Inter- and intra-rater reliability of the Mini-Balance Evaluation Systems Tests (Mini-BESTest) in adults with stroke

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Forord

Det har vært både spennende og meget lærerikt å kunne fordype seg i eget fagfelt på denne måten. Håper også at andre kan dra nytte av funnene fra studien i ettertid.

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Til slutt, en stor takk til Somnath for tålmodighet gjennom denne tiden.

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Stine Susanne Haakonsen Dahl

CONTENTS

SAMMENDRAG

Bakgrunn: Mini-Balance Evaluation Systems Test (Mini-BESTest) er et nytt og lovende måleinstrument for undersøkelse av dynamisk balanse. Intra-rater (når samme person skårer testen ved to eller flere anledninger) og inter-rater (når to eller flere personer skårer testen ved samme anledning og disse skår sammenliknes) reliabilitet av Mini-BESTest anvendt på voksne med hjerneslag er ikke vurdert. Intra- og inter-rater reliabilitet bør undersøkes før måleredskapet implementeres i behandling og rehabilitering av voksne med hjerneslag. **Hensikt:** Vurdere intra- og inter-rater reliabilitet av Mini-BESTest anvendt på voksne personer med hjerneslag. **Design:** Metodestudie som undersøker intra- og inter-rater reliabilitet. **Metode:** Tretti voksne personer, hvorav tjuefem med hjerneslag og fem uten, ble inkludert på bakgrunn av seks ulike nivåer av gangfunksjon. Deltakerne ble filmet mens de utførte Mini-BESTest. Tre testere skåret filmopptakene ved to anledninger med fire ukers mellomrom. For utregninger av relativ reliabilitet av totalskår på Mini-BESTest ble Intraclass correlation coefficient ($ICC_{1.1}$ and $ICC_{3.1}$) anvendt. For absolutt reliabilitet ble Bland-Altman plots, within-subject standard deviation (s_w) og smallest detectable difference (SDD) anvendt. For utregninger av reliabilitet for hver av deloppgavene på testen, ble Cohens kappa (*k*) og prosentvis enighet anvendt. **Resultater**: Både undersøkelse av intra- og inter-rater reliabilitet av totalskår viste veldig høy relativ reliabilitet (ICCs≥.98) og absolutt reliabilitet (enighet i skåring vist i Bland-Altman plots, og lave s_w- og SDD verdier). Kappaverdier for de ulike deloppgavene var mellom 0.33-1.00, hvorav flesteparten (intrarater=95.6%, interrater=73.4%) viste veldig god eller god enighet (*k*≥.63). Bare en oppgave (interrater=2.2%) viste nokså god enighet (*k*=33). **Begrensinger:** Personer med store kognitive utfall ble ikke inkludert og resultatene kan dermed ikke generaliseres til denne gruppen. **Konklusjon:** Studien viser veldig høy intra- og inter-rater reliabilitet av Mini-BESTest anvendt på personer med hjerneslag. Flesteparten av testens deloppgaver viste veldig god eller god reliabilitet, noen middels god og en oppgave nokså god enighet.

Nøkkelord: Intra- and inter-rater reliabilitet, balanse, måleinstrument, Mini-BESTest, hjerneslag

ABSTRACT

Background: Mini-Balance Evaluation Systems Test (Mini-BESTest) is a new and promising measure for evaluation of dynamic balance, but intra- and inter-rater reliability in individuals with stroke have not yet been examined. **Objective:** The aim of this study was to assess the within raters' (intra-rater) and between raters' (inter-rater) reliability of the Mini-BESTest in adults with stroke. **Design:** Measurement study of intra- and inter-rater reliability. **Methods:** Thirty adults, twenty-five with stroke and five without were strategically recruited according to six different ambulatory levels. Mini-BESTest performance of participants were filmed and then scored by three raters twice, with four weeks between the sessions. For total scores on the Mini-BESTest, relative reliability was investigated for by calculating Intraclass correlation coefficients ($ICC_{1.1}$ and $ICC_{3.1}$). Absolute reliability was investigated for by calculating Bland-Altman plots, within-subject standard deviation (s_w) and smallest detectable difference (SDD). For individual items, Cohen's kappa (*k*) and percentages agreement were calculated. **Results**: For both intra- and inter-rater assessments very high relative reliability (ICCs≥.98) and absolute reliability (agreement of scores in Bland-Altman plots, and low s_w and SDD) of the Mini-BESTest total score were shown. Kappa values for the individual items ranged between 0.33-1.00. The majority of items (intra-rater=95.6%, inter-rater=73.4%) showed very good or good agreement (*k*≥.63). Only one item (inter-rater=2.2%) showed fair agreement (*k*=.33). **Limitations:** Results should not be generalized to individuals with major cognitive impairments, as they were not included in this study. **Conclusions:** This study shows a very high intra- and inter-rater reliability of the Mini-BESTest in adults with stroke. The majority of the individual items showed very good or good agreement, some moderate and one item fair agreement.

Key words: Intra- and inter-rater reliability, balance, balance measure, Mini-BESTest, stroke

1. INTRODUCTION

1.1 Background of this study

Stroke is defined as "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death, with no apparent cause other than of vascular origin" (1). Each year 15000 people in Norway suffer from a new stroke, leaving stroke as the third most frequent cause of death and a major factor contributing to functional disabilities among people in Norway (2).

The causes of stoke include cerebral infarction (85 %), intracerebral hemorrhages (10 %) and subarachnoids hemorrhages (5 %) (3). The effects of a stroke on motor function for the individual, depend on which part of the brain is injured and how severely it is affected (3). However, age, pre-morbid status and secondary developed impairments may also influence the motor function after a stroke (4). Lesions affecting the anterior or middle cerebral arteries commonly associated with muscle weakness and sensory impairments (sensorimotor impairments) on the opposite side to the lesion (hemiparesis). Lesions affecting the posterior circulation (brainstem or cerebellar stroke) commonly results in more bilateral effects impairing mainly coordination and postural control (3).

Balance disorders are a frequent effect of stroke, in both individuals with hemiparesis and individuals with brainstem- or cerebellar stroke (5). Balance impairments may persist from the acute phase throughout the lifespan (6) and have been associated with low ambulatory function and an increased risk of falling (7). Moreover, mobility limitations after a stroke can lead to reduced self-efficacy, loss of independence and restrictions in daily activities for the individual affected (6, 8). Stroke ay also affect relatives, and health care professionals and is a huge economic cost for the society (5). Because of the negative impacts of reduced balance, it is important for Physiotherapists to be able to provide a comprehensive assessment of balance in individuals with stroke (5).

Standardized clinical measures are key features in the assessment of balance, as to evaluate, direct treatment and predict outcome (9). While there are many measures assessing the degree of balance disorders as well as being associated with falls prediction, there is a lack

of measures differentiating between the various subsystems for balance control in individuals with stroke (6, 8, 10, 11). Another limitation of current measures is the lack of sensitivity for individuals with stroke that have only mild balance deficits (10, 11).

This has led many clinicians, including myself, to use numerous measures in assessing the complexity of balance problems presented in individuals with stroke. Using multiple measures can be time consuming, as well the validity of the results may be questioned when different tests are interpreted together. After having attended a course on the Mini-BESTest, I have tried it out in my clinical work in stroke rehabilitation. So far I have found it a promising measure, as it seems to targets a diversity of balance disorders after stroke even in those with mild balance problems.

The Mini-Balance Evaluation Systems Test (Mini-BESTest) is a newly developed measure for evaluation of dynamic balance and is intended to be used for a variety of balance disorders including stroke (12). In particular as this measure adheres to current theoretical perspective on balance, by assessing multiple systems of balance as well as potentially being able to differentiate among them to specifically direct treatment, Mini-BESTest has been put forward as unique and promising measure (10, 12, 13). However, inter- and intra-rater reliability of the Mini-BESTest have not previously been investigated in individuals with stroke and this needs to be done to confirm its usefulness in this population (10, 12, 13).

The purpose of this study was to contribute in the evaluation of the usefulness of Mini-BEST in individuals with stroke, by assessing intra- and inter-rater reliability of the measure.

1.2 Outline of the thesis

The manuscript “Intra- and inter-rater reliability of the Mini-Balance Evaluation Systems Test (Mini-BESTest) in individuals with stroke” is considered the main part of this thesis, and is included as chapter 10. The plan is to submit the manuscript for publication as an article in the American journal *Physical Therapy*, thus the format complies with the format required for this journal (as described in the appendix: Information for authors). It is

recommended that the manuscript is read prior to reading the reminder of the thesis, as the these chapters are meant to expand on aspects described in the manuscript.

In chapter 2 of this thesis, theoretical perspectives of motor control and balance in specific relation to stroke are described. A section on clinical balance measures and a review of current research on measures of balance in individuals with stroke follows. Mini-BESTest is described in the last section of chapter 2. The aim of the study is described in chapter 3. In chapter 4, aspects of the methodology and method used in this study are discussed. A summary of the main results, in addition to supplementary results are provided in chapter 5. In chapter 6 some aspects of the results, the method used and validity of this study are discussed. Chapter 7 and 8 includes conclusions and suggestions for further research, respectively.

