectively and accurately measured the corresponding construct.

Limitations

The following were limitations of this study:

1. A sample of convenience was recruited and may not represent the population of persons following stroke. However, demographic analysis of the sample was conducted to determine similarities to the population of interest.
2. Medication effects may have interfered with participants' ability to complete the tests.
3. The study utilized one tester (the primary investigator) who was not blinded to the scores for individual test items, which may have caused the tester to remember results from the first testing session. However, the length of time between the two testing sessions should have been long enough to minimize potential bias.
4. Recruiting facilities offer rooms with different equipment and environment (e.g., bed size and shape, private versus shared room) which may have affected testing as some patients were transferred to a different room after the first testing.
5. Recruited participants' rehabilitation was covered by various insurance entities who follow different criteria, which may have influenced the length of stay and discharge placement.
6. While all participants had the same medical diagnosis, people with stroke may present with different onset, progression rate, and symptoms.

Significance of the Study

People who have suffered a stroke make up a large portion of the overall population of rehabilitation clients. During the early stages of stroke recovery, assessing

these patients' sitting balance is an important part of their rehabilitation program. Because there is no gold standard for assessing sitting balance as of this date, the available sitting balance scales have been developed only recently, and limited studies have been carried out to investigate their psychometric properties in people who have had a stroke and other neurologic diagnoses. This is the first study to compare important psychometric properties of two sitting balance scales in people with stroke in post-acute rehabilitation settings. The study's results may guide clinicians to use the most appropriate tool when assessing sitting balance in people who have had a stroke. The results may also provide clinicians and researchers with useful information about the two sitting balance scales so these tools can be confidently used in both daily practice and research.

CHAPTER II

REVIEW OF THE LITERATURE

A common impairment following stroke is impaired balance. Balance is maintained through coordination of sensory input systems (vestibular, somatosensory, and visual systems), the central nervous system's central processing, and the motor (musculoskeletal) system, which all become vulnerable after stroke. Balance impairment places people at risk of falling and the associated consequences (e.g., injuries). Clinically, several scales have been designed to detect balance impairments and, recently, scales have been developed to assess balance in the seated position allowing objective balance evaluation in low-level patients, including individuals with stroke. The goal of this study was to examine the responsiveness and predictive validity of two sitting balance scales, the Sitting Balance Scale and the Function in Sitting Test. The goal of this chapter is to review the following areas: (a) main psychometric properties of measurement tools, (b) pathology of stroke, (c) prevalence, direct and indirect cost of stroke, (d) clinical presentation of people who have had a stroke, (e) balance impairment of people with stroke, and (f) how balance, in general, and sitting balance, in particular, are assessed in clinical settings.

Methodological Studies

Methodological studies aim to examine the usefulness of a newly developed test or instrument. Employed to investigate the ability of a clinical test or instrument to

quantify impairment of body structure or function, methodical studies are nonexperimental in nature and utilize longitudinal (change over time) or transversal (specific point of time) approaches. An example of longitudinal approach is testing for reliability of a measure by repeating the test after a period of time to ensure consistency of that measure. In contrast, testing the agreement between a newly designed measure and the best available measure (gold standard) is an example of transversal (cross-sectional) study. Information from methodical studies is essential, allowing clinicians to choose tools that best show the effectiveness of their services. The ultimate goal of methodological studies is to determine the psychometric properties of one or more measures.

Psychometric Properties

Psychometric properties are quantifiable qualities that relate to data collected on a test or measurement tool to determine the statistical strength of that tool in measuring the construct of interest. Reliability and validity are the fundamental components of psychometric properties (Karanicolas et al., 2009). A tool must be valid, reliable, and sensitive to help clinicians assess and track changes over time. An assessment tool also assists clinicians in making recommendations regarding their patients' rehabilitation program and discharge plan and may predict functional improvement. Newly developed tools are subject to statistical analysis to ensure their ability to accurately measure what they are intended to measure. A measurement tool cannot be recommended confidently without well-established psychometric properties. In this section, a description and the significance of the main psychometric properties will be provided.

Reliability

Reliability refers to the ability to approximate the essential inconsistency of a condition, as well as the error attributable to the tester and the measurement tool (Portney & Watkins, 2015). For a test to be reliable, consistent results (less error) should be collected each time the test is administered by one rater (intra-rater reliability), different raters (inter-rater reliability), or over multiple instances of testing (test-retest reliability). In reality, it is rare to find absolute consistency in testing measures. Therefore, the focus of reliability testing is to evaluate the effects of inconsistency on the accuracy of a test. In fact, a wide variety of factors lead to inconsistency (source of errors). These factors include but are not limited to; the characteristics of the individual being tested (e.g., emotional status), testing environment and circumstances (e.g., instructions clarity, race of examiner), and chance influence (e.g., luck in guessing an answer). These factors are also known as errors in measurement. On the other hand, the true score involves the elements of the construct repeatedly being measured. The observed score contains both the true score and the measurement error, whereas the true score is the feature that persists over numerous measurement occasions in the absence of error. The intention in calculating the reliability of a measurement tool is to examine how much of the scores' variability can be attributed to errors in measurement and, as a result, the variability in the true scores (Davidshofer & Murphy, 2005). Reliability is often assessed using the intraclass correlation coefficient (ICC). Typically, an ICC of 0.75 or more is considered excellent reliability in rehabilitation research. A tool must be valid to be used confidently across clinical setting. However, reliability is a "prerequisite" for validity, which means a

test must be reliable before researchers examine its validity. In this study, reliability of the two sitting balance tools was not examined because it has been already examined. The reliability of the two tools will be discussed later in this chapter.

Validity

Validity is the degree to which an instrument measures what it is designed to measure (Brink, Van der Walt, & Van Rensburg, 2006). It is crucial for a measurement tool to be valid so the produced results can be precisely understood and adopted. The validity of a measurement tool is determined by several statistical tests to investigate the relationship between the results produced by the tool and the behavior of the construct being measured. Validity can be found in three forms: content, criterion-related, and construct validity. Content validity refers to whether a test (or measurement tool) covers all aspects of the construct being measured. If the content of a test matches the content of a construct, content validity is evident. To ensure the content validity of a scale, items must be selected carefully (e.g., expert opinion) to address all aspects of the construct domain. An example of content validity is face validity.

Criterion-related validity refers to an instance when a correlation is found between the selected test and a criterion known to be representative of the construct. For a measurement tool to have criterion validity, its results should correlate with results yielded by a "gold standard," which is presumed to be valid. Concurrent validity and predictive validity are examples of criterion-related validity. Concurrent validity refers to scores that are correlated from both the test and the criterion measure obtained at the

same time, while predictive validity refers to whether the test's results are correlated with measures of the same construct that are taken at some time in the future.

Construct validity means the ability of a test to generate results associated with theoretically created traits that cannot be experimentally observed. Construct validity has three forms: convergent, divergent, and discriminative validity. Convergent validity is evident when two measures that are theoretically related yield related results. On the other hand, divergent validity is indicated when two measures that are theoretically different are in fact unrelated. Discriminative validity of a measurement tool refers to its ability to differentiate between individuals who are anticipated to differ (Bannigan & Watson, 2009). In this study, predictive validity of two sitting balance measurement tools was examined.

Responsiveness

Responsiveness is the ability of a tool to detect changes that are clinically important when treatment known to be effective is applied (Anderson, Felson, Meenan, & Williams, 1989; Anderson & Chernoff, 1993; Norman, Stratford, & Regehr, 1997). The literature proposes two main features of responsiveness, internal responsiveness and external responsiveness (Husted, Cook, Farewell, & Gladman, 2000). Internal responsiveness is the ability of a measure to show changes over a predetermined time such as before and after providing an intervention that is known to be effective (Deyo & Centor, 1986; Husted et al., 2000).

The definition of external responsiveness is the degree to which changes in measures over a particular timeframe are associated with changes in a standard measure.

Unlike internal responsiveness, external responsiveness does not depend on the effectiveness of the intervention. Rather, it depends on the reference measure selected (Husted et al., 2000).

Minimal Detectable Changes/Minimal Clinically Important Difference

Minimal detectable change (MDC) is the smallest amount of change needed to be considered statistically significant (i.e., greater than measurement error) (Haley & Fragala-Pinkham, 2006). The MDC of a measurement tool is determined by calculating the standard error of measurement (SEM), a form of reliability that quantifies the measurement error in the unit of measurement itself. Clinically, it is easier to interpret the MDC (uses same unit) of a measurement tool than to deal with unitless values like the ICC (Donoghue & Stokes, 2009). For a change to be a true change, free of measurement error, it must exceed the MDC value. Statistically, two levels of confidence are reported in the literature when calculating the MDC, 95% confidence (MDC_{95}) and 90% confidence (MDC_{90}) (Lin et al., 2009; Stevenson, 2001). Apparently, MDC_{95} is a more conservative way of calculating MDC and typically used when the measure directs a critical decision, as in a surgical intervention, while MDC_{90} is accepted when a less critical decision is made (e.g., effectiveness of rehabilitation intervention). Because this change in measurement might be not sufficient to be considered clinically important, clinicians are also interested in the minimal clinically important difference (MCID). The MCID corresponds to the smallest amount of change in a measure the patient or clinician perceives as important (Jaeschke, Singer, & Guyatt, 1989; Pandian, Arya, & Kumar, 2016). As in MDC, the MCID is usually presented in the unit of measurement (Ebrahim,

1989; Finch, Brooks, Stratford, & Mayo, 2002). Not only is calculating MDC and MCID values essential for daily clinical decision-making, these values facilitate evidence-based practice and support the clinical utility of a measurement tool.

Stroke

Pathology of Stroke

A stroke involves rapid brain damage caused by cerebrovascular network interruption. Whether it is caused by ischemia (87%), when brain cells do not receive sufficient oxygen and glucose, or by hemorrhage, when vascular bleeding raises intracranial pressure, the end result is permanent damage to brain cells that control body functions (Donnan, Fisher, Macleod, & Davis, 2008; Loewen & Anderson, 1988). The wider the area of brain involved, the more functions are likely to be lost. When left without oxygen for more than 60 to 90 seconds, brain tissue stops functioning. Three hours later, irreversible damage occurs, leading to cell death. According to the World Health Organization (WHO), a neurological deficit that "persists beyond 24 hours or is interrupted by death within 24 hours" should be classified as a stroke. Otherwise, it is considered a transient ischemic attack (World Health Organization, 1978).

Prevalence and Cost

In developed countries, stroke is the third common cause of death, after coronary artery disease and cancer, and causes death up to 10 % of the population. Globally, 15 million cases of stroke occur every year. Of these incidences, one-third die and one-third survive with permanent disabilities (Mackay, Mensah, Mendis, & Greenlund, 2004). In the United States, 7 million (3% of the population) persons had a stroke between 2005

and 2008, with an incidence rate of 795,000 each year. Stroke is accountable for one in every 18 deaths in the United States (Roger et al., 2012). In 2010, the US spent 36.5 billion dollars as direct and indirect expenses associated with a stroke diagnosis (Roger et al., 2012). According to the WHO, the burden of stroke, measured by disability-adjusted life years (DALYs), will increase to 61 million DALYs in 2020 compared to 38 million DALYs in 1990 (Mackay et al., 2004).

Clinical Presentation

A stroke can damage many areas of the brain, therefore, individuals with stroke may present with different manifestations. However, muscle weakness, paralysis, sensory impairment, speech problems, and/or visual problems are common symptoms seen in individuals with stroke. Injury to main central nervous system pathways (spinothalamic, corticospinal, and dorsal column) causes symptoms including hemiplegia, hemiparesis, numbness, sensory impairment, and/or abnormal muscle tone; whereas cranial nerves symptoms (e.g., tongue weakness) are exhibited if the brain stem is the affected area. The cerebral cortex is frequently affected by stroke. Lesion in the cerebral cortex causes a wide variety of symptoms including (but not limited to): aphasia, apraxia, visual field problems, hemineglect, and dysarthria. Gait disturbance, disequilibrium, and coordination defect are common cerebellar lesion symptoms. In most cases, stroke affects one side of the brain causing symptoms on the opposite side of the body. Although stroke is a non-progressive injury, the unilateral nature of the symptoms is quite challenging (Ryeson, 2013). Hemiparesis, the most common neurological deficit after stroke, is muscle weakness of one entire side of the body. Hemiplegia is the most severe form of

hemiparesis, and causes total paralysis of the affected side of the body (Gresham et al., 1995). Stroke not only affects functional mobility, but also often results in balance difficulties. Furthermore, most of the aforementioned symptoms directly or indirectly interfere with an individual's balance.

Balance Impairment in People with Stroke

Balance control is a complex process where different body systems (sensory input systems such as the vestibular system, somatosensory system, visual system, central processing, and motor system) work collectively to maintain the center of gravity (COG) over the base of support (BOS) in a given environment. The central nervous system (CNS) has the ability to adapt to functional loss. For instance, individuals with visual impairment can rely on their vestibular system to maintain their balance. Balance becomes problematic only when an individual is left without a compensating system (Allison & Fuller, 2013). As with most neuromuscular disorders, balance is likely to be affected in people who have had a stroke because the systems that maintain human balance are vulnerable. For instance, a healthy muscular system is essential for balance control; however, individuals who have had a stroke suffer muscle weakness or paralysis that profoundly affects their balance performance. Furthermore, people who have had a stroke may present with decreased range of motion, atypical muscle tone, and sensory impairments, all of which can lead to disturbed balance (Ryeson, 2013). Balance impairment affects most activities of daily living (ADLs) by increasing the risk of falling and decreasing confidence in performing ADLs. Studies have shown the risk of falling is particularly high in patients who have had a stroke, and falling is common among stroke

survivors during rehabilitation (DeVincenzo & Watkins, 1987; Mayo, Korner-Bitensky, Becker, & Georges, 1989; Vlahov, Myers, & al-Ibrahim, 1990). Suzuki et al. found 48% of survivors of stroke fall during inpatient rehabilitation, and serious injuries occur in one-third of these fall events (Suzuki et al., 2005). Because rehabilitation has become an essential part of stroke care, more attention and effort should be dedicated to reducing the risk of falling. The goal in stroke rehabilitation is to improve patients' functional mobility and optimize their independence. Achieving rehabilitation goals depends, in part, on a reliable assessment of patients' impairments before a plan of care is developed.

Assessing balance after stroke. With the involvement of different body systems, it is quite challenging to examine human balance quickly, easily, and accurately using a single test. Clinically, balance can be assessed at the functional level or the impairment level (Allison & Fuller, 2013). Clinicians might start their assessment with the functional level where they can detect balance disorders. Once a functional balance problem is identified, further assessment is done at the impairment level, where underlying causes can be determined and an appropriate plan of care can be established. Functional assessment (the focus of this study) is a relatively inexpensive and quick way to examine people's balance in different clinical settings. Functional tests provide clinicians with information about which functions and activities are limited. In these tests, the patient is asked to perform certain functional activities requiring balance. Functional assessments, however, appear capable of detecting only gross balance changes (Allison & Fuller, 2013).

Even so, many functional assessment tools were designed to help clinicians evaluate and track patients' balance disorders. Intensive work has been conducted to examine the quality of these scales across populations, with a clear emphasis on the population of persons with stroke (Berg, Wood-Dauphinee, & Williams, 1995; Bernhardt, Ellis, Denisenko, & Hill, 1998; Hiengkaew, Jitaree, & Chaiyawat, 2012; Jonsdottir & Cattaneo, 2007; Blum & Korner-Bitensky, 2008; Ng & Hui-Chan, 2005; Pyöriä, Talvitie, & Villberg, 2005; Saso, Moe-Nilssen, Gunnes, & Askim, 2016; Tyson, Hanley, Chillala, Selley, & Tallis, 2007; Verheyden, Hughes, Jelsma, Nieuwboer, & De Weerdt, 2006; Yu, Hsueh, Hou, Wang, & Hsieh, 2012). Despite several valid and reliable tools for assessing balance in standing after stroke, floor effects are an issue when these tools are used for this population. To avoid scoring very low on these scales, an individual must stand; however, in the early stages after stroke, many individuals cannot stand or walk, which may lead to less useful and less accurate findings. Furthermore, patients with severe stroke may be wheelchair-bound; nonetheless, they may demonstrate good balance performance in the seated position. The Berg Balance Scale (BBS), for instance, is a widely used standing balance scale (Berg, Wood-Dauphine, Williams, & Gayton, 1989). Of the 14 items on the BBS, 12 require a standing position to complete. As a result, regardless of whether a patient is stable while sitting, the maximum BBS score that patient can receive is 8 out of 56, which may misrepresent the patient's actual balance performance in a seated position. Unlike the BBS, most other standing balance scales have no sitting items, which calls into question their ability to provide useful information

when used with low functioning patients. The need for more appropriate tools has led to the development of sitting balance scales.