2. THEORETICAL PERSPECTIVE

2.1 Motor control

The nature of movement is often referred to as *motor control* (4), defined as " the ability to regulate or direct the mechanisms essential to movement" (4, p.4). In Neurological Physiotherapy the *dynamic systems approach* is the most extensively used theoretical perspective of motor control (4, 14-16) and it is the theoretical perspective for how movement is viewed in the present study. This perspective encompasses that motor control arises from interactions of the individual, the task and the environment (4). Within the individual, both cognitive, perceptual and sensorimotor processes must be considered (4). Abnormal movements, as in balance disorders, are assumed to result from impairment within one or more of the systems controlling movement. For individuals with stroke, impairments may arise from the primary lesion in the central nervous system (CNS) as well as secondary developed adaptations in the neurological or the musculoskeletal systems (4, 15). Although multiple systems and their interactions must be considered, assessment of individual systems independently may be necessary in order to achieve the highest possible understanding of motor control (4). The knowledgebase is considered dynamic, adhering to current evidence in the field of motor control, motor learning and rehabilitation sciences (4).

However, it is argued that there are limitations to this perspective on motor control (17, 18). Essential knowledge concerning *holistic* and qualitative aspects of movement may be lost, in allowing for reduction of movements to observable and measurable sizes, as well as summation of individual systems to form *the whole movement* (17). In order to acquire knowledge about movement in a more *holistic* manner, a phenomenological perspective could have been used (19). According to this perspective, movement is inseparable from the individual, and the individual's being in the world. Movement is viewed as a constitution of the consciousness, where the intentionality of the subject is imperative to how the movement is understood (18, 19). Therefore using a phenomenological perspective to assess aspects of movement would likely reveal different results than when using the dynamic systems perspective. Furthermore, this exemplifies the importance of being aware of the theoretical

perspective applied, as this will determine what knowledge can be acquired and how it can be evaluated and contextualized (20).

2.2 Balance and postural control

Although there is a general agreement within the field of Neurological Physical therapy that balance is a requirement for functional movements, there are no universally accepted definition of balance, and terminology such as balance, postural control and equilibrium reactions are often used interchangeably (15, 16, 21-23). The definitions of postural control and balance by Shumway-Cook & Wollacott (2007) are commonly used. This definition involves that *postural control* is the control of body position in relation to the task and environment, for the purpose of both orientation and stability (22). *Postural orientation* is understood as active control of bodily segments and muscle tone in relation to gravity, base of support[1], visual environment, and internal models[2]. *Postural stability* on the other hand, is seen as synonymous with *balance* and is involved with coordination of sensorimotor strategies to control centre of mass (COM)[3] over its limits of stability[4] during self-initiated and externally-caused perturbations (22). For all functional tasks, both a component of stability and of orientation is required. As the present study is concerned with assessment of the measure Mini-BESTest, which is described as a measure for evaluation of *dynamic balance* performance, *dynamic balance* is the main focus in this thesis.

Balance is no longer seen as a summation of simple reflexes to regain equilibrium, but as a complex skills based on interactions of multiple body systems in relation to the task and environment (14). Traditionally, balance has been divided into *static* and *dynamic* balance. Static balance involves sitting or standing quietly, where the base of support remains unchanged (22). Dynamic balance involves perturbed stance, transfers and gait, where the

[1] ”The *base of support* is defined as the area of the body that is in contact with the support surface” (22, p.158).
[2] *Internal models* are considered models where information from multiple networks in the brain about requirements for functional tasks are saved (25).
[3] ”The *Centre of mass* is defined as the point that is at the centre of the total body mass... it is believed to be the variable that is controlled by the postural control system” (22, p.158).
[4] ”*Stability limits* are considered the boundaries within which the body can maintain stability without changeing base of support” (22, p.160)

base of support is changing (22, 24). Although this terminology may be appropriate in order to describe different types of balance task the resources required to remain stable, the use of the words *dynamic* and *static* may be misleading as there will always be some degree of movement involved in controlling balance (22). Neural networks of sensorimotor, perceptual and cognitive systems are all essential for balance control, however biomechanical factors such as joint ranges of movement, muscular properties and alignment between bodily segments will also influence balance control (25, 26). However, as impairment within a biological system may not lead directly to functional loss, resources needed for balance control also referred to as *subsystems* of balance are described (14). These subsystems are: *movement strategies, sensory modalities and integration, cognitive processing*, *control of dynamics*, *biomechanical constraints* and *verticality,* (8, 14, 26). Of these subsystems, the first four are commonly considered to adhere closest to the construct dynamic balance. The subsystems of balance control in specific relation to common balance disorders after stroke are explained below.

2.3 Balance in individuals with stroke

Balance disorders in individuals with stroke represents a wide range of interacting impairments and functional disabilities (6, 8, 10, 27). Common balance disorders in individuals with stroke have been described in several literature reviews (6, 8, 10), and some are considered below in relation to different subsystems of balance.

2.3.1 Movement strategies

Movement strategies in balance control are described as: *reactive, anticipatory* and *voluntary* strategies (14, 15, 22). *Reactive* strategies are concerned with returning the body to equilibrium when challenged by self-induced or external perturbations (14, 22). Postural reactions in standing are extensively investigated and are typically described as stereotyped strategies varying according to the size of perturbation and the response required (14). The ankle- and hip strategies are small enough to keep the feet in place by moving centre of mass around the ankles and hips respectively. In responding to larger perturbations were the base of support has to be changed, a stepping- or reaching strategy are required (14, 22). Studies have shown that individuals with stroke tends to use the stepping and reaching strategies

even in response to small perturbations, and that their strategies are less stereotyped compared to healthy controls (8). *Anticipatory* strategies involve adjustments to maintain equilibrium prior to or during voluntary movements (22). As these strategies depends on the capability of the central nervous system to predict and detect instabilities, in order to program and activate appropriate muscle synergies (8), internal models are particularly important in anticipatory control of balance. Disturbed sensory input as from a hemiparetic limb, may influence its representation in internal models leading to reduced anticipatory postural adjustments (25). Uncoordinated or delayed anticipatory adjustments can be observed as increased sway in transfer from sit to stand and during single arm raise after stroke (6). In the literature reduced anticipatory reactions are commonly described in the hemiparetic side (6, 8). However, as the neural tracts responsible for activation of axial muscles (an important part of anticipatory strategies) also run ipsilateral to the brain lesion, anticipatory control of the "unaffected side" may also be reduced in individuals with stroke (25). If anticipatory strategies are reduced, individuals with stroke tend to compensate with reactive- and fixating strategies (15). *Voluntary* movement strategies may also be used in balance control, particularly in adapting to the specific requirements of the task and the environment (27). In individuals with stroke, the demand on voluntary movement strategies for balance control may be enhanced due to lost or reduced ability to use the more automatic responses (15, 27). This related to the reduction in movement speed that is reported in individuals with stroke and may further lead to an increased risk of falls (6).

2.3.2 Sensory modalities and integration

Afferent information from somatosensory, visual and vestibular systems must be adequate and integrated for balance control in complex environment (14, 22). While healthy adults tends to rely most on information from the somatosensory system, it has been shown that adults with stroke tends to rely more on vision (6) and showing decreased balance complex environments as in the dark and when walking on uneven surfaces (8). This may be explained by impairments in the somatosensory system, which are frequently occur due to a stroke (3). Additionally, a correlation between reduced ankle proprioception and impaired dynamic balance has been reported in individuals with stroke (8).

2.3.3 Cognitive processing

Cognitive resources are required for balance control, and the more difficult the balance task is, the greater the demand on cognitive resources (14). Moreover, the demand on cognitive resources associated with balance control appears to be higher in adults with stroke compared to control (28). Additionally, cognitive processing and balance control share attention resources, thus reduced balance may reduce the ability to perform an additional task and vice versa (8, 14).

2.3.4 Control of dynamics

Walking and transfers from one position to another requires complex balance skills as it involves controlling a moving COM within a changing base of support (29). Additionally, walking and changing from one position to another require COM to be moved outside the base of support (29). Walking competency involves the ability to progress in a straight line as well as turning and stepping in multiple planes and adjusting to perturbations (10). Thus, the balance disorders presented in individuals with stroke during walking and transfers are complex and variable In individuals with hemiparesis, instability is particularly observed when the COM is moved outside the base of support during single-leg stance of gait (6, 15). This may be due to reduced sensorimotor stability as well as lack of propulsive forces and reduced speed affecting the ability to step forward to catch balance (6). Individuals with brainstem or cerebellar lesion show instability when turning due to the vestibular system being affected by the stroke (29).

2.3.5 Biomechanical constraints

Biomechanical constraints on balance involve mainly the base of support, postural alignment, and hip and ankle muscle weakness (14, 27). Asymmetrical weight bearing due to hemiparesis, will change reduce the base of support, challenging the limits of stability and ability to maintain balance. Furthermore, biomechanical constraints as lower limb weakness or stiffness are common impairments after stroke that may reduce the ability to use ankle strategy or hip strategy for regaining equilibrium (27).

2.3.6 Verticality

Verticality involves the ability to orient the body with respect to gravity, base of support, visual environment and internal references (14). Studies have shown that *visual perception of verticality*[5] is independent of *postural perception of verticality*[6] (14). In individuals with stroke, and particularly those presenting with visospatial neglect and contraversive pushing syndrome, postural perception of vertical have been reported to be abnormal meanwhile visual perception of verticality were normal (30). If postural perception of vertical is abnormal, the person will not automatically align with gravity and will therefore be unstable (14).

Considering the variety of balance disorders reported in adults with stroke, assessment of balance must comprehensive both for diagnostic and therapeutic purposes (23).

2.4 Clinical balance measures

Clinical balance measures are important components in the assessment of balance in individuals with stroke (15, 22). In this context, the term *assessment* is used to describe a number of processes employed in order to gain information about a persons balance (15, 31, 32). The term *measure* is used to describe tools that systematically differentiate balance or aspects of balance according a standard "unit". (33). Depending on whether this "unit" constitutes names, numeral or numbers, the scale on a measure will be *nominal*, *ordinal*, *interval* or *ratio* (33). A nominal scale involves classification of categories without placing the categories in an order or rank, while an ordinal scale provides classifications of categories and in addition place them in an order or rank (33). Interval scales provide numbers that have the same properties of order and distance as real-numbers, however, they lack a meaningful origin in which ratio scales have (33). A measure is describes as an *outcome measure* when it is associated with the result of an intervention of some kind (32).

The use of measures in assessing bodily functions adheres to the quantitative research paradigm and its scientific and philosophical roots, which is described in chapter 3 of this

[5] *Visual perception of vertical* is the ability to orient a line to gravity in the dark (14, 30).
[6] *Postural perception of vertical* is the ability to align to gravity without vision (14, 30).

thesis. Balance measures are used to evaluate, discriminate and predict (9), Thus measures are considered an important part of the clinical reasoning process (15, 28) and in the practice of evidence based physiotherapy (34). The use of measures are also reported to provide a shared understanding and facilitate communication between different health professionals in neurological rehabilitation (35). However, as mentioned earlier in this chapter, the reduction of qualitative aspects of motor control may be problematic. The problems may in particular arise when information obtained from measures are considered the only valid information about a phenomenon (17). Thus it is argued that how the information from measures is weighted in neurological physiotherapy varies in the literature (15, 16, 28) Assessment of the quality properties of measurement tools is covered in chapter 4.

Some balance measures only include one task to be measured (single-item measures) while some measures include several tasks (multi-item measures) where individual items are summated to give a total score (9). Mini-BESTest is a multi-item measure. Mini-BESTest is described in the last section of this chapter.

2.5 Clinical balance measures in individuals with stroke

There are several measures aiming to assess standing- and walking balance in individuals with stroke (10, 23, 28, 36). Studies have revealed that Berg Balance Scale (BBS) is the most commonly used measure for balance assessment in individuals with stroke both in Norway and worldwide (11, 37). BBS is a multi-item ordinal measure that assesses balance performance in sitting and standing, and was originally developed for elderly people, but has later been proven both reliable and valid for use in stroke populations (11, 38). However, as highlighted in a recent systematic review of BBS in individuals with stroke, limitations of the measure are floor- and ceiling effect and low validity for dynamic balance (11). BBS and most balance tests are mainly concerned with assessing the degree of the balance disorder and some are also shown to be able to predict functional outcomes and fall (6, 23, 38, 39). However, recent reviews concerning balance in the field of stroke rehabilitation have put forward a need for new and improved clinical balance measures (6, 8, 10). In particular, there is a need for measures adhering to current views on motor control in the importance of

assessing multiple systems that may contribute to poor balance, in order to be able to direct specific treatment (6, 8, 10).

2.6 Mini-BESTest

Mini-BESTest is a multi-item clinical balance measure for evaluation of the construct *dynamic* balance. It was developed for use in a wide range of balance disorders including individuals with stroke (12). Mini-BESTest adheres to the dynamic systems theory perspective on motor and balance control, and is described as evaluating four subsystems of balance; *anticipatory postural adjustments*, *postural responses*, *sensory integration* and *stability during gait*. The measure consists of 14 individual items on an ordinal scale of 0-2, were 0 is worst performance, 1 is moderate and 2 is best performance. The individual items are added to a sum score. The mini-BESTest was developed from the Balance Evaluation Systems Test (which is described in below) by removal of insensitive and redundant items in order to improve the test. In developing the Mini-BESTest, aspects of validity (content and internal construct validity) and reliability (internal consistency reliability) were assessed and the results were reported as very good (12). Reliability of the Mini-BESTest has been investigated in adults with Parkinson's disease, showing a very high inter-rater (ICC2.1=0.91) and a very high test-retest reliability (ICC2.1=0.92) (24). To the author's knowledge, there is only one published study that examines the Mini-BESTest specifically on a stroke population. This a pilot study of 9 individuals with stroke that provided a Swedish translation of the Mini-BESTest as well as evidence of high concurrent validity compared with BBS (rs=0.86, p=0.003) and the Timed "Up & go" test (rs=0.89, p=0.001) (13).

Balance evaluation systems test (BESTest) is a comprehensive measure developed from several established balance measures; Berg balance scale (38), Dynamic gait index (40), Clinical test of sensory integration of balance (41, 42), Freglys single-stance test (43), Performance-oriented mobility assessment (44), Push and release (45), and Timed "Up and go" test (26) and Timed "Up and Go" with a simultaneous cognitive task (46). BESTest provides assessment of six subsystems of balance: These subsystems are biomechanical constraints, stability limits/verticality, Anticipatory postural adjustments, postural responses,

sensory orientation and stability in gait. Each of the individual items are scored on a 4-point scale from 0-3 and each subcategory as well as a total score can be summated (26). BESTest has shown high inter-rater reliability (ICC=.91), correlation with self-reported balance function as measured with Activities-specific Balance Confidence Scale (47) (r=.636, P<.01) assessed on adults with a variety of balance problems (26). In individuals with Parkinson disease (PD) both test-retest (ICC=.88) and inter-rater reliability (ICC=.96) are high, and is more sensitive than BBS and Functional Gait Assessment (48) in falls prediction (49). However, its feasibility in clinical practice is limited as it takes approximately 35 min to complete the test. Thus Mini-BESTest was developed (12).

There is a need for studies that assess the reliability of the Mini-BESTest for evaluation of balance after stroke (10, 12).

3. THE AIM OF THE STUDY

The aim of this study was to examine the within rater (intra-rater) and between raters (inter-rater) reliability of Mini-BESTest for assessment of dynamic balance in individuals with stroke. The research question was: The research question was: - is the Mini-BESTest used within raters and between raters a reliable measure in individuals with stroke?

4. METHODOLOGICAL AND METHODICAL CONSIDERATIONS

This chapter includes methodological and methodical considerations related to this study. The *methodology* compromises theoretical considerations of what reality is (ontology), and what constitutes knowledge and how to acquire knowledge (epistemology) (20). The *method* is the procedures used in the collection and analysis of the data in this study (20). Issues concerning the methodology are mainly considered in the description of the research paradigm, while the method is considered throughout this chapter.

4.1 Quantitative research paradigm

This study is based on a quantitative research paradigm. The term *quantitative* comes from the emphasis on measurement, which is central within this paradigm (50). The paradigm has its roots in ancient and medieval natural philosophy and particularly the development of physics and mathematics. However it was particularly developed as a paradigm within the philosophical positions of empiricism and positivism in the 1700-1900s (20, 50). Traditionally the quantitative research paradigm has been based on some common assumptions; 1) a single objective reality that can be determined of systematic measurement and observation, 2) independence of the researcher and participants where the researcher is considered an neutral and objective observer of the area of interest, 3) the results from one study can be generalized to other individuals, settings and times, 4) causes and effects can be determined and be differentiated from one another, 5) providing value free results by controlling for potentially confounding variables and eliminating the influences made by the researcher (50, 51).

Controlling for *systematic errors* and *confounding factors* are considered important aspects of quantitative research (52). Systematic errors are considered limitations in the design and/or the conduction of the study, in which cause errors to occur consistently throughout the study (52). Confounding factors are other variables than those studied, that can possibly influence the result (52). Systematic errors and confounding variables are closely related to the quality criteria for evaluation of quantitative research: reliability, validity and

generalizability (50). These are explained later in this chapter. In this study attempts were made to control for both systematic errors and confounding factors by choosing a design matching the research question, and by using a highly standardized method (51). The design and the procedures used are further explained in the next sections. Although attempting to control for systematic errors and confounding factors possibly influencing the results, it is acknowledged that completely neutral and objective data is impossible (17, 53). In the present study, it is considered that preconceptions and knowledge of the author may have influenced both the design and the conduction of the study. Additionally, variations in the raters experience before, during and after the scoring procedures, may have affected the performance of the rating (17).