Measuring sitting balance in clinical settings. Several sitting balance scales have been developed over the past decade. However, limited work has been done to investigate the quality of these scales. More investigation is needed before these tools can be used with confidence across clinical settings. This section will review the available sitting balance scales and their established quality. The literature describes seven scales developed to assess balance in the seated position.

Nieuwboer, Feys, Weerdt, Nuyens, and Corte (1995) developed a tool, Sitting Balance for Hemiplegia, which was the first clinical rating scale designed to measure sitting balance. It is a 12-item scale that uses visual observation of trunk, posture, and balance in five different positions. A reliability study revealed wide differences between the items in terms of inter-rater reliability (kappa k= 0.2-1.0), but no subsequent studies have been carried out to investigate other psychometric prosperities of this scale (Nieuwboer et al., 1995). This scale is not widely used by clinicians due to lack of data that support its psychometric qualities.

Two scales having the same name, Trunk Impairment Scale (TIS), were found in the literature. The first TIS by Verheyden et al. (2004) contains 17 items designed to evaluate different aspects of sitting balance in patients with stroke. This initial TIS had three subscales: static sitting balance (3 items), dynamic sitting balance (10 items), and trunk performance (4 items) (Verheyden et al., 2004; Verheyden & Kersten, 2010). The scale has excellent test-retest (ICCs= 0.87-0.96) and excellent inter-rater (ICCs= 0.85-

0.99) results (Verheyden et al., 2004). The TIS was able to discriminate between a sample of 40 patients with stroke and 40 healthy individuals (age and sex were matched) (Verheyden et al., 2005). The TIS is also a valid and reliable tool for persons with multiple sclerosis (MS) and Parkinson's disease (Verheyden et al., 2006; Verheyden, Willems, Ooms, & Nieuwboer, 2007). A revised version, TIS 2.0, with only two subscales (dynamic siting and coordination) was introduced in 2010 (Verheyden & Kersten, 2010).

The second TIS by Fujiwara et al. (2004) was created mainly to assess trunk impairment after stroke. It is a 7-item scale that measures trunk performance at the impairment level. Inter-rater reliability of each item was established (weighted kappa values ranged from 0.66 to 1.0). The scale demonstrated a high correlation with the Trunk Control Test (r= .91). Scores from the TIS explained 66% to 75% of the variance in discharge Functional Independence Measure (FIM) scores, suggesting good predictive validity (Fujiwara et al., 2004). The main concern about both TIS scales is that they focus primarily on trunk motor ability, which is an indirect, and perhaps inaccurate, way to measure sitting balance.

The standing functional reach test (FRT) developed by Duncan et al (1990) was modified on three occasions to accommodate people with standing difficulties (Duncan, Weiner, Chandler, & Studenski, 1990). Lynch, Leahy, and Barker (1998) first modified the FRT for people who had a spinal cord injury. This test uses reaching forward in the sitting position to assess sitting balance (Lynch, Leahy, & Barker, 1998). Using the same concept, Thompson and Medley (2007) devised a second modified FRT (MFRT) by

adding a lateral reach component (Thompson & Medley, 2007). The third MFRT was presented by Katz-Leurer Fisher, Neeb, Schwartz, and Carmeli (2009) to assess sitting balance among patients with stroke (Katz-Leurer, Fisher, Neeb, Schwartz, & Carmeli, 2009). In their scale, an individual reaches forward and leans to both the right and the left. All three scales are reliable tools but only the Katz-Leurer version of the MFRT was validated in people with stroke. These MFRTs are also useful for detecting the risk of falling; however, their ability to assess aspects of sitting balance other than reaching outside the base of support is limited.

The Ottawa Sitting Scale (OSS) was developed by Thornton and Sveistrup (2009) in Canada. The OSS was designed mainly to measure sitting balance in patients who showed slow improvement in acute care settings. The OSS comprises six items, where each item must be performed under two conditions (sitting with feet supported and sitting with feet unsupported). The OSS has demonstrated excellent inter-rater reliability (ICCs=0.96-0.98) and excellent intra-rater reliability (ICC= 0.99) (Thornton & Sveistrup, 2010). However, it has ceiling effects (Thornton & Sveistrup, 2010).

The last two sitting balance scales found in the literature are the Sitting Balance Scale (SBS) and the Function in Sitting Test (FIST). The SBS was developed by Medley and Thompson (2011) to measure different aspects of sitting balance primarily in non-ambulatory, frail older adults. The 11 items of the SBS have good internal consistency (Cronbach's alpha = 0.76), excellent intra-rater reliability (ICCs= 0.96 -0.99), and excellent inter-rater reliability (ICC= 0.87). Concurrent and content validity of the SBS has been established. The SBS was able to discriminate sitting balance ability between

healthy people (n= 29) and people with pathology (n= 127). Furthermore, the SBS could differentiate between ambulatory and non-ambulatory individuals in different rehabilitation settings (Medley & Thompson, 2011; Thompson, Medley, & Teran, 2013).

The FIST was designed by Gorman et al. (2010) to quantify sitting balance performance in patients with acute stroke (Gorman, Radtka, Melnick, Abrams, & Byl, 2010). Test-retest, intra-rater, and inter-rater reliability of the FIST were found to be excellent with ICCs of 0.97, 0.99, and 0.99, respectively (Gorman, Rivera, & McCarthy, 2014). The FIST explained 83% of the total scores' variance between participants and demonstrated high internal consistency, with a Cronbach's alpha of 0.98 (Gorman et al., 2010). It is also correlated with Berg Balance Scale (Spearman p= 0.71- 0.85), and responsive to change in inpatient rehabilitation settings (effect size = 0.83). The MCID of the FIST was estimated to be 6.5 points (Gorman & Harro et al., 2014).

Of the previously reviewed sitting balance scales, the SBS and FIST were chosen for further examination in this study of people with stroke. Both scales are well designed (i.e., cover most sitting balance aspects), administered easily with clear instructions, and shown to have excellent reliability.

Conclusion

As with most other sitting balance scales, the SBS and FIST are relatively new scales and more investigation is needed before they can be adopted across clinical settings. Important psychometric properties such as responsiveness and predictive validity have not been examined for either scale. Also, it is vital for clinicians to be aware

of minimal detectable change and minimal clinically important difference, where true progress can be reported.

For newly developed functional scales, little attention is given to characteristics like responsiveness and predictive validity. Responsiveness is the ability of a scale to detect changes in a patient over time so that critical decisions for the patient's plan of care may be made. A scale must be responsive before it can be used confidently to determine whether clinically meaningful change has occurred. For a scale to be responsive, it must be reliable and include several items addressing different aspects of the construct that have a tendency to change. In addition, the way an item is scored must tolerate improvement. Previous research indicates that the two scales being examined are reliable and have sound scoring systems.

It has always been a concern for patients and/or their family members to have an idea about the highest level of function and quality of life a patient can reach once an appropriate intervention is provided. A scale with high predictive validity can provide useful information about future performance by measuring current performance as a relative measure. This information will help patients and their families, and examining the predictive validity of the SBS and FIST will also help clinicians and payers make informed decisions to manage available resources and benefit patients the most.

CHAPTER III

METHODOLOGY

A common impairment following stroke is impaired balance. Clinically, several scales have been designed to detect standing balance impairments and, recently, other scales have been developed to assess balance in the seated position to evaluate balance in low-level patients, including individuals with stroke. Using a valid, reliable, and sensitive measurement tool is essential to accurately identify balance impairment and to make informed clinical decisions. However, several qualities of these scales have not been examined. The goal of this study is to examine the responsiveness and predictive validity of two sitting balance scales, the Sitting Balance Scale (SBS) and the Function in Sitting Test (FIST). This chapter will outline the methods used in the study.

Research Design

This study is a prospective cohort study that utilized pre- and post-testing to investigate responsiveness and predictive validity of two scales. Sitting balance was assessed upon admission and prior to discharge to examine the ability of the SBS and FIST to detect change in post-acute rehabilitation settings. Functional level as measured by Functional Independence Measure (FIM), length of stay, and discharge placement were used to assess predictive validity, while level of independence, as measured by Barthel Index (BI) was used to determine the minimal clinically impotent differences (MCIDs) of the SBS and FIST.

Participants

Forty individuals with stroke (first or recurrent) were recruited from five skilled nursing facilities in south Florida. Men and women regardless of race or ethnicity who were above the age of 18 were potential participants. Participants had neuro-imaging and/or clinical evidence of stroke (ischemic or hemorrhagic). Individuals with traumatic brain injury, degenerative neurological disorders (e.g., Parkinson's disease, multiple sclerosis), acute orthopedic conditions, or who were unable to follow verbal instructions in English were excluded from the study. The U.S. Census English proficiency question (Census-LEP) was adopted to test subjects' ability to understand verbal English instructions. Subjects were asked "how well do you speak English." Subjects who indicated English proficiency of "well" or "very well" were eligible for the study (Karliner, Napoles-Springer, Schillinger, Bibbins-Domingo, & Perez-Stable, 2008). Subjects who scored less than 20 points on the Mini Mental Status Examination (MMSE) or complete the Timed Up and Go (TUG) in less than 20 seconds were also excluded from the study (refer to flow chart.) Qualified subjects who agreed to participate in the study were asked to read and sign a consent form. Table 1 shows the demographic characteristics of the participants.

Instruments

Each participant completed a standardized assessment which included measures of sitting balance, functional level, and performance in activities of daily living (ADL). Sitting balance was assessed using the SBS and FIST.

Sitting Balance Scale

The SBS (Medley & Thompson, 2011) contains 11 items and measures diverse aspects of sitting balance. The SBS was developed mainly to help clinicians quantify sitting balance for non-ambulatory, frail older adults. The items in the SBS are scored using a 5-point ordinal scale (0 = worst performance, 4 = best performance) with a maximum score of 44. Higher scores indicate better performance. The SBS has excellent intra-rater reliability (intraclass correlation coefficient (ICCs) = 0.96 - 0.99) and inter-rater reliability (ICC= 0.87). Concurrent and content validity of the SBS have been established (Medley & Thompson, 2011); the SBS has the ability to discriminate sitting balance ability between healthy people and people with pathology (Medley & Thompson, 2011). Furthermore, the SBS can differentiate between ambulatory and non-ambulatory individuals. The SBS has a moderate to strong correlation with the Trunk Impairment Scale (TIS) designed by Verheyden et al. (2004) (Thompson et al., 2013).

Function in Sitting Test

Sitting balance was also assessed using the FIST. The FIST (Gorman et al., 2010) is a 14-item test designed to assess sitting balance performance in patients with acute stroke. Each item is scored on a 0 to 4 ordinal scale (0 = complete assistance is needed and 4 = independent) and quantifies specific functions in the seated position. Test-retest, intra-rater, and inter-rater reliability of the FIST are excellent with ICCs of 0.97, 0.99, and 0.99, respectively (Gorman & Rivera et al., 2014). The FIST demonstrates high internal consistency (Cronbach's alpha = 0.98) (Gorman et al., 2010). It is also correlated with the Berg Balance Scale (Spearman p= 0.71- 0.85), and responsive to change in

inpatient rehabilitation settings (effect size = 0.83). The MCID of the FIST was estimated to be 6.5 points (Gorman & Harro et al., 2014).

Functional Independence Measure

The ability of the FIST and SBS to predict functional level as measured by the FIM was investigated. The FIM scale measures motor and cognitive disability by assessing the amount of assistance needed to complete ADLs. The scale contains 18 items (13 motor and 5 cognitive). In this study, we only used the motor component of the FIM. Motor items are categorized into three domains: self-care, sphincters, and mobility. Items are scored from 1 to 7 according to the level of independence. Level 1 indicates that the subject is completely dependent, while 7 is designated for those who are totally independent. Therefore, the motor subscale score can range from 13 to 91. The FIM has been used broadly as an outcome measure to assess stroke rehabilitation outcome and has demonstrated superior or comparable properties to other functional assessment tools (Cohen & Marino, 2000; Granger, 1998; Hsueh, Lin, Jeng, & Hsieh, 2002; Stucki, Ewert, & Cieza, 2002). This measure has been extensively examined and found to be a reliable, valid, and responsive tool for use in rehabilitation (Chau, Daler, Andre, & Patris, 1994; Dodds, Martin, Stolov, & Deyo, 1993; Gosman-Hedström & Svensson, 2000; Hamilton, Laughlin, Fiedler, & Granger, 1994; Wallace, Duncan, & Lai, 2002).

Barthel Index

The ultimate goal of stroke rehabilitation is for patients to be independent in their ADL. Thus, the level of independence in ADL was used to examine the external responsiveness and to calculate the MCIDs of the SBS and FIST. ADL performance was

assessed using the BI scale. The BI (Mahoney & Barthel, 1965) is used to measure individuals' level of independence in 10 ADL tasks. The modified version of BI (Granger, Dewis, Peters, Sherwood, & Barrett, 1979) uses an ordinal scale to quantify each task, with maximum score of 20. Higher scores indicate a greater possibility of living at home independently. The BI has been widely used to screen for functional changes in individuals in inpatient rehabilitation. The BI has also been used to predict functional outcomes for patients with stroke and has well established reliability, validity, and responsiveness for individuals with stroke (Gosman-Hedström & Svensson, 2000; Loewen & Anderson, 1988; Wallace et al., 2002).

Timed Up and Go

The TUG is designed to assess functional mobility. The test requires people to have both static and dynamic balance to complete the test in a timely manner. Flansbjer et al. calculated the minimal detectable change (MDC) for patients with chronic stroke to be 2.9 seconds (Flansbjer, Holmback, Downham, Patten, & Lexell, 2005). The TUG is valid in persons with stroke, demonstrating excellent correlation between the TUG and 6MW ($r = 0.92$)) and excellent test-retest reliability (ICC = 0.96) (Flansbjer et al., 2005). In this study the TUG was used to exclude participants who demonstrated high levels of functional mobility as indicated by performing the TUG in less than 20 seconds.

Mini Mental State Examination

To ensure the ability of participants to understand and follow test instructions, the MMSE was administered. The MMSE is a screening tool used to quantify cognitive impairment and includes 11 items. The maximum score is 30, with a cutoff score of 24

indicating cognitive impairment (Lancu & Olmer, 2006). The MMSE is also a valid, reliable, and sensitive tool for use in clinical settings (Pangman, Sloan, & Guse, 2000).

Procedures

Texas Woman's University (TWU) Institutional Review Boards and approval letter from each facility were obtained prior to the recruitment process. Within 72 hours of admission to each facility, patients with stroke were identified and approached for further screening to be participants in the study. The primary investigator (PI) screened for stroke diagnosis, absence of other major co-morbidities (e.g., traumatic brain injury, degenerative neurological disorders, acute orthopedic condition), and the ability to understand English instruction. Prior to testing, each participant's blood pressure (BP) and O_2 saturation were measured to ensure safe levels for testing. Participants with BP over 140/90 or O_2 less than 95% were not tested until safe vitals were met. Once identified, qualified, and agreed to participate, informed consent was obtained. Each participant completed a medical intake form to collect demographic and medical history information. To further ensure patients' eligibility, the MMSE and TUG were administered. Patients with scores greater than 20 on the MMSE qualified for further screening and were asked to complete the TUG test. Patients who took more than 20 seconds to complete the TUG were asked to complete the study. Next, the two sitting balance tests, the SBS and FIST, and the BI were administered by the PI in random order as determined by a drawn card with the prescribed order. A five-minute rest was offered after each test. Participants were encouraged to perform to the best of their abilities. The items of each test were scored according to the instructions provided by the test

developers, but not summed. Scoring sheets of each participant were placed in a sealed envelope. Participants then received their usual plan of care as established by the rehabilitation team. The PI was not part of the rehabilitation team of any of the participants. Within 48 hours of the proposed discharge date and regardless of the length of stay, participants' sitting balance and independence with ADL were assessed again using the same measurement tools in random order. In addition, functional level was assessed through administering the FIM scale. Following discharge, participants' charts were reviewed for length of stay and discharge placement data.

Data Analysis

All data were analyzed using SPSS 24.0 for Apple Macintosh. Descriptive statistics were analyzed for demographic and baseline characteristic of the participants. The floor effect was calculated as the percentage of the participants scoring between the minimum possible score (zero) and the estimated MDC of each scale. The ceiling effect was calculated as the percentage of participants scoring between the maximum possible score and the maximum score minus the MDC of each scale (Gorman & Harro et al., 2014).