4.2 Measurement study

This study is a measurement study of inter- and intra-rater reliability, which is within the field of methodological research. The purpose of methodological research is to document and improve clinical and research measures (33). The characteristics of interests in a methodological study are often referred to as *psychometric properties,* which are certain criteria that are required for any measurement tool. Psychometric properties are primarily described as *reliability* and *validity*, (31), however, *floor- and ceiling-effect, responsiveness, sensitivity to change feasibility, cost* and *language* are characteristics that also should be considered in deciding the usefulness of the measure (31, 33). The method used to examine a measure is influenced by the level of data produced by the measure (52). As described in chapter 2 under *Clinical balance measures,* data can be on a *categorical*, *ordinal*, *interval* and *ratio* level. It is recommended that the psychometric properties of a measure are examined prior to implementing the measure in clinical and research practice (9).

As it has been shown that the individual items on the Mini-BESTest can be summated to give a total score (12), inter- and intra-rater reliability could be assessed (31, 54). The terms reliability, validity and floor- and ceiling-effects are explained below.

4.3 Reliability

Reliability is about the consistency, stability and accuracy of measurements (31, 33, 54). When repeated scoring of the same phenomenon give equal to or the same results, the measure is reliable. The assumption is that the higher degree of reliability, the higher the probability the results are not caused by chance or measurement error. If reliability is poor, data obtained from the measure cannot be trusted and the measure is invalid. Thus assessment of reliability of the Mini-BESTest is recommended prior to further assessment of other psychometric properties, as for example validity (9, 54).

However, different interpretations of the term reliability exist. Carter and colleagues (2011) describe two theories of reliability: *the classical measurement theory* and *the generelizability theory* (33). According to the classical measurement theory, every measurement or score have a true value. The relationship in scores between repeated measurements of a person is used to estimate the true score of that individual. All variability in scores is assumed to be caused by error, thus the measurement is said to be reliable if the error is small (33). This theory has been extended to the generalizability theory, which recognizes several sources of variability in a measure. The variables that need to be considered when assessing the reliability of a measure are mainly attributed to the instrument (the measure), intra-subject components (the participants), intra-rater (within raters) and inter-rater (between raters) (33, 54).

4.3.1 Assessment of intra- and inter-rater reliability

The scores on ordinal measures as the Mini-BESTest, are particularly vulnerable from being influenced by the rater (s), as scoring involves the raters subjective judgments in assessing qualitative aspects of motor behavior (23). In clinical practice and research, scores on balance measures assigned by the same rater at different times or scores assigned by different raters, are commonly compared. Thus inter- and intra-rater reliability of a measure needs to be assessed (54, 55). Inter-rater reliability is " the consistency of performance among different raters or judges in assigning scores to the same subject or response" (55, p.152). Intra-rater reliability is defined as " the consistency with which one rater assigns scores to a single set of responses on two occasions" (55, p.140). Inter- and intra-rater reliability should be differentiated from test-retest reliability. Test-retest reliability involves

assigning scores of a group of participants performing the test at two different occasions in time, and is therefore also subject to variability in the participants performance and the measure that is being used (33).

As this study is concerned with assessing inter- and intra-rater reliability, attempts are made to eliminate that any variability in The-MiniBESTest (instrument) or in the performance of the participants (intra-subject) are influencing the results. This is done by using a highly standardized procedure of filming the Mini-BESTest performance of the participants being examined by the same person, using the same instructions and equipments, as well as ensuring that training- and scoring procedures were equal for all raters. In this study a highly standardized approach were used to be able to assess the upper limits of inter- and intra-rater reliability of the Mini-BESTest (33). As this method attempts to control for confounding factors it is also the choice of method if the results of this study are to be generalized to a wider population than the population that was studied (51).

When designing a reliability study selecting appropriate participants is important of two main reasons (33): First of all, the reliability should be tested on the population that the measure is going to be used on. Thus in this study of reliability of Mini-BESTest in individuals with stroke, individuals with stroke were included. Furthermore, these individuals presented with a wide range of characteristics in terms of age, sex, type of stroke, time since the stroke and effects from the stroke. This variability in the sample is considered to broaden the external validity of the results (50). Secondly, reliability should be assessed over the full range of possible scores. This is to enable use of appropriate statistical methods such as calculations of ICC and Kappa (which are described later in this chapter) and because the reliability may vary at different points in the range of scores (33). Thus the participants in this study were recruited based on a strategic sampling procedure. The participants were recruited based on ambulatory levels measured with Functional Ambulation Classification of the Hospital of Sagunto (FACHS). This measure was chosen because it describes 5 different levels of ambulation that were appropriate for individuals in this study and because good properties of validity and reliability in individuals with stoke have been reported (56, 57). Additionally, FACHS was considered a feasible measure for purpose of separating individuals into different levels. Six individuals without stroke were

also included in this study. This was to ensure that the highest scores on the Mini-BESTest could be assessed.

Both *relative* and *absolute* reliability should be reported when assessing reliability (33, 54). Relative reliability examines the relationship between two or more variables on repeated measurements and is commonly assessed with a correlation coefficient were a correlation of 1.0 indicates perfect association between the measurements (54, 58). *Absolute reliability* examines the extent to which a score varies on repeated measurements and is reported in units of the scale applied (33). Absolute reliability is often referred to measurement error. Calculation of within-subject standard deviation (s_w) is the recommended statistical method for assessment of absolute reliability in balance measures (54). Intraclass correlation coefficients and within-subject standard deviation are described in further details under the section Statistical methods.

4.4 Validity

Validity is concerned with qualities as meaningfulness and usefulness (33, 52, 54). Validity should be considered as properties associated with the results obtained from the measure or the study, rather than inherent properties of the measure or the study itself (33). Thus, validity is a property that changes with both context and time (50). In this study, validity is considered both in relation to the Mini-BESTest and this research study

Earlier in this thesis it was stated that reliability is a prerequisite for assessment of validity of a measure. Furthermore a reliable measure is only a valid one if it produces believable and useful information (33). In assessing the validity of a measure *construct, content and criterion validity* should be considered (9, 31, 33). Construct validity means that individual items on the measure can be summated to give a score adhering to the same construct, and is commonly assessed by Factor analysis or Rasch analysis (31). Content validity is the extent to which a measure is a complete representation of critical components of the construct being assessed (33). For ordinal scales, content validity is traditionally assessed by using an expert panel (31). Criterion validity involves comparing the measure with a "a gold standard" in the field of interest (33). Accuracy of the measure, concurrent validity and predictive validity are subcategories of criterion validity (33).

Determination of the validity of a research study is primarily concerned with assessment of *internal, construct* and *external validity* (50). "Internal validity is the extent to which the results of a study demonstrate a causal relationship between the independent and dependant variables" (50, p. 239), meanwhile "external validity is concerned with whom, in what setting, and at what times the results of research can be generalized" (50, p. 239). *Construct* validity of a study concerns with the meaning of the variables within the study and whether these are defined in such a way that they can be interpreted in relation to other research within that field (50). For this study, aspects of internal, external and construct validity are discussed in chapter 6 and in the manuscript.

4.5 Floor- and ceiling effect

The data were also investigated for any floor- or ceiling effect. A measurement is considered to have a ceiling- or floor effect if it cannot register improvements or deteriorations in scores for the participants of interests (33). Floor- and ceiling effect is defined as >15% of participants achieving the highest or lowest score, respectively (31). In this present study, possible effects were assessed for in the total sample of participants and within the 6 levels of ambulation.

4.6 Statistical methods

In this study statistical methods were used to assess the intra- and inter-rater reliability of the Mini-BESTest. ICCs were used to assess relative reliability of the total score. Bland-Altman plots, calculations of within-subject standard deviation and smallest detectable difference were used for assessment of absolute reliability. Cohen's kappa and percent agreement were used to assess the reliability of the individual items of the Mini-BESTest. The statistical methods are described in more details below.

4.6.1 Intraclass correlation coefficient (ICC)

To assess inter- and intra-rater correlations of the Mini-BESTest total score ICCs were calculated. ICC reflects the relation of variability caused by measurement error to total

variability in the data and the method allow comparison of repeated measurements on interval or ratio level (54). The extent of correlation of repeated scorings is expressed in a coefficient value between 0 and 1 (were 0 is no agreement and 1 is perfect agreement). Guidelines for interpretation of ICC values are presented by Munro (58). However the interpretation is debated, first of all because the correlation will be stronger if the group shows high variability in scores (like in the present study) than in a group with less variability in scores. This fact needs to be considered when comparing values with studies using different measurement tool, sample, raters or setting (58).

There are approximately six different ICC models, and which to choose depends on characteristics of the raters, participants and the measure (59). As the raters were strategically recruited, ICC(1,1) was used in this study. Additionally, ICC(3.1) was used to investigate for any systematic error influencing the data, as this model assumes that systematic errors are not part of the measurement error. ICC(1,1) was calculated using a 1-way random-effects model for single measure and ICC(3,1) was calculated using a 2-way mixed effects model for single measure (59).

The ICC is the recommended correlation coefficient in assessing relative reliability of balance measures as it accounts for "level" differences (33, 54, 60). However, ICC is not a true measure of agreement and should be reported together with results from methods assessing absolute reliability (33).