Internal responsiveness, effect size (ES), was calculated by dividing the mean change in scores between admission and discharge by the standard deviation of the baseline (admission) scores. In addition, the standardized response mean (SRM) was calculated to serve as another indicator of internal responsiveness. The SRM is the average change in score divided by the standard deviation of the change between the corresponding scores (Husted et al., 2000; Norman, Wyrwich, & Patrick, 2007). Cohen's

criteria (0.2 = small, 0.5 = moderate, and 0.8 = large) for interpreting the effect size were adopted (Cohen, 1988). A scale with moderate or large ES was considered to have sufficient responsiveness. The external responsiveness of the SBS and FIST was tested by examining the association between the difference in scores on the SBS or FIST and the difference in scores on the BI using Pearson's correlation coefficient. Moderate to good (r = 0.50 - 0.75) and excellent (r > than 0.75) association indicates sufficient external responsiveness (Portney & Watkins, 2015).

To investigate predictive validity, separate univariate linear regression analyses were conducted to examine the ability of the FIST and SBS to predict FIM scores and the length of stay (LOS). To determine the ability of each scale to predict discharge placement (home versus institution), we used the receiver operating characteristic (ROC) curve. A cutoff score, where a good balance of sensitivity and specificity exists, was identified for each scale.

MDC_{90} for the FIST and SBS were calculated using the formula 1.65 x √2 x SEM, where 1.65 is the z value (2-tailed) of the 90% confidence interval, √2 is the variance of the two measurement occasions (admission and discharge), and SEM is the standard error of measurement. The SEM was estimated using the formula SEM = SD √ (1-r), where SD is the standard deviation of the measures and r is the reliability coefficient of the test (Fritz & Irrgang, 2001; Haley & Fragala-Pinkham, 2006; Stratford, 2004; Wyrwich, Tierney, & Wolinsky, 1999). As reliability coefficients, we used intraclass correlation coefficients (ICCs) from published studies on each scale (Portney & Watkins, 2015).

No gold standard to estimate MCID is present in the literature. However, two methods, anchor-based and distribution-based are widely used. Anchor-based does not take into account measurement error and distribution-based does not provide a clinically based MCID, so both methods were used in this study. MCID distribution-based estimates were calculated according to a commonly used ES in the literature, that is 0.5 (Norman, Sloan, & Wyrwich, 2003). MCIDs were calculated by multiplying 0.5 by the SD of the baseline scores.

Additionally, the change in sitting balance scores were anchored against change in another outcome measure to estimate the MCID of each scale. Improvement in BI score (≥ 2) served as an anchor to identify the MCID of the two sitting balance scales. We divided the sample into two groups, those who experienced true change in their level of independence (BI ≥ 2) and those who did not. The ROC curve method was used by plotting sensitivity against 1-specificity at different potential cut off points. The SBS and FIST cutoff points, which maximized sensitivity and specificity, were chosen as MCIDs.

CHAPTER IV

RESULTS

The goal of this study was to examine the responsiveness and predictive validity of two sitting balance scales, the Sitting Balance Scale (SBS) and the Function in Sitting Test (FIST) in patients with stroke and limited functional level receiving usual rehabilitation in post-acute care facilities. Additionally, the study aimed to estimate the minimal detectable change (MDC) and minimal clinically important difference (MCID) of the two scales. This chapter provides a description of the study participants followed by descriptive and inferential statistical data for both scales.

Participants

Using a sample of convenience, participants were directly recruited from five different skilled nursing facilities in South Florida. Seventy-six people were screened for eligibility. Sixty-nine people met inclusion criteria, while 7 residents were disqualified due to lack of proper stroke diagnosis. Twenty-five people were excluded due to a preexisting major orthopedic condition, major neuromuscular disease, severe cognitive impairment, inability to follow English verbal instructions, and/or demonstrating high functional level (i.e., mainly ambulatory). A total of 43 people enrolled in the study and completed the initial testing within 72 hours of admission. However, 3 participants dropped out of the study due to unplanned discharge. Forty participants completed the

second testing (within 48 hours of discharge.) A flow chart illustrating the recruitment process, testing, and attrition is presented in Figure 1.

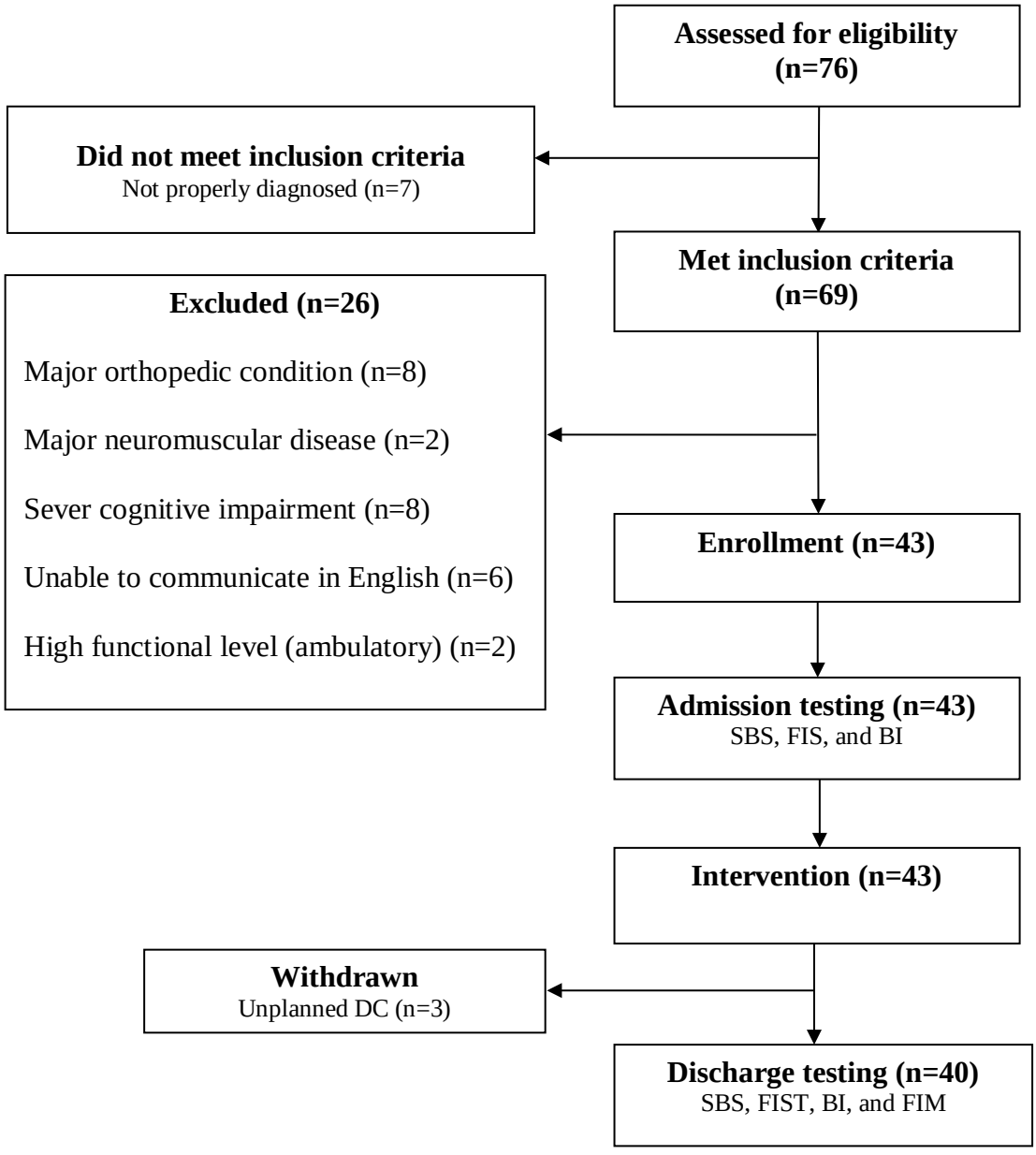


Figure 1. The flow chart for screening, enrollment, testing, and participation in the study

Of the 40 participants who completed the study, 23 were men and 17 were women. The majority of the participants (28) presented with left side weakness, while the rest (12) exhibited weakness in the right side. After completion of the rehabilitation program nearly half of the participants were discharged home, whereas the other half were discharged to either assisted living or a long term care facility. Participants' characteristics are shown in Table 1.

Table 1

Participants Characteristics

Characteristic	Value
Age	
Mean (SD)	71.6 (11.4)
Minimum-Maximum	47-96
Gender	
Men (%)	23 (57.5)
Women (%)	17 (42.5)
Affected Side	
Right (%)	12 (30)
Left (%)	28 (70)
Days since onset	
Mean (SD)	106 (247.7)
Median	11.5
Minimum-Maximum	3 - 1072
Length of stay (days)	
Mean (SD)	23.8 (12.8)
Minimum-Maximum	4 - 56
Discharge placement	
Institution, LTC or ALF (%)	19 (47.5)
Home (%)	21 (52.5)

Note. LTC = long term care facility; ALF = assisted living facility

Among the participants, 80% were in their sub-acute stage of recovery, while the rest were primarily admitted for late effects of cerebrovascular disease with significant decline in function. Our analysis showed no significant difference in sitting balance and functional level between participants in the sub-acute stage of recovery and those who were in the chronic stage (see Table 2). Therefore, all participants were included in subsequent analyses.

Table 2

Mean Performance by Stage of Stroke Recovery

Scale		Sub-acute [a]	Chronic [b]	P value
SBS				
	Admission	24.16	22.75	0.51
	Discharge	33.53	32.25	0.54
FIST				
	Admission	29.28	27.13	0.55
	Discharge	39.25	40.63	0.63
BI				
	Admission	7.63	7.75	0.91
	Discharge	12.22	11.63	0.62
FIM				
	Discharge	55.03	56.75	0.75

Note. SBS = Sitting Balance Scale; FIST = Function in Sitting Test; BI = Barthel Index; FIM = Functional Independence Measure.
[a] n=32
[b] n=8

While being screened for eligibility, only 7 participants were able to complete the Time Up and Go (TUG) test. The rest were unable to perform the test due to an inability to stand or walk without assistance of another person. Between the two testing occasions, subjects were required to actively participate in their rehabilitation program to

successfully complete the study. A description of participants' performance on all tests at the admission and upon discharge is presented in Table 3.

Table 3

Participants Scores Description

Measure	Mean (SD)	(Minimum-Maximum)
SBS		
Admission	23.9 (7.0)	10-36
Discharge	33.3 (6.6)	16-41
Difference	9.4 (4.1)	4-22
FIST		
Admission	28.9 (9.7)	9-46
Discharge	39.5 (8.3)	21-50
Difference	10.7 (7.1)	0-32
BI		
Admission	7.7 (3.3)	2-15
Discharge	12.1 (3.5)	4-18
Difference	4.5 (1.9)	1-9
FIM at discharge	55.4 (13.5)	24-77
MMSE at admission	22.5 (2.6)	20-26
TUG[a] at admission	29.4 (4.6)	23-36

Note. SBS = Sitting Balance Scale; FIST = Function in Sitting Test; BI = Barthel Index; FIM = Functional Independence Measure; MMSE = Mini Mental State Examination; TUG = Timed Up and Go

[a] n=7

Responsiveness

Following their rehabilitation, all participants demonstrated change in their sitting balance except one participant who showed no difference in FIST score between the two testing sessions. For the study sample, given the corresponding standardized response mean (SRM) and effect size (ES) of the SBS and the FIST, significant change in sitting

balance was found. The ESs and the SRMs of both scales were large (1.01 – 2.30) indicating excellent internal responsiveness. In addition, paired t tests of both scales showed a significant difference between admission and discharge scores ($p < 0.01$). When tested for external responsiveness, change in SBS and change in FIST scores were found to have good association with change in Barthel Index (BI) scores ($p < 0.01$). Table 4 displays the results of the internal and external responsiveness of the SBS and the FIST.

Table 4

Internal and External Responsiveness of Balance Measures

	SBS	FIST
Internal responsiveness		
ES	1.34	1.11
SRM	2.29	1.49
Paired t test (p value)	-14.5 (< 0.01)	-9.5 (< 0.01)
External responsiveness		
r (p value)	0.61 (< 0.01)	0.60 (< 0.01)

Note. ES = effect size, SRM = standardized response mean, SBS = Sitting Balance Scale, FIST = Function in Sitting Test; r = Pearson correlation coefficient

Predictive Validity

To investigate predictive validity, regression analysis was conducted to answer the question concerning the ability of the FIST and SBS to predict Functional Independence Measure (FIM) scores and the length of stay (LOS). Univariate linear regression analysis revealed that admission SBS and FIST scores were significant predictors of level of function at discharge as measured by the FIM. The explanatory power (R^2) to predict discharge FIM scores of the SBS and the FIST were 0.53 and 0.43

respectively. Scatterplots and regression lines are illustrated in Figure 2. In contrast, both scales did not have sufficient explanatory power to predict length of stay.

The area under the curve (AUC) of the SBS and the FIST suggest good levels of sensitivity and specificity in predicting discharge placement (see Figure 3). A cutoff score, where a good balance of sensitivity and specificity exists, was identified to be 24.5 for the SBS and 27 for the FIST. Table 5 summarizes the main predictive validity indicators of both scales.

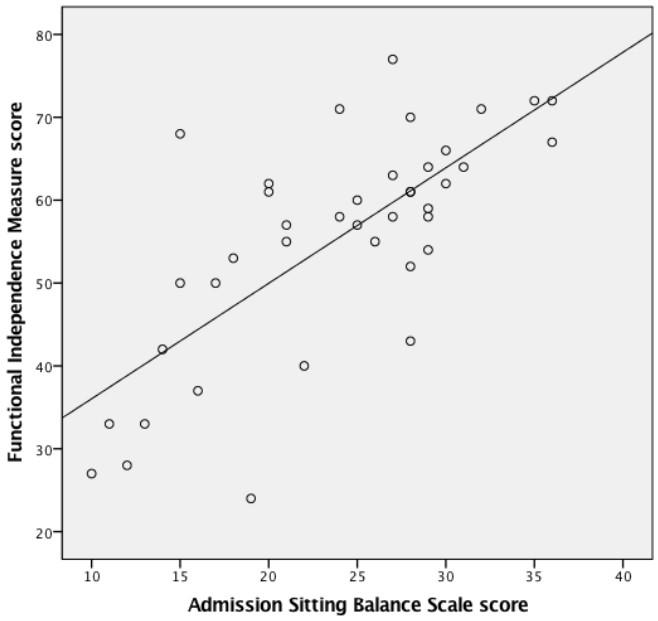
Table 5

Linear Regression Model to Predict Functional Independence and Length of Stay

	SBS	FIST
FIM		
B (95% CI)	1.39 (0.96-1.83)	0.91 (0.56-1.26)
R (R^2)	0.73 (0.53)	0.65 (0.43)
P value	< 0.01	< 0.01
Length of Stay		
B (95% CI)	-0.58 (-1.14 - -0.01)	-0.48 (-0.89 - -0.08)
R (R^2)	0.32 (0.1)	0.37 (0.13)
P value	0.047	0.021
Discharge placement		
AUC (p value)	0.82 (<0.01)	0.81 (<0.01)
Cutoff score	24.5	27

Note. SBS = Sitting Balance Scale; FIST = Function in Sitting Test; FIM = Functional Independence Measure; B = Standardized Coefficients Beta; R = correlation coefficient; R^2 = coefficient of determination; AUC: Area Under the Curve.

(a)



(b)

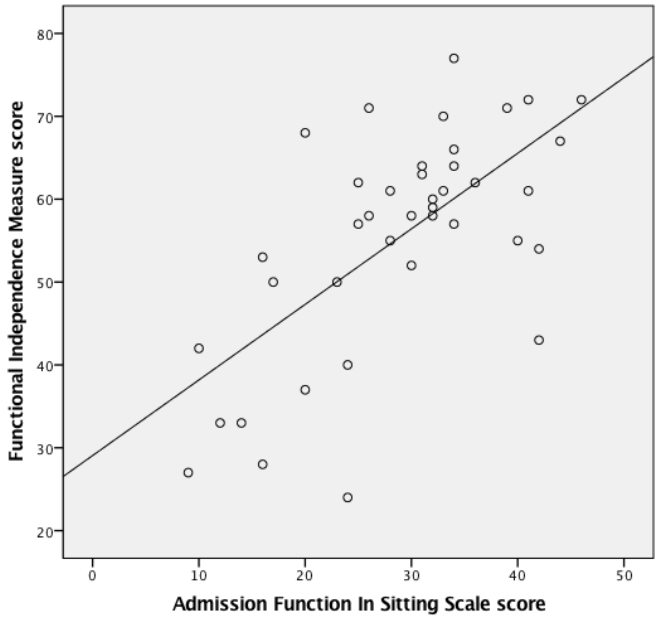
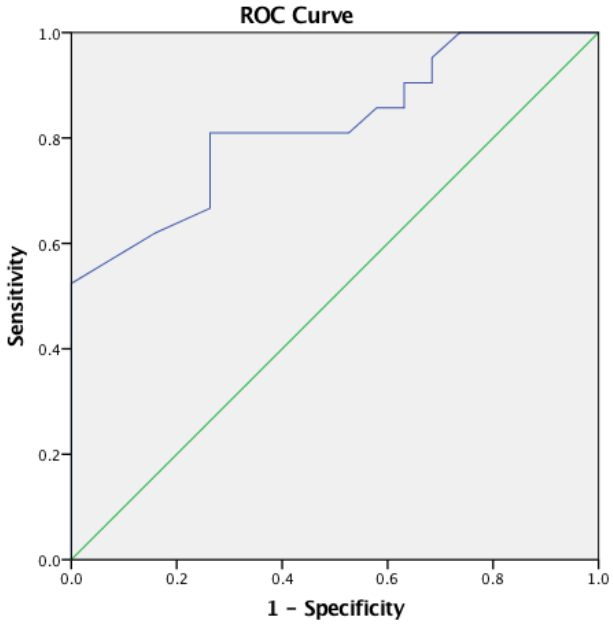
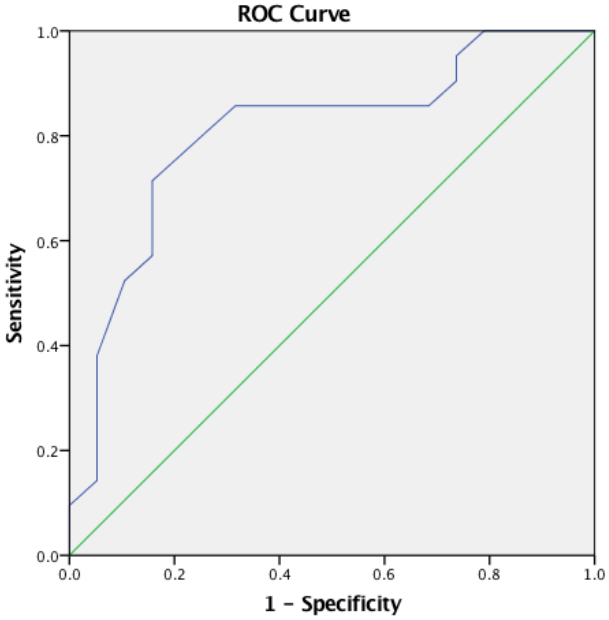


Figure 2. Scatterplots with regression lines illustrating the correlation between (a) the FIM scores (y-axis) and the admission SBS scores (x-axis), and (b) the FIM scores (y-axis) and the admission FIST scores (y-axis)

(a)



(b)



Minimal Detectable Change and Minimal Clinically Importance Difference

Figure 3. The ROC curves exhibiting the sensitivity (y-axis) and 1-specificity (x-axis) of (a) the SBS and (b) the FIST cutoff scores for detecting DC placement.

MDC_{90} for the SBS and the FIST were calculated using the formula 1.65 x √2 x SEM, where 1.65 is the z value (2-tailed) of the 90% confidence interval, √2 is the

variance of the two measurement occasions (admission and discharge), and SEM is the standard error of measurement. The SEM was estimated using the formula SEM = SD √ (1-r), where SD is the standard deviation of the measures and r is the reliability coefficient of the test. MDCs of the SBS and the FIST were calculated to be 2.32 and 3.9 respectively.

Distribution and anchor-based MCIDs were calculated. For the SBS, the AUC value was 0.937 ($p = 0.013$), and the cutoff point that maximized sensitivity (0.97) and specificity (0.67) was a score of 4.5. With regard to FIST, the AUC value was 0.95 ($p = 0.01$), and the cutoff point that maximized sensitivity (0.87) and specificity (1.00) was a score of 5.5.

Based on the anchor-based suggested MCID for SBS, 37 out of 40 participants (92.5%) experienced improvement in their sitting balance, while 32 out of 40 participants (80%) improved according to the projected MCID for FIST. The MDC_{90} and MCID (distribution and anchor-based) values for the SBS and the FIST are shown in Table 6.

Table 6

Minimal Detectable Change and Minimal Clinically Important Difference of the Measures

	SBS	FIST
MCID		
Distribution based (ES 0.5)	3.51	4.83
Anchor based	4.5	5.5
MDC_{90}	2.32	3.9

Note. SBS = Sitting Balance Scale; FIST = Function in Sitting Test; MDC_{90} = Minimal Detectable Change; EF = effect size; MCID = Minimal Clinically Importance Difference

CHAPTER V

DISCUSSION

A common impairment following a stroke is compromised balance. Balance is maintained through coordination of sensory input systems, the central nervous system's central processing, and the motor system, which all become vulnerable when a stroke develops. Balance impairment places people at risk of falling and the associated consequences. Falls interfere with functional recovery as well as limit activities of daily living (ADL). Assessing balance is necessary before clinicians can develop effective plans of care. Current literature highlights several scales developed to identify balance impairments in a seated position. These scales provide a resource to evaluate lower level patients, including individuals who have developed a stroke. Using a valid, reliable, and sensitive measurement tool is essential to accurately identify balance impairment and to make informed clinical decisions. Additionally, valid conclusions about the effectiveness of treatment trials require high-quality outcome measures that meet rigorous measurement standards. However, several qualities of these scales have not been examined. The primary goal of this dissertation was to examine the responsiveness and predictive validity of two sitting balance scales, the Sitting Balance Scale (SBS) and the Function in Sitting Test (FIST). The secondary purpose was to estimate the minimal detectable change (MDC) and minimal clinically important difference (MCID) of the SBS and the FIST people with stroke.

To the best of our knowledge, this is the first study to investigate the responsiveness, predictive validity, MDC, and MCID of the SBS and FIST exclusively in post-acute stroke rehabilitation. The study included a sample of convenience including participants with stroke. This sample may be similar to individuals with stroke seeking extended rehabilitation care in skilled nursing facilities. Our sample included patients at different recovery stages, sub-acute (~80%) and chronic (~20%). Patients in the chronic stage were admitted for late effects of a stroke, but did not demonstrate significant differences in their initial sitting balance and functional level from the sub-acute participants. Thus, the results of this study may be generalized to individuals in the chronic and sub-acute phase of recovery following stroke. Interestingly, patients in sub-acute and chronic stage did not differ on discharge measures benefiting from rehabilitation on average to the same extent.

Sitting balance scales are most appropriate and validated for low-level individuals. Therefore, we did not exclude low functioning subjects. Nonetheless, no participant scored at the floor range (i.e., 0 + MDC_{90}) on the SBS or the FIST at their admission assessment. The lowest performing participant scored 10 on the SBS and 9 on the FIST. The lack of floor effect in our study is similar to that reported by Gorman and Harro et al. (2014) for the FIST. The floor effects in their study (4%) were considered acceptable. Unlike our study, their study included patients with a varity of medical conditions, which may have accounted for this slight floor effect (Gorman & Harro et al., 2014).

Regarding ceiling effects at discharge, no participant in our study reached the ceiling range (i.e., maximum score – MDC_{90}) on the SBS or the FIST. In contrast, Gorman and Harro et al. reported a 29% ceiling effect for the FIST at discharge from rehabilitation (Gorman & Harro et al., 2014). The reported ceiling effect may have resulted from including relatively high functioning patients in their study. In our study, we purposely used the Timed Up and Go (TUG) test to exclude participants who functioned at a high level at admission. The use of TUG may have led to no ceiling effect in our sample. We support the TUG is a quick and easy screen to determine a more practical use of the SBS and the FIST. Only two subjects were disqualified (less than 3% of those who met inclusion criteria) for their high functional level. The lack of floor and ceiling effects in our study suggests that both scales are effective tools for patients receiving post-acute stroke rehabilitation in skilled nursing facilities.

Responsiveness

Responsiveness is an imperative qualification for balance measures intended to gauge change (Deyo & Centor, 1986; Guyatt, Walter, & Norman, 1987; Yu, Chen, Chou, Hsueh, & Hsieh, 2013), which may reflect the effectiveness of an ongoing intervention (Chinsongkram, Chaikeeree, Saengsirisuwan, Horak, & Boonsinsukh, 2016; Knorr, Brouwer, & Garland, 2010). To our knowledge, this is the first study to investigate the responsiveness of the SBS. Also, this is the first study to examine the responsiveness of the FIST solely in patients with stroke currently receiving skilled rehabilitation. There is no agreement in the literature of which method is superior for estimating responsiveness (Chen et al., 2016; Husted et al., 2000; Wright & Young, 1997). In the current study, we

used two approaches to examine the internal responsiveness, the effect size (ES) and the standardized response mean (SRM). Additionally, to address external responsiveness, we used Pearson's correlation coefficient to assess the association between the difference in sitting balance scores and difference in Barthel Index (BI) scores. The SBS and the FIST demonstrated responsiveness to change over the course of in-patient rehabilitation as determined by substantial changes in the participants' scores from admission to discharge and supported by very large to huge corresponding ES and SRM values. These results are consistent with a previous study on the FIST and confirmed high values of ES and SRM (Gorman & Harro et al., 2014).

Cohen's criteria define a large effect size as 0.8 (Cohen, 1988). The ES and SRM values in this study (1.11 – 2.29) broadly exceeded the large Cohen's d first introduced by Cohen. To further refine these properties, we assessed them using Sawilowsky's criteria. Sawilowsky (2009) expanded the magnitude of Cohen's *d* value to 2.0 by adding three more effect size categories, "very small", "very large" and "huge" (0.01, 1.2, and 2.0 respectively) (Sawilowsky, 2009). Given Sawilowsky's criteria, the FIST demonstrated large to very large ES (1.11) and very large to huge SRM (1.49) compared to large to very large ES (0.83) and SRM (1.04) as reported by Gorman and Harro et al. (Gorman & Harro et al., 2014). These values suggest that the FIST is more sensitive to change when used exclusively in patients with stroke. Sawilowsky's definition makes a clear distinction between the SBS and the FIST in our study. The ES of the SBS revealed by this study is very large to huge, whereas the ES of the FIST falls between the large and very large categories. Also, the SRM of the SBS yielded by this study is huge, while

the SRM of the FIST is very large to huge implying that the SBS is more responsive than the FIST when used in patients with stroke receiving rehabilitation in skilled nursing facilities.

The difference in interpretation of the ES and the SRM may have resulted from the different descriptions for the ES and the SRM. The ES is a relation between mean change scores and the standard deviation (SD) at baseline, and reflects the variability of the baseline scores, whereas the SRM is a relation of mean change scores and the SD of the change in scores, reflecting the variability of the change scores. The SD at baseline is commonly larger than the SD of a change in scores (SBS: baseline SD 7.0, change SD 4.1; FIST: baseline SD 9.7, change SD 7.1) (Yu et al., 2013). Consequently, the SRM in this study was larger than the ES. The SRM, may be more sensitive than the ES in identifying a change from baseline. Therefore, clinicians and researchers may consider using the SRM to choose a more responsive tool.

Concerninig external responsiveness, our results revealed a moderate to good association between changes in scores on both sitting balance scales and changes in scores on the BI. This means, improvement demonstrated by the SBS and the FIST reflected a substantial functional mobility (i.e., basic ADL) change in people with stroke. Moderate to good association indicates that the SBS and FIST are able to identify meaningful change that is important to people with stroke (e.g., basic ADL) (Husted et al., 2000). Also, changes in scores on the SBS and the FIST had similar associations with changes in scores on the BI, suggesting equivalent levels of external responsiveness for both scales.

Predictive Validity

Impaired sitting balance shortly after stroke has repeatedly been shown to be a predictor of recovery. Patients who lack sitting balance show less functional recovery than those with adequate sitting balance soon after stroke (Feigin, Sharon, Czaczkes, & Rosin, 1996; Kwakkel, Wagenaar, Kollen, & Lankhorst, 1996; Morgan, 1994; Nichols, Miller, Colby, & Pease, 1996; Nitz & Gage, 1995; Tsang & Mak, 2004; Tyson et al., 2007). To our knowledge, this is the first study to examine the predictive validity of two sitting balance scales, the SBS and the FIST. This study assessed the ability of admission SBS and FIST scores to predict the functional status of patients with stroke at the end of their rehabilitation as measured by an extensively used outcome measure, the Functional Independence Measure (FIM) scale. Additionally, this study intended to examine the ability of both scales to predict length of stay and discharge placement.

Consistent with previous studies (Feigin et al., 1996; Kwakkel et al., 1996; Morgan, 1994; Nichols et al., 1996; Nitz & Gage, 1995; Tsang & Mak, 2004; Tyson et al., 2007), we found participants' sitting balance scores at admission could markedly predict their scores on the FIM at discharge. In this study we only used the physical component (13 items) of FIM with a maximum score of 91. The univariate linear regression analyses revealed that admission SBS and FIST scores were significant predictors of level of function at discharge as measured by FIM, $R^2 = 0.53$ and 0.43 respectively. By looking at R^2 values, 53% of the variability in FIM scores can be accounted for by the admission SBS score alone, and 43% can be accounted for by the FIST scores as per separate univariate linear regression analyses. The univariate linear

regression analysis calculates the unstandardized Beta (B). The B value indicates the steepness of the line of regression (i.e., the slope). In our study, the B value is the expected amount of increase in the FIM score for each point increase in either of the two sitting balance scales. The calculated B values of the SBS and the FIST were 1.39 and 0.91 correspondingly. For example, with an increase of 3 points in the SBS score at admission, the FIM score is expected to increase by 4.17 points at discharge. Now, to be able to predict FIM scores from initial sitting balance scores, a complete regression equation is needed. To complete the equation, another element is the intercept (refers to as "constant" in SPSS). The intercept is the height of the regression line when it crosses the Y axis. In other words, the intercept represents the predicted value of FIM when the SBS or the FIST score is zero. Estimated intercept values were 22.1 for the SBS and 29.1 for the FIST. From the above discussion, the regression equations of the SBS and the FIST areas as follows:

$$\text{FIM score} = 22.1 + 1.39 \times \text{SBS score}$$

$$\text{FIM score} = 29.1 + 0.91 \times \text{FIM score}$$

According to the results of this study, if an individual with stroke scores 25 on the SBS at admission to skilled nursing facilities, the expected FIM motor subscale score at discharge would be 57/91. To get the same expected FIM motor score at discharge, the admission FIST score would be 31. Our R^2 values suggest that the SBS has better predictive power than the FIST. Since the SBS demonstrates better predictive power, if

scores from both scales are available, the SBS equation should be used to predict discharge FIM scores.

As far as the length of stay, both scales failed to demonstrate sufficient predictive validity (the SBS $R^2 = 0.1$ and the FIST $R^2 = 0.13$). In other words, initial SBS and FIST scores did not predict the length of stay for our post-acute rehabilitation participants. Multiple factors may have contributed to this finding. One factor that may affect the length of stay is the funding source of their rehabilitation. While the majority of patients receiving rehabilitation in skilled nursing facilities are funded by Medicare, other payers may be Medicaid or private companies. Different funding sources base decisions regarding when a patient is ready for discharge on different criteria. Functional progress rate and current functional status are not the only factors that lead to rehabilitation termination. In fact, some insurance companies adhere to a predetermined maximum length of stay. Patients with similar conditions or injuries may end up with a different length of stay due to having different medical coverage plans. Another key factor that may affect one's length of stay is family support. The availability of strong social support system may shorten the length of stay (Zhang, Harvey, & Andrew, 2011). A patient with a strong social support may be discharged after a relatively short rehabilitation stay even though he/she exhibited a low sitting balance ability initially. In contrast, a patient with a relatively high sitting balance score at admission may end up staying longer due to the lack of family support. For these reasons and potentially others, sitting balance appears to have a marginal influence on how long patients stay in extended rehabilitation facilities.