4.6.2 Bland-Altman plot

Bland-Altman plots were used to assess intra- and inter-rater agreement of the Mini-BESTest total scores (61). This method was developed from the argument that any two sets of scores on a measure, derived from a sample representing a wide range of scores, should have a good correlation. Thus a high correlation in itself is just indicative of a wide spread sample and does not necessary imply good agreement between the scores (61). The Bland-Altman plot aims at assessing by how much the two sets of scores differ. The method involves plotting the difference in scores between two observations (from the same rater or from two different raters) against the mean of the same two observations, displaying the mean and the standard deviation of difference. If the differences are normally distributed,

95% of scores will lie between ±1,96 standard deviations (SD) of the mean differences. This is described as the *limits of agreement* (61). It is argued that the visual presentation allows for easy identification of outliers and observation of the consistency of scoring throughout the range of available scores. However, what constitute a clinically important difference of the mean, and clinically important limits of agreement are a matter of clinical judgment depending on the measurement tool(s), population(s) and setting (s) assessed (61).

4.6.3 Within-subject standard deviation and smallest detectable difference

The within-subject standard deviation (s_w), also referred as standard error of measurement (SEM), is used in this study to report the measurement error in scores on the Mini-BESTest (33, 54). S_w was found using an analysis of variance (ANOVA), where s_w was calculated as the square root of the within-people residual mean square (62). The difference between a participants score assigned by one rater, and the "true" score is expected to be $<1.96\ s_w$ for 95% of the measurements. From s_w, calculations of the smallest detectable difference (SDD) between repeated scores of the same participant were done ($\geq\sqrt{2}\times1.96\ s_w$ 95% CI) (54, 62). S_w and SDD was used for assessment of both intra- and inter-rater reliability. It may be worth to note that several names which appear to describe this outcome (SDD) are used in the literature; minimal detectable difference (MDC) (63, 64) and minimal detectable change (MCD) (33).

4.6.4 Cohen's kappa and percent agreement

Cohen's kappa (*k*) is used to investigate pair wise intra- and inter-rater agreement of each of the individual items of the Mini-BESTest. Kappa is an extension of the simple percent agreement, but *k* correct for chance agreement in which percent agreement does not(60). There are different types of *k* statistics, the basic *k* as described by Cohen (65) is used in this study.

The *k* formula is: $\frac{P_0 - P_c}{1 - P_c}$

P_0 is the proportion of observed agreements and P_c is the proportion of observed agreements expected by chance. Cohen's *k* is recommended for assessing agreement between two independent ratings or raters when data is measured on a nominal or ordinal scale (54, 66).

K values can range from -1.0 to 1.0, where values > 0 indicates agreement better than chance and 1 perfect agreement. Guidelines for interpretation of values between 0-1 as described by Landis & Koch (67) is used in this study. As k statistics corrects for chance values obtained can possibly be compared across different settings and conditions (66). However, as *k* values depend on the proportion of subjects in each category, comparison may be misleading were the prevalence of each category differs. As an example, if the scores to be examined lacks variability or if the scores are varied but the distinctions between them are infrequent or small, it is unlikely that the *k* values will be high (66).

Where *k* could not be calculated, pair wise percent agreement was calculated for each item, using the formula: $\frac{\text{number of exact agreement}}{\text{number of possible agreement}}$

5. SUMMARY OF RESULTS

5.1 Summary of the main results

This study showed, for intra- and inter-rater assessments, very high relative reliability (ICCs≥.98) and absolute reliability (agreement of scores in Bland-Altman plots, and low s_w and SDD) of the Mini-BESTest total score. Kappa values for individual items ranged between 0.33-1.00, were the majority of items showed very good or good agreement (intra-rater=95.6%, inter-rater= 73.4%) some moderate agreement (intra-rater=4.4%, inter-rater=24.4%) and 1 item fair agreement (inter-rater=2,2%).

5.2 Assessment of floor- and ceiling effect

Assessment of both the total scores for the whole sample (n=30) and for the participants according to six the individual ambulatory levels, showed no floor- or ceiling effects. Assessment of the sample of participants without stroke showed that 2.8% were assigned the highest score (points=32). Assessment of the sample of participants in FACHS 2 showed that 8.3% were assigned the lowest score (points=0).

6. DISCUSSION OF ASPECTS OF THE RESULTS AND THE METHODS

6.1 Results

In this study, there was a very high correlation (ICCs≥.98) of the total scores on the Mini-BESTest for both intra- and inter-rater assessments. This means that the participants remained at almost the same positions within group, for repeated ratings. However, when interpreting this results it is important to be aware of factors that may have influenced the ICC value (68). Firstly, calculation of ICC is highly influenced by the range of scores in the studied sample. If the range is low, there is little mathematical basis for the calculations and the ICC value tends to artificially low. Contrary, if the range of scores is wide (as it was in this study) the correlation tends to be higher. Secondly, the correlations tends to be higher if a highly standardized procedure is used (as in this study), compared to if a less standardized procedure is used, which may be the case in common clinical practice (68). As described earlier, recruiting participants both with a wide range of scores and using a highly standardized procedure was purposely done in this study to be able to assess the upper limits of reliability. Another concern in interpreting the value obtained from a correlation coefficient is that most do not control well for systematic errors. However, ICC(3.1) was used in addition to ICC(1.1), as ICC(3.1) does control for systematic error in which ICC(1.1) does not. As ICC(1.1) and ICC(3.1) were identical it is assumed that no systematic error influenced the calculations of relative reliability. In this study the position of the participants within the group on repeated scorings were verified by Bland-Altman plots (61) and calculations of s_w (62).

Calculations of s_w and SDD showed a low measurement error. However, calculations of sw and SDD may vary along the range of scores (63). In this present study, observations of Bland-Altman plots showed a tendency for the measurement error to be larger in individuals in the middle and on the lower part of the scale compared to individuals in the upper part of the Mini-BESTest total point scale. Thus it must be considered that the score value obtained for and the individuals without stroke. It is argued that this information is particularly useful for clinicians as it provides information on the measurement error in actual scores on the Mini-BESTest. However, the results of SDD may not be equal to what is considered the

smallest clinically relevant difference. What is considered a clinically relevant difference will vary according to both the population and the purpose of use (54). In a clinical situation, it is argued that both perceptions of the clinician and the patient, in which the measure is used on, will influence what constitute a clinically meaningful difference in scores.

The absence of floor- and ceiling effect shown in this study, is supported by other studies of the Mini-BESTest in Parkinson's disease (24, 69). The absence of floor- or ceiling effect means that the measure can be used to detect both deterioration and improvement in performance across the whole sample (31). As reported earlier in this thesis, a ceiling-effect in stroke-individuals with mild balance disorders have been shown on the Berg Balance Scale (11). Thus, it may indicate that Mini-BESTest is better than the BBS in detecting mild balance disorders in individuals with stroke (69). However, the absence of floor- and ceiling effects on the Mini-BESTest in individuals with stroke should be confirmed in a lager sample (33).

6.2 Methods

Although hesitant to modify the original Mini-BESTest as this may change its psychometric properties (33), some modifications were considered necessary. Modifications of the postural responses (item 6-8) and the added task in item 14 were mainly based on experiences from the pilot study. Allowing two trials for the postural responses (item 6-8) was because it was experienced that, on their first attempt, all individuals hesitated to lean appropriately into the examiners hands for a stepping reaction to occur For item 14, it was experienced that even for healthy person counting backwards in three from one-hundred, may be too difficult. Thus the alternative task (listing girls names according to the alphabet) was given to those who could not complete the counting task in quiet sitting. For individuals with aphasia a manual task was given. In older adults, provision of a added cognitive or manual task while completing the timed "Up and Go" test show similar results in time to complete the tasks and in sensitivity to predict fallers (46). Similar modifications of items of postural responses (item 6-8) and the dual-tasking (item 14) is also applied in a study of reliability in Parkinson's disease (24).

At the present time, there is no published Norwegian translation of the Mini-BESTest, therefore participants' instructions were translated by the author (the Norwegian translation is included in the appendices). Although the translation was done with accuracy by someone who knew the measure and the testing environment, as well as proven feasible in a pilot study, it is acknowledged that a more comprehensive procedure is required for a "formal" translation of the measure (31). As this is a study of rater reliability and all the participants were given the same instructions (and by the same person), it is argued that this does not limit the validity of this present study. But there is a need for a "formal" Norwegian translation of the Mini-BESTest.

6.3 Validity

Internal validity concerns with whether the results of intra- and inter-reliability from this study can be trusted. The central question is whether the results were due to agreement between the raters, and not due to confounding or systemic errors influencing the results (50). Both strengths and limitations of the study have been discussed above and in the manuscript, in order to evaluate the internal validity.

Intra-rater reliability and inter-rater reliability are the main constructs that are assessed in this study (50). It is considered that these constructs are thoroughly described, and that methods allowing for these constructs to be assessed are used in this study. However, issues associated with *construct validity* is included in the discussion of the methods as well as in the discussion of the results from this study in relation to the results from similar studies.

External validity concerns with to whom, in what settings, and at what times the results from this study can be generalized (50). Thus external validity is not only determined by the design and the conduction of the study, but also is also influenced by the "consumer" of the results (50). Results from this study can be generalized to similar groups of individuals with stroke, similar settings and times (50). However, caution must be made in applying the results to similar populations as variables such as cultural differences and experiences may influence both performance on the Mini-BESTest and how the scores are assigned (50).