Regarding discharge placement, we used receiver operating characteristic (ROC) curve to examine the scales' ability to predict for discharge location. Patients were classified based on their discharge placement (home or institution). The ROC curve was used to test the ability of admission sitting balance scores to predict discharge placement after post-acute rehabilitation in individuals with stroke. In the ROC approach, the area under the curve (AUC) represents the usefulness of a test. The greater the AUC, the more useful the test is. Our study revealed an AUC of 0.82 for the SBS and 0.81 for the FIST, indicating good levels of sensitivity and specificity for both scales. The AUC in both scales were statistically significant ($p < 0.01$). A cutoff score, where a good balance between sensitivity and specificity exists, was identified as 24.5 for the SBS and 27 for the FIST. According to our findings, patients with stroke who scored below the cutoff score were more likely to be discharged to an institution, whereas those who scored above the cutoff score were more likely to be discharged home.

As demonstrated above, both scales were equally useful in predicting discharge placement. The variation in cutoff scores is expected because the examined scales have different maximum scores. Based on these findings, initial sitting balance scores may be helpful in predicting patients' discharge placement upon the completion of post-acute rehabilitation. Both cutoff scores fall in the middle of scores' range of the corresponding scale, suggesting that a patient must exhibit a considerable amount of sitting balance ability at admission to be eligible for the home environment upon discharge. The difference between the scales' predictive power is marginal. The comparable predictive

ability may be expected because both scales involve some identical tasks (e.g., sitting unsupported with eyes close and picking up an object from the floor).

For people with stroke, a FIM score of 80 (63% of maximum score) was identified as a cutoff score for discharge placement (Black, 1999). Patients who score more than 80 are likely to be discharged to their homes. Unlike Black's study that used both motor and cognitive components (maximum score is 126), we only used the motor component of the FIM with a maximum score of 91. Based on our corresponding prediction equations, predicted FIM scores for the SBS and FIST cutoff scores are 56 (62% of maximum score) and 54 (59% of maximum score) respectively. Our predicted FIM cutoff scores seem to be close to the one proposed by the earlier study.

Minimal Detectable Change

Unlike measures used for surgical interventions where MDC_{95} (95% confidence) is recommended, measuring sitting balance is important for less critical decisions (e.g., examine the effectiveness of intervention). Therefore, MDC_{90} (90% confidence) is acceptable and could be of practical use in the clinic (Donoghue & Stokes, 2009; Romero, Bishop, Velozo, & Light, 2011). Our analyses showed that the MDC_{90} was 2.32 and 3.9 for the SBS and FIST, respectively. This means when the change in score of an individual with stroke between two measurement occasions exceeds 2.32 on the SBS or 3.9 on the FIST, clinicians can be 90% confident in interpreting the change as true and genuine (i.e., outside measurement error). Clinicians consequently can make evidence-based clinical decisions and modify their interventions to maximize rehabilitation outcomes.

The MDC of the SBS has not been previously reported in the literature. Therefore, this is the first study to establish the MDC of the SBS in patients recovering from a stroke. For the FIST, previous studies have reported different MDC from our study. Gorman and Harro et al. (2014) estimated the MDC of the FIST to be 5.5. In contrast to our study, they used a confidence level of 95% which may have resulted in a more conservative MDC (Gorman & Harro et al., 2014). Additionally, Gorman's study included participants other than stroke (36%), which also may have contributed to this difference as MDC values could vary by medical conditions (Steffen & Seney, 2008).

In our analysis, the SBS demonstrated far less the amount of estimated error as compared to the FIST. However, this comparison may be irrelevant and gives no consideration to the range of scores in both scales. Therefore, a more relevant comparison is taking into account the percentage of the total possible score (Romero et al., 2011). That is, the MDC of 2.32 points in the SBS is equal to 5.3% of the total possible score (44 points), whereas the MDC of 3.9 corresponded to the FIST is 6.9% of the total possible score (56 points). According to these results, both instruments demonstrated similar MDCs than appears when looking at the raw MDC.

Minimal Clinically Importance Difference

Different methods to determine the minimal clinically importance difference (MCID) of an instrument are discussed in the literature. As a result, different MCID estimates may be obtained when using different methods (Haley & Fragala-Pinkham, 2006; Hays & Woolley, 2000; Lin et al., 2009). Due to the lack of consensus, using multiple approaches to find one value or a small range is recommended and has been a

practice of recent studies (Crosby, Kolotkin, & Williams, 2004; Eton et al., 2004; Hsieh et al., 2007; Terwee et al., 2010). Because they have different advantages, a combination of anchor-based and distribution-based methods were used in this study (Crosby, Kolotkin, & Williams, 2003). In the anchor-based approach, a popular anchor is asking patients, at a specific point in time, about whether they had improved. However, patient's perception of important change (i.e., improvement) may depend on their age, psychological expectations, prior level of function, the severity of their injury, and the surrounding environment. Case in point, in a study by Beninato Fernandes, & Plummer (2014) 124 patients indicated that important change occurred; however, only 92 patients were deemed to have meaningful improvement according to therapists' ratings (Beninato, Fernandes, & Plummer, 2014). Disagreement between patients and clinician in the perception of important change is not unusual (Beninato et al., 2014; Fulk et al., 201; Wyrwich et al., 2007). Due to the variation of cognitive impairments in our sample, we adopted an external anchor (the BI) to differentiate between those who experienced notable improvement and those who did not. According to Revicki, Hays, Cella, and Sloan (2008), the anchor being used and the measurement of interest have to be correlated (0.30 is suggested) to confidently determine the MCID of that measure (Revicki, Hays, Cella, & Sloan, 2008). Our study shows that change of scores in the SBS and the FIST demonstrated a moderate to good correlation with the change of scores in the BI according to Pearson's correlations ($r = 0.61$ and 0.60, respectively). In a distribution-based approach, an effect size (ES) of 0.5 is considered the "threshold" for

detecting change (Norman et al., 2003). Therefore, the expected change scores in the SBS and FIST were computed for an ES of 0.5 to establish the MCID for each scale.

The MCID estimates revealed by the anchor-based approach were 4.5 and 5.5, and those by the distribution-based were 3.51 and 4.83 for the SBS and FIST, respectively. Combining the two methods, the changes have to be in the range of 3.51 to 4.5 points on the SBS and 4.83 to 5.5 points on the FIST to meet the MCID standards. In our ROC analyses, the AUC for the SBS was ~ 0.94 and for the FIST was 0.95. The high AUC values provided by the ROC curves signify that the chance to inaccurately describe a patient as improved or unimproved is low when using 4.5 points on the SBS and 5.5 points on the FIST as cut off points. Due to the lack of fractions in both scale's scoring systems and the belief that the anchor method is superior to the distribution method (Turner et al., 2009), we endorse that 5 points (11.3% of the maximum score) is the MCID for the SBS and 6 points (10.7% of the maximum score) to be the MCID for the FIST. This is the first study to establish the MCID of the SBS scale. The MCID of the FIST across medical conditions with sitting balance impairment was estimated to be 6.5. Again, the small variation between the MCID in Gorman's study and the one established in this study may have resulted from the difference in the population of interest.

It is worth noting that there are some concerns over the difference between group and individual clinically meaningful change. Mean change in a group of patients may not be equally meaningful to an individual patient (Schmitt & Di Fabio, 2004). MCID values estimated for a group of patients are frequently used to interpret change at the individual level (Cella, Bullinger, Scott, & Barofsky, 2002; Lin et al., 2009). To reasonably use a

group driven MCID for individuals, the estimated MDC is expected to be less than or similar to the MCID of the same scale (Lin et al., 2009). Our study yielded smaller MDC values for both scales, which satisfies this expectation. As the MCID values were estimated based on improvement in sitting balance and other basic skills, clinicians may use these results only when patient's condition improves rather than declines (Hsieh et al., 2007).

To bring more insight and appropriate clinical description, the percentage of participants who reached the MCID in each scale was calculated. Of those who were selected as having had important improvement (≥2 on the BI, 37 participants), 97% (36 participants) exhibited a change equal to or greater than the MCID (5 points) for the SBS; whereas only 86% (32 participants) demonstrated a change equal to or greater than the MCID (6 points) for the FIST. This finding suggests that the SBS is more sensitive than the FIST in identifying patients who experienced a clinically important change, which is vital for clinicians. Furthermore, the number of patients who reach or exceed the MCID may serve as an indicator for the effectiveness of an intervention (Chen et al., 2016). Of all participants (n=40), 37 (~93%) reached or exceeded the MCID of the SBS and 32 (80%) reached or exceeded the MCID of the FIST. Data from the more sensitive scale (i.e., the SBS), supports the effectiveness of post-acute rehabilitation.

Of note, elements like the anchor used, the recruitment settings, and the targeted population of this study have to be considered when interpreting the established MCID values. Moreover, the MCID of a measure may differ across stages of stroke (Chen et al., 2016). Our sample included sub-acute and chronic patients. Due to the lack of significant

differences in their sitting balance, our estimated MCID values may be used for all individuals with stroke who are in their sub-acute or chronic stages of recovery (i.e., post-acute).

Limitations of the Study

Several issues in our study are of concern and should be mentioned. First, our sample was recruited from skilled nursing facilities at one geographical place. Findings from a multisite (e.g., acute rehabilitation, long-term acute care) and areas with different culture and lifestyle might be more generalizable. This study included patients with one clinical diagnosis. The generalizability of our results is limited to patients in the chronic and subacute phase of recovery following stroke with characteristics similar to those of our study's participants. Third, our study recruited subjects with sufficient cognitive ability. The findings of this study may not apply to patients with marked cognitive difficulties who score less than 20 on the MMSE.

Recommendation for Future Research

These limitations should be considered in future studies. We recommend future studies include patients with variety of medical conditions and from different rehabilitation settings. We also suggest further research to examine the ability of the SBS and the FIST to predict fall risk.

Conclusion

This study investigated the responsiveness, predictive validity, MDC and MCID of the SBS and the FIST in patients with stroke receiving rehabilitation in sub-acute facilities. The results indicate that both scales are highly responsive (the SBS is more

responsive than the FIST) to change. Admission SBS and FIST scores are significant predictors of level of function at discharge as measured by FIM. The SBS demonstrated better predictive power than the FIST. Both scales were equally useful in predicting discharge placement. However, they failed to demonstrate sufficient predictive validity with regard to length of stay. This study established the MDC and the MCID of the SBS and the FIST. The established MDCs and MCIDs may help clinicians to interpret the change in performance and verify treatment effects after stroke rehabilitation. When a change in score between two measurement occasions exceeds 2.32 on the SBS or 3.9 on the FIST, clinicians can be 90% confident in interpreting the change as error free. Our findings suggest that a clinically important change has to reach 5 on the SBS and 6 on the FIST.

REFERENCES

Allison, L. K., & Fuller, K. (2013). Balance and vestibular dysfunction. *Neurological rehabilitation* (6th ed., pp. 653-710). St. Louis, Mo: Elsevier Health Sciences.

Amusat, N. (2009). Assessment of sitting balance of patients with stroke undergoing inpatient rehabilitation. *Physiotherapy Theory and Practice, 25*(2), 138-144.

Anderson, J. J., & Chernoff, M. C. (1993). Sensitivity to change of rheumatoid arthritis clinical trial outcome measures. *The Journal of Rheumatology, 20*(3), 535-537. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8478866

Anderson, J. J., Felson, D. T., Meenan, R. F., & Williams, H. J. (1989). Which traditional measures should be used in rheumatoid arthritis clinical trials? *Arthritis and Rheumatism, 32*(9), 1093-1099. doi:10.1002/anr.1780320907

Bannigan, K., & Watson, R. (2009). Reliability and validity in a nutshell. *Journal of Clinical Nursing, 18*(23), 3237-3243. doi:10.1111/j.1365-2702.2009.02939.x

Beninato, M., Fernandes, A., & Plummer, L. S. (2014). Minimal clinically important difference of the functional gait assessment in older adults. *Physical Therapy, 94*(11), 1594-1603. doi:10.2522/ptj.20130596

Berg, K., Wood-Dauphinee, S., & Williams, J. I. (1995). The balance scale: Reliability assessment with elderly residents and patients with an acute stroke. *Scandinavian Journal of Rehabilitation Medicine, 27*(1), 27-36. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/7792547

Berg, K., Wood-Dauphine, S., Williams, J. I., & Gayton, D. (1989). Measuring balance in the elderly: Preliminary development of an instrument. *Physiotherapy Canada, 41*(6), 304-311. doi:10.3138/ptc.41.6.304

Bernhardt, J., Ellis, P., Denisenko, S., & Hill, K. (1998). Changes in balance and locomotion measures during rehabilitation following stroke. *Physiotherapy Research International: The Journal for Researchers and Clinicians in Physical Therapy, 3*(2), 109-122. doi:10.1002/pri.130

Black, T. M., Soltis, T., & Bartlett, C. (1999). Using the functional independence measure instrument to predict stroke rehabilitation outcomes. *Rehabilitation Nursing, 24*(3), 109-121.

Blum, L., & Korner-Bitensky, N. (2008). Usefulness of the Berg Balance Scale in stroke rehabilitation: A systematic review. *Physical Therapy, 88*(5), 559-566. doi:10.2522/ptj.20070205

Brink, H., Van der Walt, C., & Van Rensburg, G. (2006). *Fundamentals of research methodology for health care professionals* (2nd ed., pp. 158-167). Cape Town: Juta and Company Ltd.

Cella, D., Bullinger, M., Scott, C., & Barofsky, I. (2002). Group vs individual approaches to understanding the clinical significance of differences or changes in quality of life. *Mayo Clinic Proceedings, 77*(4), 384-392. doi:10.1016/S0025-6196(11)61794-1

Chau, N., Daler, S., Andre, J. M., & Patris, A. (1994). Inter-rater agreement of two functional independence scales: The Functional Independence Measure (FIM) and a subjective uniform continuous scale. *Disability and Rehabilitation, 16*(2), 63-71. doi:10.3109/09638289409166014

Chen, P., Lin, K., Liing, R., Wu, C., Chen, C., & Chang, K. (2016). Validity, responsiveness, and minimal clinically important difference of EQ-5D-5L in stroke patients undergoing rehabilitation. *Quality of Life Research, 25*(6), 1585-1596. doi:10.1007/s11136-015-1196-z

Chinsongkram, B., Chaikeeree, N., Saengsirisuwan, V., Horak, F. B., & Boonsinsukh, R. (2016). Responsiveness of the Balance Evaluation Systems Test (BESTest) in people with subacute stroke. *Physical Therapy, 96*(10), 1638-1647. doi:10.2522/ptj.20150621

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ [u.a.]: Erlbaum. doi:10.4324/9780203771587

Cohen, M. E., & Marino, R. J. (2000). The tools of disability outcomes research functional status measures. *Archives of Physical Medicine and Rehabilitation, 81*(12 Suppl 2), S21-S29. doi:10.1053/apmr.2000.20620

Collin, C., Wade, D. T., Davies, S., & Horne, V. (1988). The barthel ADL index: A reliability study. *International Disability Studies, 10*(2), 61-63. doi:10.3109/09638288809164103

Crosby, R. D., Kolotkin, R. L., & Williams, G. R. (2004). An integrated method to determine meaningful changes in health-related quality of life. *Journal of Clinical Epidemiology, 57*(11), 1153-1160. doi:10.1016/j.jclinepi.2004.04.004

Crosby, R. D., Kolotkin, R. L., & Williams, G. R. (2003). Defining clinically meaningful change in health-related quality of life. *Journal of Clinical Epidemiology, 56*(5), 395-407. doi:10.1016/S0895-4356(03)00044-1

Davidshofer, C. O., & Murphy, K. R. (2005). *Psychological testing: Principles and applications* (6th ed.). Upper Saddle River, NJ: Pearson, Prentice Hall.

DeVincenzo, D. K., & Watkins, S. (1987). Accidental falls in a rehabilitation setting. *Rehabilitation Nursing, 12*(5), 248-252. doi:10.1002/j.2048-7940.1987.tb01010.x

Deyo, R. A., & Centor, R. M. (1986). Assessing the responsiveness of functional scales to clinical change: An analogy to diagnostic test performance. *Journal of Chronic Diseases, 39*(11), 897-906. doi:10.1016/0021-9681(86)90038-X

Dodds, T. A., Martin, D. P., Stolov, W. C., & Deyo, R. A. (1993). A validation of the functional independence measurement and its performance among rehabilitation inpatients. *Archives of Physical Medicine and Rehabilitation, 74*(5), 531-536. doi:0003-9993(93)90119-U

Donnan, G. A., Fisher, M., Macleod, M., & Davis, S. M. (2008). Stroke. *The Lancet, 371*(9624), 1612-1623. doi:10.1016/s0140-6736(08)60694-7

Donoghue, D., & Stokes, E. K. (2009). How much change is true change? the minimum detectable change of the berg balance scale in elderly people. *Journal of Rehabilitation Medicine, 41*(5), 343-346. doi:10.2340/16501977-0337

Duncan, P. W., Weiner, D. K., Chandler, J., & Studenski, S. (1990). Functional reach: A new clinical measure of balance. *Journal of Gerontology, 45*(6), M197. doi:10.1093/geronj/45.6.M192

Ebrahim, S. (1989). Measuring health: A guide to rating scales and questionnaires. *Statistics in Medicine, 8*(10), 1308-1309. doi:10.1002/sim.4780081017

Eton, D. T., Cella, D., Yost, K. J., Yount, S. E., Peterman, A. H., Neuberg, D. S., . . . Wood, W. C. (2004). A combination of distribution- and anchor-based approaches

determined minimally important differences (MIDs) for four endpoints in a breast cancer scale. *Journal of Clinical Epidemiology*, *57*(9), 898-910. doi:10.1016/j.jclinepi.2004.01.012

Feigin, L., Sharon, B., Czaczkes, B., & Rosin, A. J. (1996). Sitting equilibrium 2 weeks after a stroke can predict the walking ability after 6 months. *Gerontology, 42*(6), 348-353. doi:10.1159/000213814

Finch, E., Brooks, D., Stratford, P. W., & Mayo, N. E. (2002). In Canadian Physiotherapy Association (Ed.), *Physical rehabilitation outcome measures: A guide to enhanced clinical decision making.* (2nd ed.). Hamilton: BC Decker Inc.

Flansbjer, U. B., Holmback, A. M., Downham, D., Patten, C., & Lexell, J. (2005). Reliability of gait performance tests in men and women with hemiparesis after stroke. *Journal of Rehabilitation Medicine: Official Journal of the UEMS European Board of Physical and Rehabilitation Medicine, 37*(2), 75-82. doi:10.1080/16501970410017215

Forhan, M., & Gill, S. V. (2013). Obesity, functional mobility and quality of life. *Best Practice and Research: Clinical Endocrinology and Metabolism, 27*(2), 129-137. doi:10.1016/j.beem.2013.01.003

Fritz, J. M., & Irrgang, J. J. (2001). A comparison of a Modified Oswestry Low Back Pain Disability Questionnaire and the Quebec Back Pain Disability Scale. *Physical Therapy, 81*(2), 776-788. doi:10.1093/ptj/81.2.776

Fujiwara, T., Liu, M., Tsuji, T., Sonoda, S., Mizuno, K., Akaboshi, K., . . . Chino, N. (2004). Development of a new measure to assess trunk impairment after stroke (Trunk Impairment Scale): Its psychometric properties. *American Journal of Physical Medicine and Rehabilitation / Association of Academic Physiatrists, 83*(9), 681-688. doi:10.1097/01.phm.0000137308.10562.20

Fulk, G., Ludwig, M., Dunning, K., Golden, S., Boyne, P., & West, T. (2011). Estimating clinically important change in gait speed in people with stroke undergoing outpatient rehabilitation. *Journal of Neurologic Physical Therapy, 35*(2), 82-89. doi:10.1097/NPT.0b013e318218e2f2

Gorman, S. L., Harro, C. C., Platko, C., & Greenwald, C. (2014). Examining the Function in Sitting Test for validity, responsiveness, and minimal clinically important difference in inpatient rehabilitation. *Archives of Physical Medicine and Rehabilitation, 95*(12), 2304-2311. doi:10.1016/j.apmr.2014.07.415 [doi]

Gorman, S. L., Radtka, S., Melnick, M. E., Abrams, G. M., & Byl, N. N. (2010). Development and validation of the Function in Sitting Test in adults with acute stroke. *Journal of Neurologic Physical Therapy, 34*(3), 150-160. doi:10.1097/NPT.0b013e3181f0065f

Gorman, S. L., Rivera, M., & McCarthy, L. (2014). Reliability of the Function in Sitting Test (FIST). *Rehabilitation Research and Practice, 2014*, 1-6. doi:10.1155/2014/593280

Gosman-Hedström, E., & Svensson, G. (2000). Parallel reliability of the functional independence measure and the Barthel ADL Index. *Disability and Rehabilitation, 22*(16), 702-715. doi:10.1080/09638280050191972

Granger, C. V. (1998). The emerging science of functional assessment: Our tool for outcomes analysis. *Archives of Physical Medicine and Rehabilitation, 79*(3), 235-240. doi:S0003-9993(98)90000-4

Granger, C. V., Dewis, L. S., Peters, N. C., Sherwood, C. C., & Barrett, J. E. (1979). Stroke rehabilitation: Analysis of repeated Barthel Index measures. *Archives of Physical Medicine and Rehabilitation, 60*(1), 14-17. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/420565

Gresham, G. E., Duncan, P. W., Stason, W. B., Adams, H. P., Adelman, A. M., Alexander, D. M., . . . Trombly, C. A. (1995). *Post–Stroke rehabilitation: Clinical practice guidelines*. Silver Spring, MD: U.S. Dept. of Health and Human Services, Public Health Service, Agency for Healthcare Research and Quality.

Guyatt, G., Walter, S., & Norman, G. (1987). Measuring change over time: Assessing the usefulness of evaluative instruments. *Journal of Chronic Diseases, 40*(2), 171-178. doi:10.1016/0021-9681(87)90069-5

Haley, S. M., & Fragala-Pinkham, M. A. (2006). Interpreting change scores of tests and measures used in physical therapy. *Physical Therapy, 86*(5), 735-743. doi:10.1093/ptj/86.5.735

Hamilton, B. B., Laughlin, J. A., Fiedler, R. C., & Granger, C. V. (1994). Interrater reliability of the 7-level Functional Independence Measure (FIM). *Scandinavian Journal of Rehabilitation Medicine, 26*(3), 115-119. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/7801060

Hays, R. D., & Woolley, J. M. (2000). The concept of clinically meaningful difference in health-related quality of life research: How meaningful is it? *Pharmacoeconomics, 18*(5), 419-423. doi:10.2165/00019053-200018050-00001

Hiengkaew, V., Jitaree, K., & Chaiyawat, P. (2012). Minimal detectable changes of the Berg Balance Scale, Fugl-Meyer Assessment Scale, Timed "Up & Go" test, gait speeds, and 2-Minute Walk Test in individuals with chronic stroke with different degrees of ankle plantarflexor tone. *Archives of Physical Medicine and Rehabilitation, 93*(7), 1201-1208. doi:10.1016/j.apmr.2012.01.014

Hsieh, Y., Wang, C., Wu, S., Chen, P., Sheu, C., & Hsieh, C. (2007). Establishing the minimal clinically important difference of the Barthel Index in stroke patients. *Neurorehabilitation and Neural Repair, 21*(3), 233-238. doi:10.1177/1545968306294729

Hsueh, I., Lin, J., Jeng, J., & Hsieh, C. (2002). Comparison of the psychometric characteristics of the Functional Independence Measure, 5 item Barthel Index, and 10 item Barthel Index in patients with stroke. *Journal of Neurology, Neurosurgery, and Psychiatry, 73*(2), 188-190. doi:10.1136/jnnp.73.2.188

Husted, J. A., Cook, R. J., Farewell, V. T., & Gladman, D. D. (2000). Methods for assessing responsiveness: A critical review and recommendations. *Journal of Clinical Epidemiology, 53*(5), 459-468. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10812317

Jaeschke, R., Singer, J., & Guyatt, G. H. (1989). Measurement of health status. ascertaining the minimal clinically important difference. *Controlled Clinical Trials, 10*(4), 407-415. doi:10.1016/0197-2456(89)90005-6

Jonsdottir, J., & Cattaneo, D. (2007). Reliability and validity of the Dynamic Gait Index in persons with chronic stroke. *Archives of Physical Medicine and Rehabilitation, 88*(11), 1410-1415. doi:10.1016/j.apmr.2007.08.109

Karanicolas, P. J., Bhandari, M., Kreder, H., Moroni, A., Richardson, M., Walter, S. D., . . . Guyatt, G. H. (2009). Evaluating agreement: Conducting a reliability study. *The Journal of Bone and Joint Surgery, 91*(Supplement_3), 99-106. doi:10.2106/JBJS.H.01624

Karliner, L. S., Napoles-Springer, A. M., Schillinger, D., Bibbins-Domingo, K., & Perez-Stable, E. J. (2008). Identification of limited english proficient patients in clinical care. *Journal of General Internal Medicine, 23*(10), 1555-1560. doi:10.1007/s11606-008-0693-y [doi]

Katz-Leurer, M., Fisher, I., Neeb, M., Schwartz, I., & Carmeli, E. (2009). Reliability and validity of the Modified Functional Reach Test at the sub-acute stage post-stroke. *Disability and Rehabilitation, 31*(3), 243-248. doi:10.1080/09638280801927830

Knorr, S., Brouwer, B., & Garland, S. J. (2010). Validity of the community balance and mobility scale in community-dwelling persons after stroke. *Archives of Physical Medicine and Rehabilitation, 91*(6), 890-896. doi:10.1016/j.apmr.2010.02.010

Krishchiunas, A. I., & Savitskas, R. I. (2004). Falls in early in-patient rehabilitation of stroke patients [Abstract]. *Zhurnal Nevrologii i Psikhiatrii Imeni S.S. Korsakova / Ministerstvo Zdravookhraneniia i Meditsinskoĭ Promyshlennosti Rossiĭskoĭ Federatsii, Vserossiĭskoe Obshchestvo Nevrologov [i] Vserossiĭskoe Obshchestvo Psikhiatrov,* (Suppl 11), 47 -50. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/15559221

Kwakkel, G., Wagenaar, R. C., Kollen, B. J., & Lankhorst, G. J. (1996). Predicting disability in stroke: a critical review of the literature. *Age and Ageing, 25*(6), 479-489. doi:10.1093/ageing/25.6.479

Lancu, I., & Olmer, A. (2006). The minimental state examination–an up-to-date review. *Harefuah, 145*(9), 687-690. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/17078433

Lin, K., Hsieh, Y., Wu, C., Chen, C., Jang, Y., & Liu, J. (2009). Minimal detectable change and clinically important difference of the Wolf Motor Function Test in stroke patients. *Neurorehabilitation and Neural Repair, 23*(5), 429-434. doi:10.1177/1545968308331144

Loewen, S. C., & Anderson, B. A. (1988). Reliability of the Modified Motor Assessment Scale and the Barthel Index. *Physical Therapy, 68*(7), 1077-1081. Retrieved from http://ptjournal.apta.org/content/68/7/1077.abstract

Lynch, S. M., Leahy, P., & Barker, S. P. (1998). Reliability of measurements obtained with a Modified Functional Reach Test in subjects with spinal cord injury. *Physical Therapy, 78*(2), 128-133. Retrieved from http://ptjournal.apta.org/content/78/2/128.abstract

Mackay, J., Mensah, G. A., Mendis, S., & Greenlund, K. (2004). *The Atlas of Heart Disease and Stroke*. Geneva: World Health Organization.

Mahoney, F. I., & Barthel, D. W. (1965). Functional evaluation: The Barthel Index. *Maryland State Medical Journal, 14*(2), 61-65. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/14258950

Mayo, N. E., Korner-Bitensky, N., Becker, R., & Georges, P. (1989). Predicting falls among patients in a rehabilitation hospital. *American Journal of Physical Medicine and Rehabilitation / Association of Academic Physiatrists, 68*(3), 139-146. doi:10.1097/00002060-198906000-00008

Medley, A., & Thompson, M. (2011). Development, reliability, and validity of the Sitting Balance Scale. *Physiotherapy Theory and Practice, 27*(7), 471-481. doi:10.3109/09593985.2010.531077

Morgan, P. (1994). The relationship between sitting balance and mobility outcome in stroke. *Australian Journal of Physiotherapy, 40*(2), 91-96. doi:10.1016/S0004-9514(14)60455-4

Ng, S. S., & Hui-Chan, C. W. (2005). The Timed Up & Go test: Its reliability and association with lower-limb impairments and locomotor capacities in people with chronic stroke. *Archives of Physical Medicine and Rehabilitation, 86*(8), 1641-1647. doi:10.1016/j.apmr.2005.01.011

Nichols, D. S., Miller, L., Colby, L. A., & Pease, W. S. (1996). Sitting balance: Its relation to function in individuals with hemiparesis. *Archives of Physical Medicine and Rehabilitation, 77*(9), 865-869. doi:10.1016/S0003-9993(96)90271-3

Nieuwboer, A., Feys, H., Weerdt, W. D., Nuyens, G., & Corte, E. D. (1995). Developing a clinical tool to measure sitting balance after stroke: A reliability study. *Physiotherapy, 81*(8), 439-445. doi:10.1016/S0031-9406(05)66720-X

Nitz, J., & Gage, A. (1995). Post stroke recovery of balanced sitting and ambulation ability. *Australian Journal of Physiotherapy, 41*(4), 263-267. doi:10.1016/S0004-9514(14)60435-9

Norman, G. R., Wyrwich, K. W., & Patrick, D. L. (2007). The mathematical relationship among different forms of responsiveness coefficients. *Quality of Life Research, 16*(5), 815-822. doi:10.1007/s11136-007-9180-x

Norman, G. R., Sloan, J. A., & Wyrwich, K. W. (2003). Interpretation of changes in health-related quality of life: The remarkable universality of half a standard deviation. *Medical Care, 41*(5), 582-592. Retrieved from http://www.jstor.org/stable/3768017

Norman, G. R., Stratford, P., & Regehr, G. (1997). Methodological problems in the retrospective computation of responsiveness to change: The lesson of cronbach.

Journal of Clinical Epidemiology, 50(8), 869-879. doi:10.1016/S0895-4356(97)00097-8

Nyberg, L., & Gustafson, Y. (1997). Fall Prediction Index for patients in stroke rehabilitation. *Stroke, 28*(4), 716-721. doi:10.1161/01.STR.28.4.716

Pandian, S., Arya, K. N., & Kumar, D. (2016). Minimal clinically important difference of the lower-extremity Fugl-Meyer Assessment in chronic-stroke. *Topics in Stroke Rehabilitation, 23*(4), 233-239. doi:10.1179/1945511915Y.0000000003

Pangman, V. C., Sloan, J., & Guse, L. (2000). An examination of psychometric properties of the Mini-Mental State Examination and the standardized mini-mental state examination: Implications for clinical practice. *Applied Nursing Research, 13*(4), 209-213. doi:10.1053/apnr.2000.9231

Portney, L., & Watkins, M. (2015). The Correlation. *Foundations of clinical research: Applications to practice* (3rd ed., pp. 523-538). Philadelphia: F.A. Davis. Retrieved from http://www.r2library.com/resource/title/9780803646575

Pyöriä, O., Talvitie, U., & Villberg, J. (2005). The reliability, distribution, and responsiveness of the postural control and balance for stroke test. *Archives of Physical Medicine and Rehabilitation, 86*(2), 296-302. doi:10.1016/j.apmr.2004.01.024

Revicki, D., Hays, R. D., Cella, D., & Sloan, J. (2008). Recommended methods for determining responsiveness and minimally important differences for patient-reported outcomes. *Journal of Clinical Epidemiology, 61*(2), 102-109. doi:10.1016/j.jclinepi.2007.03.012

Roger, V. L., Go, A. S., Lloyd-Jones, D. M., Benjamin, E. J., Berry, J. D., Borden, W. B., . . . Turner, M. B. (2012). Heart disease and stroke statistics – 2012 update: A report from the american heart association. *Circulation, 125*(1), e2-e220. doi:10.1161/cir.0b013e31823ac046

Romero, S., Bishop, M. D., Velozo, C. A., & Light, K. (2011). Minimum detectable change of the Berg Balance Scale and Dynamic Gait Index in older persons at risk for falling. *Journal of Geriatric Physical Therapy (2001), 34*(3), 131-137. doi:10.1519/JPT.0b013e3182048006

Ryeson, S. D. (2013). Movement dysfunction associated with hemiplegia. *Neurological rehabilitation* (6th ed., pp. 711-752). St. Louis, Mo: Elsevier Health Sciences.