7. CONCLUSIONS

This study is the first to assess intra- and inter-rater reliability of the Mini-BESTest in individuals with stroke. The study shows that the Mini-BESTest is a reliable measurement tool for adults with stroke presenting with a wide range of balance problems and rated by physical therapists with varied working experiences. A very high intra- and inter-rater reliability of the Mini-BESTest total score was shown in adults with stroke. The majority of the individual items showed very good or good agreement, some moderate and one item fair agreement.

8. FUTURE RESEARCH

Further assessment to optimize the reliability of the items 10-13 (in the subsection stability during gait and which showed the lowest reliability in this study) in individuals with stroke is suggested. There is also a need for assessment of reliability in a test-retest design in order to further evaluate the responsiveness and sensitivity of the scale.

Mini-BESTest is a unique measurement tool in that it provides a conceptual framework around which to evaluate and direct specific treatment for individuals with a variety of balance problems. However, studies examining the validity of the Mini-BESTest in individuals with stroke are warranted. In particular, there is a need for assessment of the individual subsections. At present, only the total Mini-BESTest score can be summated and it is unclear how well the individual subsections represent their respective subsystems of balance. Thus, it is suggested that the four individual subsections should be assessed separately for content- and internal construct validity as well as reliability. For the total Mini-BESTest there is also a need for further assessment: Criterion validity of the measure could be assessed by comparison to other measures as Bergs Balance Scale, Dynamic Gait index & Functional Gait Index. Assessment of predictive and discriminative validity concerning falls and/ or functional outcomes could provide useful knowledge. Normative data may also extend the clinical usefulness of the Mini-BESTest.

9. REFERENCES

1. WHO. *Cerebrovascular Disorders (Offset Publications)*. Geneva 1978.
2. Ellekjær H, Selmer R. Hjerneslag - like mange rammes, men prognosen er bedre. Tidsskrift for den norske lægeforening. 2007;127(6):740-3.
3. Dahl A, Lund C, Bjørnstad A, Russell D. Cerebrovaskulære sykdommer. In: Gjerstad L, Helseth E, Rootwelt T, editors. Nevrologi og nevrokirurgi fra barn til voksen. 5 ed. Høvik: Forlaget Vett og viten; 2010. p. 341-59.
4. Shumway-Cook A, Wollacott M. Motor Control: Issues and Theories. In: Shumway-Cook A, Wollacott M, editors. Motor Control: Translating Research into Clinical Practice. 3 ed. Baltimore: Lippincott Williams & Wilkins; 2007. p. 3-20.
5. Helsedirektoratet. Nasjonal retningslinje for behandling og rehabilitering ved hjerneslag. Oslo: Helsedirektoratet2010.
6. Weerdesteyn V, de Niet M, van Duijnhoven HJR, Geurts ACH. Falls in individuals with stroke. Journal of Rehabilitation Research and Development. 2008;45(8):1195 — 214.
7. Michael KM, Allen JK, Macko RF. Reducd ambulatory activity after stroke: the role of balance, gait, and cardiovascular fitness. Arch Phys Med Rehabil. 2005;86:1552-6.
8. de Oliveira CB, de Medeiros IR, Frota NAF, Greters ME, Conforto AB. Balance control in hemiparetic stroke patients: Main tools for evaluation. Journal of Rehabilitation Research and Development. 2008;45(8):1215-26.
9. Finch E, Brooks D, Stratford PW, Mayo NE. Physical rehabilitation outcome measures; a guide to en hanced clinical decision making. 2 ed. Ontario: Canadian Physiotherapy Association; 2002.
10. Pollock CL, Eng JJ, Garland SJ. Clinical measurement of walking balance in people post stroke: a systematic review. Clinical Rehabilitation. 2011;25(8):693-708.
11. Blum L, Korner-Bitensky N. Usefulness of the Berg Balance Scale in Stroke Rehabilitation: A Systematic Review. Physical therapy. 2008;88(5):559-66.
12. Franchignoni F, Horak FB, Godi M, Nardone A, Giordano A. Usig psychometric techniques to improve the balance evaluation systems test: the mini-bestest. J Rehabil Med. 2010(42):323-31.
13. Bergstrom M, Lenholm E, Franzen E. Translation and validation of the Swedish version of th mini-BESTest in subjects with Parkinson´s disease or stroke: A pilot study. Physiotherapy Theory and Practice. 2012:6 pages.

14. Horak FB. Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? Age and Ageing. 2006;35(S2):ii7-ii11.
15. Raine S, Meadows L, Lynch-Ellerington M, editors. Bobath Concept: Theory and clinical practice in neurlogical rehabilitation. Chichester: Wiley-Blackwell; 2009.
16. Carr JH, Shepherd RB. Enhancing Physical Activity and Brain Reorganization after Stroke. Neurol Res Int. 2011;2011:7 pages
17. Thornquist E. Sammenheng: vitenskapsteori og forskningsvirksomhet. Vitenskapsfilosofi og vitenskapsteori for helsefag. Bergen: Fagbokforlaget; 2003. p. 197-221.
18. Merleau-Ponty M. Phenomenology of Perception. 1 ed. New york: Routledge; 2002.
19. Bengtsson J. En livsverdenstilnærming for helsevitenskaplig forskning. In: Bengtsson J, editor. Å forske i sykdoms- og pleieerfaringer Livsverdensfenomenologiske bidrag. Oslo: Høyskoleforlaget; 2006. p. 13-59.
20. Thornquist E. Innledning. Vitenskapsfilosofi og vitenskapsteori for helsefag. Bergen: Fagbokforlaget; 2003. p. 7-16.
21. Hammer A, Nilsgård Y, Walquist M. Balance training in stroke patients - a systematic review of randomized, controlled trials. Advances in Physiotherapy. 2008;10:163-72.
22. Shumway-Cook A, Wollacott M. Normal Postural Control. In: Shumway-Cook A, Wollacott M, editors. Motor Control: Translating research into practice. 3 ed. Baltimore: Lippincott Williams &Wilkins; 2007. p. 157-86.
23. Mancini M, Horak FB. The relevance of clinical balance assessment tools to differentiate balance deficits. Eur J Phys Rehabil Med. 2010;46(2):239-48.
24. Leddy AL, Crowner BE, Earhart GM. Utility of the Mini-BESTest, BESTest, and BESTest Sections for Balance Assessments in Individuals With Parkinson Disease. JNPT. 2011;35:90-7.
25. Brodal. Sentralnervesystemet. 4 ed. Oslo: Universitetsforlaget; 2007.
26. Horak FB, Wrisley DM, Frank J. The Balance Evaluation Systems Test (BESTest) to Differentiate Balance Deficits. Physical Therapy. 2009;89:484-98.
27. Shumway-Cook A, Wollacott M. Abnormal Postural Control. Motor Control: Translating Research into Clinical Practice. 3 ed. Baltimore: Lippincott Williams & Wilkins; 2007. p. 233-56.

28. Shumway-Cook A, Wollacott M. Clinical Management of the Patient with a Postural Control Disorder. In: Shumway-Cook A, Wollacott M, editors. Motor Control: Translating Research into Clinical Practice. 3 ed. Baltimore: Lippincott Williams & Wilkins; 2007. p. 257-95.
29. Shumway-Cook A, Wollacott M. Clinical Management of the Patient with a Mobility Disorder. In: Shumway-Cook A, Wollacott M, editors. Motor Control: Translating Research into Clinical Practice. 3 ed. Baltimore: Lippincott Williams & Wilkins; 2007. p. 390-440.
30. Karnath HO, Broetz D. Understanding and treating "pusher syndrome". Physical Therapy. 2003;83(12):1119-25.
31. Küçükdeveci AA, Tennant A, Grimby G, Franchignoni F. Strategies for assessment and outcome measurement in physical and rehabilitation medicine: An eductational review. J Rehabil Med. 2011;43:661-72.
32. Wade DT. Outcome measurement and rehabilitation. Clin Rehabil. 1999;13:93-5.
33. Carter RE, Lubinsky J, Domholdt E. Measurement. Rehabilitation Research Principles and Applications. 4 ed. St. Louis: Elsevier Saunders; 2011. p. 229-46.
34. Herbert R, Jamtvedt G, Mead J, Hagen KB. Practical Evidence-Based Physiotherapy. London: Elsevier; 2005.
35. Tyson SF, Greenhalgh J, Long AF, Flynn R. The influence of objective measurement tools on communication and clinical decision making in neurological rehabilitation. Journal of Evalution in Clinical Practice. 2010;6:1-9.
36. Tyson SF, Connell LA. How to measure balance in clinical practice. A systematic review of the psychometrics and clinical utility of measures of balance activity for neurological conditions. Clinical Rehabilitation. 2009;23(9):824-40.
37. Muren AM. Use of outcome measures in norwegian neurological physiotherapy. Fysioterapeuten. 2006;10:22-5.
38. Berg KO, Wood-Dauphinee SL, Williams JI, Maki B. Measuring balance in the elderly: validation of an instrument. Can J Public Health. 1992;83(2):7-11.
39. Podsialdo D, Richardson S. The timed "Up and Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1992;39:142-8.
40. Whitney SL, Hudak MT, Marchetti GF. The dynamic gait index relates to self-reported fall history in individuals with vestibular dysfunction. J Vestib Res. 2000;10:99-105.