Saso, A., Moe-Nilssen, R., Gunnes, M., & Askim, T. (2016). Responsiveness of the Berg Balance Scale in patients early after stroke. *Physiotherapy Theory and Practice, 32*(4), 251-261. doi:10.3109/09593985.2016.1138347

Sawilowsky, S. S. (2009). New effect size rules of thumb. *Journal of Modern Applied Statistical Methods*, 8(2), 597 – 599. Retrieved from http://digitalcommons.wayne.edu/coe_tbf/4

Schmitt, J. S., & Di Fabio, R. P. (2004). Reliable change and minimum important difference (MID) proportions facilitated group responsiveness comparisons using individual threshold criteria. *Journal of Clinical Epidemiology, 57*(10), 1008-1018. doi:10.1016/j.jclinepi.2004.02.007

Shumway-Cook, A., Anson, D., & Haller, S. (1988). Postural sway biofeedback: Its effect on reestablishing stance stability in hemiplegic patients. *Archives of Physical Medicine and Rehabilitation, 69*(6), 395-400. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/3377664

Steffen, T., & Seney, M. (2008). Test-retest reliability and minimal detectable change on balance and ambulation tests, the 36-item short-form health survey, and the unified parkinson disease rating scale in people with parkinsonism. *Physical Therapy, 88*(6), 733-746. doi:10.2522/ptj.20070214

Stevenson, T. J. (2001). Detecting change in patients with stroke using the Berg Balance Scale. *The Australian Journal of Physiotherapy, 47*(1), 29-38. doi:10.1016/S0004-9514(14)60296-8

Stratford, P. W. (2004). Getting more from the literature: Estimating the standard error of measurement from reliability studies. *Physiotherapy Canada, 56*(1), 27-30. doi:10.2310/6640.2004.15377

Stucki, G., Ewert, T., & Cieza, A. (2002). Value and application of the ICF in rehabilitation medicine. *Disability and Rehabilitation, 24*(17), 932-938. doi:10.1080/09638280210148594

Suzuki, T., Sonoda, S., Misawa, K., Saitoh, E., Shimizu, Y., & Kotake, T. (2005). Incidence and consequence of falls in inpatient rehabilitation of stroke patients. *Experimental Aging Research, 31*(4), 457-469. doi:10.1080/03610730500206881

Terwee, C. B., Roorda, L. D., Dekker, J., Bierma-Zeinstra, S. M., Peat, G., Jordan, K. P., . . . de Vet, H. C. W. (2010). Mind the MIC: Large variation among populations and methods. *Journal of Clinical Epidemiology, 63*(5), 524-534. doi:10.1016/j.jclinepi.2009.08.010

Thompson, M., & Medley, A. (2007). Forward and lateral sitting functional reach in younger, middle-aged, and older adults. *Journal of Geriatric Physical Therapy (2001), 30*(2), 43-48. doi:10.1519/00139143-200708000-00002

Thompson, M., Medley, A., & Teran, S. (2013). Validity of the sitting balance scale in older adults who are non-ambulatory or have limited functional mobility. *Clinical Rehabilitation, 27*(2), 166-173. doi:10.1177/0269215512452879

Thornton, M., & Sveistrup, H. (2010). Intra- and inter-rater reliability and validity of the Ottawa Sitting Scale: A new tool to characterise sitting balance in acute care patients. *Disability and Rehabilitation, 32*(19), 1568-1575. doi:10.3109/09638280903567893

Towfighi, A., & Saver, J. L. (2011). Stroke declines from third to fourth leading cause of death in the united states: Historical perspective and challenges ahead. *Stroke, 42*(8), 2351-2355. doi:10.1161/STROKEAHA.111.621904

Tsang, Y. L., & Mak, M. K. (2004). Sit-and-reach test can predict mobility of patients recovering from acute stroke. *Archives of Physical Medicine and Rehabilitation, 85*(1), 94-98. doi:10.1016/S0003-9993(03)00377-0

Turner, D., Schünemann, H. J., Griffith, L. E., Beaton, D. E., Griffiths, A. M., Critch, J. N., & Guyatt, G. H. (2009). Using the entire cohort in the receiver operating characteristic analysis maximizes precision of the minimal important difference. *Journal of Clinical Epidemiology, 62*(4), 374-379. doi:10.1016/j.jclinepi.2008.07.009

Tyson, S. F., Hanley, M., Chillala, J., Selley, A. B., & Tallis, R. C. (2007). The relationship between balance, disability, and recovery after stroke: Predictive validity of the brunel balance assessment. *Neurorehabilitation and Neural Repair, 21*(4), 341-346. doi:10.1177/1545968306296966

Verheyden, G., Hughes, J., Jelsma, J., Nieuwboer, A., & De Weerdt, W. (2006). Assessing motor impairment of the trunk in patients with traumatic brain injury: Reliability and validity of the trunk impairment scale. *South African Journal of Physiotherapy, 62*(2), 23-28. Retrieved from http://www.sajp.co.za/index.php/sajp/article/viewPDFInterstitial/153/150

Verheyden, G., Nieuwboer, A., Feys, H., Thijs, V., Vaes, K., & de Weerdt, W. (2005). Discriminant ability of the Trunk Impairment Scale: A comparison between stroke patients and healthy individuals. *Disability and Rehabilitation, 27*(17), 1023-1028. doi:10.1080/09638280500052872

Verheyden, G., Nieuwboer, A., Mertin, J., Preger, R., Kiekens, C., & De Weerdt, W. (2004). The Trunk Impairment Scale: A new tool to measure motor impairment of the trunk after stroke. *Clinical Rehabilitation, 18*(3), 326-334. doi:10.1191/0269215504cr733oa

Verheyden, G., & Kersten, P. (2010). Investigating the internal validity of the Trunk Impairment Scale (TIS) using rasch analysis: The TIS 2.0. *Disability and Rehabilitation, 32*(25), 2127-2137. doi:10.3109/09638288.2010.483038

Verheyden, G., Nuyens, G., Nieuwboer, A., Van Asch, P., Ketelaer, P., & De Weerdt, W. (2006). Reliability and validity of trunk assessment for people with multiple sclerosis. *Physical Therapy, 86*(1), 66-67. doi:10.1093/ptj/86.1.66

Verheyden, G., Willems, A., Ooms, L., & Nieuwboer, A. (2007). Validity of the trunk impairment scale as a measure of trunk performance in people with parkinson's disease. *Archives of Physical Medicine and Rehabilitation, 88*(10), 1304-1308. doi:10.1016/j.apmr.2007.06.772

Vlahov, D., Myers, A. H., & al-Ibrahim, M. S. (1990). Epidemiology of falls among patients in a rehabilitation hospital. *Archives of Physical Medicine and Rehabilitation, 71*(1), 8-12. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2297314

Wallace, D., Duncan, P. W., & Lai, S. M. (2002). Comparison of the responsiveness of the Barthel Index and the motor component of the Functional Independence Measure in stroke: The impact of using different methods for measuring responsiveness. *Journal of Clinical Epidemiology, 55*(9), 922-928. doi:10.1016/s0895-4356(02)00410-9

World Health Organization. (2006). *Neurological disorders: public health challenges.* World Health Organization.

World Health Organization. (1978). *Cerebrovascular disorders: A clinical and research classification.* Geneva: World Health Organization.

Wright, J. G., & Young, N. L. (1997). A comparison of different indices of responsiveness. *Journal of Clinical Epidemiology, 50*(3), 239-246. doi:10.1016/S0895-4356(96)00373-3

Wyrwich, K. W., Tierney, W. M., & Wolinsky, F. D. (1999). Further evidence supporting an SEM-based criterion for identifying meaningful intra-individual changes in health-related quality of life. *Journal of Clinical Epidemiology, 52*(9), 861-873. doi:10.1016/S0895-4356(99)00071-2

Wyrwich, K., Metz, S., Kroenke, K., Tierney, W., Babu, A., & Wolinsky, F. (2007). Measuring patient and clinician perspectives to evaluate change in health-related quality of life among patients with chronic obstructive pulmonary disease. *Journal of General Internal Medicine, 22*(2), 161-170. doi:10.1007/s11606-006-0063-6

Yu, W., Chen, K., Chou, Y., Hsueh, I., & Hsieh, C. (2013). Responsiveness and predictive validity of the hierarchical balance short forms in people with stroke. *Physical Therapy, 93*(6), 798-808. doi:10.2522/ptj.20120259

Yu, W., Hsueh, I., Hou, W., Wang, Y., & Hsieh, C. (2012). A comparison of responsiveness and predictive validity of two balance measures in patients with stroke. *Journal of Rehabilitation Medicine, 44*(2), 176-180. doi:10.2340/16501977-0903

Zhang, J., Harvey, C., & Andrew, C. (2011). Factors associated with length of stay and the risk of readmission in an acute psychiatric inpatient facility: A retrospective study. *Australian and New Zealand Journal of Psychiatry, 45*(7), 578-585. doi:10.3109/00048674.2011.585452

APPENDIX A

IRB Approval Letter

Institutional Review Board
Office of Research and Sponsored Programs
P.O. Box 425619, Denton, TX 76204-5619
940-898-3378
email: IRB@twu.edu
http://www.twu.edu/irb.html

DATE: October 29, 2015

TO: Mr. Jehad Alzyoud
Physical Therapy - Dallas

FROM: Institutional Review Board (IRB) - Dallas

Re: Approval for Responsiveness and Predictive Validity of the Sitting Balance Scale and Function in Sitting Test in People with Stroke (Protocol #: 18576)

The above referenced study has been reviewed and approved by the Dallas IRB (operating under FWA00000178) on 10/29/2015 using an expedited review procedure. This approval is valid for one year and expires on 10/28/2016. The IRB will send an email notification 45 days prior to the expiration date with instructions to extend or close the study. It is your responsibility to request an extension for the study if it is not yet complete, to close the protocol file when the study is complete, and to make certain that the study is not conducted beyond the expiration date.

If applicable, agency approval letters must be submitted to the IRB upon receipt prior to any data collection at that agency. A copy of the approved consent form with the IRB approval stamp is enclosed. Please use the consent form with the most recent approval date stamp when obtaining consent from your participants. A copy of the signed consent forms must be submitted with the request to close the study file at the completion of the study.

Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any adverse events or unanticipated problems. All forms are located on the IRB website. If you have any questions, please contact the TWU IRB.

cc. Dr. Ann Medley, Physical Therapy - Dallas
Graduate School

APPENDIX B

IRB Approved Consent Form

TEXAS WOMAN'S UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

Title: Responsiveness and Predictive Validity of the Sitting Balance Scale and Function in Sitting Test in People with Stroke

Investigator: Jehad Alzyoud MSc
Advisor: Ann Medley PT, PhD

Explanation and Purpose of the Research

You are being asked to participate in a research study for Mr. Jehad Alzyoud who is a PhD student at Texas Woman's University (TWU) and a licensed physical therapist in the state of Florida. The goal of this study is to determine the best way to assess balance in a seated position. In order to be a participant in this study, you must be diagnosed with stroke and be able to follow English verbal instructions. If you score less than 14 seconds on the Time Up and Go test (test designed to assess functional mobility) or less than 24 in Mini Mental State Examination (screening tool used to quantify cognitive impairment), you will not be able to be in the study.

Description of Procedures

As a participant in this study you will be asked to participate in two 60-minute sessions, one right after admission and one right before discharge. First you will be asked to fill out a form that asks questions about your medical history. Next, the researcher will test your balance by asking you to perform several tasks while you are in a seated position. Tasks include sitting still, reaching while sitting, turning while sitting, standing from sitting, and grabbing an object from the ground. In addition, the researcher will test your level of independence on several functional mobility tasks (e.g., bed to wheelchair transfers). The researcher will record your scores on the tasks. Three rest periods, five minutes each, will be given throughout the session. You may refuse to do any part of the tests at any time.

Potential Risks

Although it is rare and unlikely to happen, one potential risk of this study is injury from falling (e.g., muscle strain, ligaments sprain, skin breakdown). The researcher will ask you to do physical tasks that have very minimal risk of injuries. The researcher will guard and observe you for any signs of distress or discomfort throughout the session. Your blood pressure and other vital signs will be taken prior to testing to make sure that vitals are within the safe limit. If you have any problems during the testing session, let the researcher know immediately. You may also become tired during the testing session. You will be given a 5-minute rest period after each test. If you need more time, let the researcher know. If you are unable to continue testing for any reason, all testing will stop immediately.

Another risk in this study is loss of confidentiality. Confidentiality will be protected to the extent that is allowed by law. A code number, other than your real name, will be used during the study. All written documents will be stored in a locked cabinet at the facility where testing is taking place. Three years after the study, all data will be destroyed. The results of the study will be reported in scientific magazines or journals but your name or any other identifying information will not be included.

_____
Initials

The researcher will try to prevent any problem that could happen because of this research. You should let the researchers know at once if there is a problem and they will help you. However, TWU does not provide medical services or financial assistance for injuries that might happen because you are taking part in this research.

Participation and Benefits

Your involvement in this study is completely voluntary and you may withdraw from the study at any time. If you would like to know the results of this study we will mail or email them to you upon request.*

Questions Regarding the Study

You will be given a copy of this signed and dated consent form to keep. If you have any questions about the research study you should ask the researchers; their phone numbers are at the top of this form. If you have questions about your rights as a participant in this research or the way this study has been conducted, you may contact the Texas Woman's University Office of Research and Sponsored Programs at 940-898-3378 or via e-mail at IRB@twu.edu.

_____ _____

Signature of Participant Date

*If you would like to know the results of this study tell us where you want them to be sent:

Email: _____

or

Address:

_____

_____

_____

APPENDIX C

Intake Form

Intake Form

General Information: **ID: _____**

Name: _____

Contact (phone #):

Birth date: _____/_____/_____

Sex:

Male Female

Side of Injury:

Right Left

Date of Onset: _____/_____/_____

Vitals:

Admission testing: BP: ____/___ Heart rate: _____ O2 Sat: _____

Prior D/C testing: BP: ____/____ Heart rate: _____ O2 Sat: _____

Admission MMSE: _____/30 D/C MMSE: _____/30

TUG: _____ Sec

LOS: _____Days

D/C placement:

LTC

ALF

ILF

Home: Independent Family support HH

Other: _____

LTC: long term care, ALF: assisted living facility, ILF: independent living facility, HH: home health

APPENDIX D

Sitting Balance Scale

Sitting Balance Scale 2009:

Note: All sitting items are performed with the patient sitting unsupported on a surface with both feet in weight bearing unless otherwise indicated.

Equipment needed to assess the items: 12-inch ruler, stop watch (items 1, 2, and 6), pen (Items 4 and 7), slipper (items 5 and 11), *Physician's Desk Reference* or other item 3 to 3.5 inches thick (item 6), 2lb. cuff weight (item 3), 15"x15"x5" piece of foam (item 11); clipboard (item 9)

Indicate what surface the patient is sitting on: ☐ folding chair, ☐ wheelchair, ☐ mat, ☐ other_____

1. **Sitting unsupported (eyes open)**
   Instructions: Please sit with your arms folded for 60 seconds. (Examiner must make sure the patient's feet are in weight bearing)

   ( ) 4 Able to sit safely and securely 60 seconds
   ( ) 3 Able to sit 60 seconds under supervision
   ( ) 2 Able to sit 30 seconds
   ( ) 1 Able to sit 10 seconds
   ( ) 0 Unable to sit without support 10 seconds

2. **Sitting unsupported with eyes closed**
   Instructions: Please sit with your eyes closed for 30 seconds. (Examiner must make sure the patient's feet are in weight bearing).

   ( ) 4 Able to sit safely and securely 30 seconds
   ( ) 3 Able to sit 30 seconds under supervision
   ( ) 2 Able to sit 10 seconds
   ( ) 1 Able to sit 3 seconds
   ( ) 0 Unable to sit without support 3 seconds

3. **Sitting unsupported with arms as levers**
   Instructions: Please lift this cuff weight out in front of you with your arm straight. (Starting position for all scores is with patients' hands in their lap. Examiner must ensure that the arm moves to at least 90 degrees of shoulder flexion for a score of 4 or 3. If the patient has hemiplegia, test using the unaffected arm.)

   ( ) 4 Able to sit while lifting a 2lb. cuff weight at 90° shoulder flexion
   ( ) 3 Able to sit while lifting one arm to 90 ° flexion
   ( ) 2 Able to sit with hands folded across chest
   ( ) 1 Able to sit with hands in lap
   ( ) 0 Able to sit with hands at side on the mat

4. **Reaching forward with outstretched arm while sitting**
   Instructions: Reach forward and touch this pen. (Ask patient to make a fist and extend arm forward to shoulder height (approximately 90 degrees). Place a 12 inch ruler touching patient's fist in line with patient's arm. Hold up a pen 12 inches from patient's fist. Ask the patient to try to touch the pen with knuckles without losing balance. Note distance reached.