41. Shumway-Cook A, Horak FB. Assessing the influence of sensory interaction of balance. Suggestions from the field. Phys Ther. 1986;66:1548-50.
42. Cohen H, Blatchly CA, Gombash LL. A study of the clinical test of sensory interaction and balance. Phys Ther. 1993;73:99-105.
43. Graybiel A, Fregly AR. A new quantitative ataxia test battery. Acta Otolaryngol. 1966;6:292-312.
44. Tinetti ME, Richman D, Powell L. Falls efficacy as a measure of fear of falling J Gerontol. 1990;45:239-43.
45. Jacobs JV, Horak FB, Van Tran K, Nutt JG. An alternative clinical postural stability test for patients with Parkinson's disease. J Neurol. 2006;253(11):1404-13.
46. Shumway-Cook A, Brauer S, Wollacott M. Predicting the probability for falls in community-dwelling older adults using the timed up and go test. Physical Therapy. 2000;80:897-903.
47. Powell LE, Myers AM. The Activities-specific Balance Confidence (ABC) Scale. J Geront A Biol Sci Med Sci. 1995;50:M28-M34.
48. Wrisley DM, Marchetti GF, Kuharsky DK, Whitney SL. Reliability, internal consistency, and validity of data obtained with the functional gait assessment. Physical Therapy. 2004;84:906-18.
49. Leddy AL, Crowner BE, Earhart GM. Functional Gait Assessment and Balance Evaluation System Test: Reliability, Validity, Sensitivity and Specificity for Identifying Indviduals With Parkinson Disease Who Fall. Physical Therapy. 2011;91(1):102-13.
50. Carter RE, Lubinsky J, Domholdt E. Research Design. Rehabilitation Research Principles and Applications. 4 ed. St. Louis: Elsevier Saunders; 2011. p. 55-104.
51. Bjørndal A, Hofoss D. Forskningsprosessen. Statistikk for helse- og sosialfagene. 2 ed. Oslo: Gyldendal Akademisk; 2010. p. 18-30.
52. Bjørndal A, Hofoss D. Grunnleggende begreper. Statestikk for helse- og sosialfagene. 2 ed. Oslo: Gyldendal Akademisk; 2010. p. 31-9.
53. Ekeli BV. Det vokser ikke pærer på epletrær. Innlegg i debatten om evidensbasert fysioterapi. Fysioterapeuten. 2001;14:14-24.
54. Moe-Nilssen R, Nordin E, Lundin-Olsson L. Criteria for evaluation of measuremnt properties of clinical balance measures for use in fall prevention studies. Journl of Evaluation in Clinical Practice. 2008;14.

55. Waltz CF, Strickland OL, Lenz ER. Measurement in Nursing Research. 4 ed. New York: Springer Publishing; 2010.
56. Viosca E, Lafuente R, Martinez JL, Almagro PL, Gracia A, Gonzalez C. Walking recovery after an acute stroke: Assessment with a new functional classification scale and barthel index. Arch Phys Med Rehabil. 2005;86:1239-44.
57. Viosca E, Martinez JL, Almagro PL, Gracia A, Gonzalez C. Proposal and validation of a new functional ambulation classification scale for clinical use. Arch Phys Med Rehabil. 2005(86):1234-8.
58. Carter RE, Lubinsky J, Domholdt E. Data Analysis. Rehabilitation Research Principles and Applications. 4 ed. St. Louis: Elsevier Saunders; 2011. p. 255-340.
59. Shrout PE, Fleiss JL. Intraclass Correlations: Uses in Assessing Rater Reliability. Psychological Bulletin. 1979;86(2):402-28.
60. Ottenbacher KJ, Tomchek SD. Reliability Analysis in Therapeutic Research: Practice and Procedures. American Journal of Occupational Therapy. 1993;47(1):10-6.
61. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurements. Lancet. 1986;1:307-10.
62. Bland JM, Altmann DG. Measuremnt error. BMJ. 1996;313:744.
63. Stevenson TJ. Detecting change in patients with stroke using the Berg Balance Scale. Australian Journal of Physiotherapy. 2001;47:29-38.
64. Donoghue D, Stokes EK. How much change is true change? The minimum detectable change of the Berg Balance Scale in elderly people. J Rehabil Med. 2009;41(5):343-6.
65. Cohen JA. A coefficient of agreement for nominal scales. Educ Psychol Meas. 1960(20):37-46.
66. Tooth LR, Ottenbacher KJ. The *k* statistics in rehabilitation research: an examiniation. Arch Phys Med Rehabil. 2004;85:1371-6.
67. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33(1):159-74.
68. Carter RE, Lubinsky J, Domholdt E. Section 7 Data Analysis. Rehabilitation Research Principles and Applications. 4 ed. St. Louis: Elsevier Saunders; 2011. p. 255-340.

69. King LA, Priest K, Salarian A, Pierce D, Horak FB. Comparing the MIni-BESTest with the Berg Balance Scale to Evaluate Balance Disorders in Parkinson´s Disease. Parkinson´s disease. 2012;2012:7.

10. MANUSCRIPT

Intra- and inter-rater reliability of the Mini-Balance Evaluation Systems Test (Mini-BESTest) in individuals with stroke

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Abstract

Background: Mini-Balance Evaluation Systems Test (Mini-BESTest) is a new and promising measure for evaluation of dynamic balance, but intra- and inter-rater reliability in individuals with stroke have not yet been examined. **Objective:** The aim of this study was to assess the within raters' (intra-rater) and between raters' (inter-rater) reliability of the Mini-BESTest in adults with stroke. **Design:** Measurement study of intra- and inter-rater reliability. **Methods:** Thirty adults, twenty-five with stroke and five without were strategically recruited according to six different ambulatory levels. Mini-BESTest performance of participants were filmed and then scored by three raters twice, with four weeks between the sessions. For total scores on the Mini-BESTest, relative reliability was investigated for by calculating Intraclass correlation coefficients ($ICC_{1.1}$ and $ICC_{3.1}$). Absolute reliability was investigated for by calculating Bland-Altman plots, within-subject standard deviation (s_w) and smallest detectable difference (SDD). For individual items, Cohen's kappa (*k*) and percentages agreement were calculated. **Results**: For both intra- and inter-rater assessments very high relative reliability (ICCs≥.98) and absolute reliability (agreement of scores in Bland-Altman plots, and low s_w and SDD) of the Mini-BESTest total score were shown. Kappa values for the individual items ranged between 0.33-1.00. The majority of items (intra-rater=95.6%, inter-rater=73.4%) showed very good or good agreement (*k*≥.63). Only one item (inter-rater=2.2%) showed fair agreement (*k*=.33). **Limitations:** Results should not be generalized to individuals with major cognitive impairments, as they were not included in this study. **Conclusions:** This study shows a very high intra- and inter-rater reliability of the Mini-BESTest in adults with stroke. The majority of the individual items showed very good or good agreement, some moderate and one item fair agreement.

Introduction

Individuals with stroke frequently have balance disorders that can lead to reduced level of mobility and increased risk of falling (1, 2). Consequently, a comprehensive assessment of balance is important for both diagnostic and therapeutic purposes. Clinical balance measures are key features in balance assessment as to evaluating balance functions, directing treatment and predicting outcome (3, 4). The Mini-Balance Evaluation Systems Test (Mini-BESTest) is a new and promising balance measure (5). However, intra- and inter-rater reliability in individuals with stroke has not yet been assessed, and is needed to establish the usefulness of the Mini-BESTest in stroke rehabilitation (5-7).

While there are many balance measures concerned with measuring the degree of the balance disorder and predicting outcome, there are few measures evaluating the underlying systems causing the balance disorder (1, 6, 8-10). The Balance Evaluation Systems Test (BESTest) was developed for this purpose. The BESTest is an extensive balance measure developed to differentiate six balance systems underlying poor functional balance in adults with a wide range of balance problems (11). The test has high reliability, validity and sensitivity in a wide range of patients (11-13). The disadvantage of the test is that it takes approximately 35 minutes to complete and therefore may not be feasible in clinical practice (10). The Mini-BESTest is a shortened and improved version of the BESTest focusing on *dynamic* balance, and takes between 10 and 15 minutes to administer (5). In developing this test, a wide range of psychometric properties (dimensions, quality of the scoring categories, construct validity and item separation reliability indices) were investigated, and excellent characteristics were reported. However, further studies are warranted to establish its usefulness in clinical practice (5). To our knowledge, there are no studies examining intra- and inter-rater

reliability of the Mini-BESTest in individuals with stroke. As satisfactory reliability is a requirement for precise and consistent measurements, it is an essential part in evaluating the usefulness of the Mini-BESTest in individuals with stroke (14).

The purpose of this study was to assess the intra-rater (within the same rater) and inter-rater (between different raters) reliability of the Mini-BESTest for assessment of dynamic balance in individuals with stroke. The research question was: - is the Mini-BESTest used within raters and between raters a reliable measure in individuals with stroke?