   ( ) 4 Can reach forward confidently > 10 inches
   ( ) 3 Can reach forward > 5 inches
   ( ) 2 Can reach forward >2 inches
   ( ) 1 Reaches forward but needs supervision
   ( ) 0 Loses balance while trying/ requires external support

Medley A. Thompson M. Development, reliability and validity of the Sitting Balance Scale, *Physiotherapy Theory and Practice* 2011;27(7):471-481.

5. **Pick up an object from the floor while sitting unsupported**
Instructions: Pick up the slipper. (Examiner should place the slipper on the floor 3 inches in front of the patient's toes.)

( ) 4 Able to pick up slipper without losing balance
( ) 3 Able to pick up slipper but needs supervision for balance
( ) 2 Unable to pick up slipper but reaches 1-2 inches from slipper and keeps balance independently
( ) 1 Unable to pick up and needs supervision while trying
( ) 0 Unable to try/needs assistance to keep from losing balance or falling

6. **Placing alternate foot on a *Physician's Desk Reference* (PDR) while sitting unsupported**
Instructions: Place each foot alternately on this book four times. (Place a PDR or other item that is 3 to 3 ½ inches high, 6 inches in front of the toes. Have patient alternately touch feet to the top of the PDR. Patient should continue until each foot has touched the PDR four times. Patients with hemiplegia or unilateral amputation may perform the task with their uninvolved leg)

( ) 4 Able to sit independently and safely complete 8 steps in 20 seconds
( ) 3 Able to sit independently and completes 8 steps >20 seconds
( ) 2 Able to complete 4 steps without aid with supervision
( ) 1 Able to complete >2 steps needs minimal assistance
( ) 0 Needs assistance to keep from falling/unable to try

7. **Reaching laterally with outstretched arm while sitting unsupported**
Instructions: Reach to the side and touch this pen. (Ask patient to make a fist and extend arm out to the side, laterally, to shoulder height approximately 90 degrees. Place a 12 inch ruler touching the patient's fist in line with patient's arm. Hold up a pen 12 inches from patient's fist. Ask patient to try to touch the pen with knuckles without losing balance. Note distance reached. If the patient is in a wheelchair, remove the arms of the chair).

( ) 4 Can reach laterally confidently > 10 inches
( ) 3 Can reach laterally >5 inches
( ) 2 Can reach laterally >2 inches
( ) 1 Reaches laterally but needs supervision
( ) 0 Loses balance while trying/ requires external support

8. **Turning to look behind over left and right shoulders while sitting**
Instructions: Turn to look directly behind you over your left shoulder. Repeat to the right. (Patient is seated with hands in lap. Examiner may identify an object directly behind the patient to encourage a complete turn of the trunk.)

( ) 4 Looks behind from both sides while shifting weight appropriately
( ) 3 Looks behind one side only other side shows less weight shift
( ) 2 Turns sideways only but maintains balance
( ) 1 Needs supervision when turning
( ) 0 Needs assist to keep from losing balance or falling

Medley A, Thompson M. Development, reliability and validity of the Sitting Balance Scale, *Physiotherapy Theory and Practice* 2011;27(7):471-481.

9. **Lateral bend to elbow in sitting**
   Instructions: While facing forward, bend sideways to your left until your forearm touches the clipboard and return to an upright position. Repeat to the right. (Place a clipboard level with the sitting surface. Patients with hemiplegia should perform this task to both sides)

   ( ) 4 Able to smoothly perform the motion bilaterally and return to midline
   ( ) 3 Able to perform 2/3 of the motion or difficulty returning to midline on one or both sides
   ( ) 2 Able to perform 1/3 of the motion or only performs unilaterally
   ( ) 1 Initiates motion, but requires assistance to go further
   ( ) 0 Unable to complete motion

10. **Sit to Stand Transfers**
   Instructions: Please stand up. Try not to use your hands for support.

   ( ) 4 Able to transfer safely with the minor use of hands
   ( ) 3 Able to transfer safely with verbal cuing and/or supervision
   ( ) 2 Able to transfer with assistance x 1
   ( ) 1 Able to transfer with assistance x 2
   ( ) 0 Unable to transfer or needs a lift

Note: On the following items have the patient sit unsupported on a 15"x15"x5" piece of foam to further evaluate sitting balance. Density should be such that when the patient sits on the foam, their balance is challenged but the foam should not be compressed all the way to the chair seat. The patient's feet should remain in weight bearing.

11. **Pick up an object from the floor while sitting unsupported on foam**
   Instructions: Pick up the slipper that is placed 3 inches in front of your toes. (Examiner should place the slipper on the floor 3 inches in front of the patient's toes.)

   ( ) 4 Able to pick up slipper safely and easily
   ( ) 3 Able to pick up slipper but needs supervision
   ( ) 2 Unable to pick up slipper but reaches 1-2 inches from slipper and keeps balance independently
   ( ) 1 Unable to pick up and needs supervision while trying
   ( ) 0 Unable to try/needs assistance to keep from losing balance or falling

Revised as of 8/23/02
Revised 9/24/03
Revised 10/26/04
Revised 06/02/05
Revised 05/01/06
Edited for consistent language 06/27/07
Revised 03/26/09 for final version

Medley A, Thompson M. Development, reliability and validity of the Sitting Balance Scale. *Physiotherapy Theory and Practice* 2011;27(7):471-481.

APPENDIX E

Function in Sitting Test

FIST Test Item ½ femur on surface; hips &knees flexed to 90° □Used step/stool for positioning & foot support		**Date:**	**Date:**	**Date:**
Randomly Administered Once	**Anterior Nudge**: superior sternum			
	Posterior Nudge: between scapular spines			
	Lateral Nudge: to dominant side at acromion			
Static sitting: 30 seconds				
Sitting, shake 'no': left and right				
Sitting, eyes closed: 30 seconds				
Sitting, lift foot: dominant side, lift foot 1 inch twice				
Pick up object from behind: object at midline, hands breadth posterior				
Forward reach: use dominant arm, must complete full motion				
Lateral reach: use dominant arm, clear opposite ischial tuberosity				
Pick up object from floor: from between feet				
Posterior scooting: move backwards 2 inches				
Anterior scooting: move forward 2 inches				
Lateral scooting: move to dominant side 2 inches				
TOTAL		/ 56	/ 56	/ 56
Administered by:				
Notes/comments:				

Scoring Key:
4 = Independent (completes task independently & successfully)
3 = Verbal cues/increased time (completes task independently & successfully and only needs more time/cues)
2 = Upper extremity support (must use UE for support or assistance to complete successfully)
1 = Needs assistance (unable to complete w/o physical assist; **document level: min, mod, max**)
0 = Dependent (requires complete physical assist; unable to complete successfully even w/physical assist)

APPENDIX F

Time Up and Go Test

Timed Up and Go (TUG) Test

Name:_____ MR: _____ Date:_____

1. Equipment: arm chair, tape measure, tape, stop watch.
2. Begin the test with the subject sitting correctly (hips all of the way to the back of the seat) in a chair with arm rests. The chair should be stable and positioned such that it will not move when the subject moves from sit to stand. The subject is allowed to use the arm rests during the sit – stand and stand – sit movements.
3. Place a piece of tape or other marker on the floor 3 meters away from the chair so that it is easily seen by the subject.
4. Instructions: "On the word GO you will stand up, walk to the line on the floor, turn around and walk back to the chair and sit down. Walk at your regular pace.
5. Start timing on the word "GO" and stop timing when the subject is seated again correctly in the chair with their back resting on the back of the chair.
6. The subject wears their regular footwear, may use any gait aid that they normally use during ambulation, but may not be assisted by another person. There is no time limit. They may stop and rest (but not sit down) if they need to.
7. Normal healthy elderly usually complete the task in ten seconds or less. Very frail or weak elderly with poor mobility may take 2 minutes or more.
8. The subject should be given a practice trial that is not timed before testing.
9. Results correlate with gait speed, balance, functional level, the ability to go out, and can follow change over time.

Normative Reference Values by Age

Age Group	Time in Seconds (95% Confidence Interval)	
60 – 69 years	8.1	(7.1 – 9.0)
70 – 79 years	9.2	(8.2 – 10.2)
80 – 99 years	11.3	(10.0 – 12.7)

Cut-off Values Predictive of Falls by

Group	Time in Seconds
Community Dwelling Frail Older Adults	> 14 associated with high fall risk
Post-op hip fracture patients at time of discharge[3]	> 24 predictive of falls within 6 months after hip fracture
Frail older adults	≥ 30 predictive of requiring assistive device for ambulation and being dependent in ADLs

Date	Time	Date	Time	Date	Time	Date	Time

APPENDIX G

Mini Mental State Examination

MMSE - Standardized Mini Mental Status Examination

ORIENTATION
What is the? Year? Season? Date? Day? Month? **/5**
Where are we? Country? State? Suburb? Street? Room? **/5**

REGISTRATION (1 point for each correct reply on the first attempt) **/3**
I am going to name 3 words. After I have said all 3, I want you to repeat them. (**BELL JAR FAN**)
Remember what they are because I am going to ask you to name them again in a few minutes.

Name the 3 words several more times (maximum 5 times) if needed, for the patient to report correctly.
(Record number of trials_____)

ATTENTION AND CALCULATION **/5**
Spell WORLD backwards (D L R O W)
or Serial sevens. Ask the patient to count backwards by 7 from 100 (100,93,86,79,72,65)
Stop after five answers (1 point for each correct answer) use higher of the 2 scores

RECALL
Do you recall the three words I asked you to remember?.....
(give 1 point for each correct answer) **/3**

LANGUAGE

What is this called? (show **WATCH** then **PENCIL**) **/2**
I'd like you to repeat a phrase after me: **"No ifs, ands, or buts**." **/1**

PAPERWORK

1. Have the patient read and do the following "Close your eyes" **/1**
2. Write any complete sentence (subject, object, verb). **/1**
3. Copy this design (intersecting pentagons) **/1**
4. Give pt. paper, ask them to take into their R/L hand, fold the paper in half once with both hands, and put the paper down on the floor**.** **/3**

MMSE SCORE ____/30

Additional: Draw clock, make it read '10 past 2'; (no points)

APPENDIX H

Barthel Index

Barthel Index of Activities of Daily Living

Instructions: Choose the scoring point for the statement that most closely corresponds to the patient's current level of ability for each of the following 10 items. Record actual, not potential, functioning. Information can be obtained from the patient's self-report, from a separate party who is familiar with the patient's abilities (such as a relative), or from observation. Refer to the Guidelines section on the following page for detailed information on scoring and interpretation.

The Barthel Index

Bowels
0 = incontinent (or needs to be given enemata)
1 = occasional accident (once/week)
2 = continent
Patient's Score: _____

Bladder
0 = incontinent, or catheterized and unable to manage
1 = occasional accident (max. once per 24 hours)
2 = continent (for over 7 days)
Patient's Score: _____

Grooming
0 = needs help with personal care
1 = independent face/hair/teeth/shaving (implements provided)
Patient's Score: _____

Toilet use
0 = dependent
1 = needs some help, but can do something alone
2 = independent (on and off, dressing, wiping)
Patient's Score: _____

Feeding
0 = unable
1 = needs help cutting, spreading butter, etc.
2 = independent (food provided within reach)
Patient's Score: _____

(Collin et al., 1988)

Transfer
0 = unable – no sitting balance
1 = major help (one or two people, physical), can sit
2 = minor help (verbal or physical)
3 = independent
Patient's Score: _____

Mobility
0 = immobile
1 = wheelchair independent, including corners, etc.
2 = walks with help of one person (verbal or physical)
3 = independent (but may use any aid, e.g., stick)
Patient's Score: _____

Dressing
0 = dependent
1 = needs help, but can do about half unaided
2 = independent (including buttons, zips, laces, etc.)
Patient's Score: _____

Stairs
0 = unable
1 = needs help (verbal, physical, carrying aid)
2 = independent up and down
Patient's Score: _____

Bathing
0 = dependent
1 = independent (or in shower)
Patient's Score: _____

Total Score: _____

Scoring:

Sum the patient's scores for each item. Total possible scores range from 0 – 20, with lower scores indicating increased disability. If used to measure improvement after rehabilitation, changes of more than two points in the total score reflect a probable genuine change, and change on one item from fully dependent to independent is also likely to be reliable.

Sources:

- Collin C, Wade DT, Davies S, Horne V. The Barthel ADL Index: a reliability study. *Int Disabil Stud*. 1988;10(2):61-63.
- Mahoney FI, Barthel DW. Functional evaluation: the Barthel Index. *Md State Med J*. 1965;14:61-65.
- Wade DT, Collin C. The Barthel ADL Index: a standard measure of physical disability? *Int Disabil Stud*. 1988;10(2):64-67.

Guidelines for the Barthel Index of Activities of Daily Living

General

- The Index should be used as a record of what a patient ***does***, NOT as a record of what a patient ***could do***.
- The main aim is to establish degree of independence from any help, physical or verbal, however minor and for whatever reason.
- The need for supervision renders the patient not independent.
- A patient's performance should be established using the best available evidence. Asking the patient, friends/relatives, and nurses will be the usual source, but direct observation and common sense are also important. However, direct testing is not needed.
- Usually the performance over the preceding 24 – 48 hours is important, but occasionally longer periods will be relevant.
- Unconscious patients should score '0' throughout, even if not yet incontinent.
- Middle categories imply that the patient supplies over 50% of the effort.
- Use of aids to be independent is allowed.

Bowels (preceding week)

- If needs enema from nurse, then 'incontinent.'
- 'Occasional' = once a week.

Bladder (preceding week)

- 'Occasional' = less than once a day.
- A catheterized patient who can completely manage the catheter alone is registered as 'continent.'

Grooming (preceding 24 – 48 hours)

- Refers to personal hygiene: doing teeth, fitting false teeth, doing hair, shaving, washing face. Implements can be provided by helper.

Toilet use

- Should be able to reach toilet/commode, undress sufficiently, clean self, dress, and leave.
- 'With help' = can wipe self and do some other of above.

Feeding

- Able to eat any normal food (not only soft food). Food cooked and served by others, but not cut up.
- 'Help' = food cut up, patient feeds self.

Transfer

- From bed to chair and back.
- 'Dependent' = NO sitting balance (unable to sit); two people to lift.
- 'Major help' = one strong/skilled, or two normal people. Can sit up.
- 'Minor help' = one person easily, OR needs any supervision for safety.

Mobility

- Refers to mobility about house or ward, indoors. May use aid. If in wheelchair, must negotiate corners/doors unaided.
- 'Help' = by one untrained person, including supervision/moral support.

Dressing

- Should be able to select and put on all clothes, which may be adapted.
- 'Half' = help with buttons, zips, etc. (*check!*), but can put on some garments alone.

Stairs

- Must carry any walking aid used to be independent.

Bathing

- Usually the most difficult activity.
- Must get in and out unsupervised, and wash self.
- Independent in shower = 'independent' if unsupervised/unaided.

(Collin et al., 1988)

APPENDIX I

Functional Independence Measure

Functional Independence Measure (FIM) Instrument

	ADMISSION	DISCHARGE	FOLLOW-UP
Self-Care			
A. Eating			
B. Grooming			
C. Bathing			
D. Dressing - Upper Body			
E. Dressing - Lower Body			
F. Toileting			
Sphincter Control			
G. Bladder Management			
H. Bowel Management			
Transfers			
I. Bed, Chair, Wheelchair			
J. Toilet			
K. Tub, Shower			
Locomotion			
L. Walk/Wheelchair			
M. Stairs			
Motor Subtotal Score			
Communication			
N. Comprehension			
O. Expression			
Social Cognition			
P. Social Interaction			
Q. Problem Solving			
R. Memory			
Cognitive Subtotal Score			
TOTAL FIM Score			

LEVELS	**Independent** 7 Complete Independence (Timely, Safely) 6 Modified Independence (Device)	**NO HELPER**
	Modified Dependence 5 Supervision (Subject = 100%+) 4 Minimal Assist (Subject = 75%+) 3 Moderate Assist (Subject = 50%+) **Complete Dependence** 2 Maximal Assist (Subject = 25%+) 1 Total Assist (Subject = less than 25%)	**HELPER**
Note: Leave no blanks. Enter 1 if patient is not testable due to risk.		