Methods

Design

Measurement study of intra- and inter-rater reliability.

Materials

Setting

This study was conducted in Bodø, Norway, from September to December 2011. The testing procedure was conducted in the Physiotherapy department at Bodø Rehabilitation Unit, Bodø.

Participants

Thirty individuals: twenty-four people with stroke and six without stroke were recruited via health professionals working in stroke rehabilitation. Inclusion criteria were: ≥18 years, ability to walk at least six meters independently (cane was allowed) and giving informed

consent to participate. Individuals that could not follow the test instructions or whose balances were impaired mainly due to another diagnosis were not included. In order to enable assessment of all available scores on the Mini-BESTest, participants were strategically recruited based on their level of functional ambulation. Functional Ambulation Classification of the Hospital of Sagunto (FACHS) (15) was used to assess ambulatory levels of the adults with stroke. The FACHS is a measure of six different ambulatory levels on an ordinal scale (0-5): level 0-1 means inability to walk or requiring person assistance of ≥1 to walk, level 2 ability to ambulate within the household, level 3 ambulation in surroundings of the house and neighborhood, level 4 independent community ambulation and level 5 describes normal ambulation (15). Six individuals from each of the levels 2-5 on this scale were recruited. FACHS has been found to significantly correlate with standing balance and lower limb paresis (16) and has a good inter-rater reliability for subjects with stroke (15). The author of this paper assigned FACHS scores. Age, sex and information about the stroke (date of incident, type, brain localization and hemiparetic side) were also registered for each of the participants.

Conduction of this study complied with the Helsinki Declaration and was approved by The Regional Committee for Medical Health Research Ethics in Norway.

Raters

Three raters, labeled A, B and C, were selected among physiotherapists working with patients with stroke. Rater A, B and C had worked as physiotherapists for 17, 16 and 1.5 years, respectively. Rater A also had a master's degree in physiotherapy. None of the raters were familiar with the Mini-BESTest prior to participating in this study.

Assessment tool

The Mini-BESTest (appendix 1) consists of 14 items, grouped into four systems of dynamic balance: "Anticipatory postural adjustments", "Postural responses", "Sensory orientation" and Balance during gait". For items 3 (single leg stance) and 6 (lateral compensatory stepping reactions), the right and left side of the body was scored separately, thus a total of 16 items to score. All items are scored on an ordinal scale were 0 is severe, 1 is moderate and 2 is normal performance. The scores of each item are added together to a total score, with a maximum of 32 points. The Mini-BESTest consists of standard instructions for patients and raters, and a description of what equipment to use (5). A few modifications from the original test were applied: For the compensatory stepping reaction tasks (items 4, 5 and 6) the participants were given two trials instead of one, and the best out of the two was scored. Some participants (n=5) were unable to count backwards in three (when tested in sitting) for the dual-task component of the timed "Up & Go" test (item 14) and were given alternative tasks; individuals with aphasia (n=2) were asked to walk with a cup of water (17), and the reminder (n=3) were asked to list girls names from A-Z in the alphabet. All participants mother tongue were Norwegian, thus instructions to the participants were given in Norwegian. As no authorized Norwegian translation of the Mini-BESTest was available when this study was conducted, instructions to the participants were directly translated from the original test (by the author of this paper), standardized, trailed in the pilot study (see below) and proven feasible. For all other purposes the original test in English (5) was used.

Procedures

Training and pilot

The three raters attended a three-hour training session to become familiar with the test and scoring instructions. The raters were given a copy of the Mini-BESTest and general information about the test. Each items of the test were demonstrated in the same room and with the same equipment as used for the study sample, and each score alternative was discussed. The raters then watched the original BESTest training DVD and video clips from the pilot of adults performing the Mini-BESTest. Video clips were discussed to obtain a common understanding of the scores, and then scored independently by each rater. All raters mastered the English language, however they were encouraged to ask questions in the training session. Two people, with physiotherapy background, received training in the filming procedure (see testing procedure below). Testing and filming procedures were piloted on one adult with impaired balance from a neurological diagnosis and two adults without neurological disorders. Training was provided by the author of this paper, who has attended a BESTest and Mini-BESTest training course held by one of its developers (Fay Horak) in Norway, and also has 10 years of working experience in Neurological Physiotherapy.

Testing procedure

All participants completed Mini-BESTest using the same procedure and equipment in a quiet room in the Physiotherapy Department. The participants wore shorts or equivalent, and flat shoes or were bare feet. One person wore an ankle and foot orthosis and two individuals used a cane for walking. The author of this paper, who was not one of the raters, instructed the subjects in performing the test while an assistant filmed their performance. The participants were informed that they were allowed to rest at any time. Mini-BESTest took from 15 to 20 minutes to complete for each participant.

The sessions were recorded using a handheld camera following a standardized procedure where the angle, height and distance of the camera were adapted from the procedures used in the original BESTest instructions video. For items allowing two trials of the task, both trials were recorded. The participants were filmed from when the instructions of the task were given, to completion of the given task.

Scoring

All three raters (A, B, C) scored the video clips of the 30 adults twice, with four weeks between the first (A1, B1, C1) and second (A2, B2, C2) rating. Each rater assigned scores independently, but from the same video recordings, at the same time and in the same room. They were instructed not to discuss the scores with each other during or between the two sessions. For each new day of rating, the raters started by watching video clips of a healthy person (who was not in the studied sample) performing the test. The participants were shown in random orders, in which differed from session one to session two. Individual items were shown in the same order as on the Mini-BESTest, and one item was scored before the next item was shown. When more than one trial was recorded, the raters were instructed to register the best score. The raters were allowed to watch each video clip several times, given that all raters watched all repetitions and scored after seeing the last one. Scores were registered on the Mini-BESTest standard assessment forms. A new form was distributed for each participant and forms were unavailable for the raters after assessment was completed. The FACHS scores of the participants were not available for the raters.

Data Analysis

Frequency and percentages were used to describe sex, type of stroke and ambulatory level. Mean values, standard deviation (SD) and minimum and maximum values (min-max) were calculated to describe age, number of months since the stroke and total score on the Mini-BESTest for the participants.

The total scores of the Mini-BESTest were assessed for normality using the Kolmogorov-Smirnov test. As the test results were not statistically significant (p >0.05), parametric statistics could be used for the sum scores of the Mini-BESTest (18).

Relative reliability of the Mini-BESTest was assessed with Intraclass correlation coefficients (ICC) (14, 18). ICCs were calculated to assess pairwise correlation between raters (A1-B1, A1-C1, B1-C1), within the group of raters (A1-B1-C1), and within raters (A1-A2, B1-B2, C1-C2) for Mini-BESTest total score. ICC (1.1) was used because the raters were strategically chosen (19). As ICC (1.1) assumes all errors to be random measurement errors, ICC (3.1) was used in addition to ICC (1.1) enabling investigation for systematic errors. When ICC (1.1) equals ICC (3.1), no systematic errors are present (19). The ICC ranges from 0 to 1, where 0 indicates no agreement and 1 perfect agreement. ICC values of .90 and above are considered very high (18).

Absolute reliability was investigated with two methods; Bland-Altman plots and within-subject standard deviations (s_w). Bland-Altman plots were used to assess agreement between the raters (A1-B1, A1-C1, B1-C1) and within the raters (A1-A2, B1-B2, C1-C2) (20). The consistency in score values, range of differences, distribution along the Mini-BESTest scale, and possible measurement bias were observed for. No heteroscedasticity (when the

measurement error depends on the size of the score value) was found, allowing for calculation of within-subject standard deviation (s_w).

Within-subject standard deviation (s_w) was calculated to assess how a given sum score on the Mini-BESTest is related to a "true" score for that person, and to investigate variability in total scores with repeated observations, expressed in scores on the Mini-BESTest (18). S_w was found using an analysis of variance (ANOVA), where s_w was calculated as the square root of the within-people residual mean square (21). The difference between a participant's score assigned by one rater and the "true" score is expected to be $<1.96\ s_w$ for 95% of the observations. Thus the difference between two scores for the same participant is expected to be $\geq\sqrt{2}\times1.96\ s_w$ for 95% of the pairwise observations (21). This value is an estimate of the minimum change in score that is needed to be sure that the change is greater than the measurement error, and is referred to as the smallest detectable difference (SDD) (14).

Kappa (*k*) statistics was used to analyze degree of intra- and inter-rater agreement for each items of the Mini-BESTest (18). The guidelines from Landis and Koch (1977) were used to interpret the results (18, 22). A *k* value of <0.20 is described as poor agreement, .21-.40 fair, .41-.60 moderate, .61-.80 good and .81-1.00 is very good agreement (22). As kappa can only be analyzed when all score alternatives for an item are used, percentages agreement was calculated for items where some scores were not used. Kappa was the first choice as it corrects for chance agreement, while percentages of agreement does not (18).

Analyses were performed using IBM SPSS version 19. For Bland-Altman plots Medcalc version 12.1 was used.

Results

Characteristics of the participants

Characteristics of the participants according to ambulatory levels are presented in Table 1. Of the 30 participants, 46.7% were woman. Among the 24 adults with stroke, 17 had cerebral infarction, 6 had intra-cerebral hemorrhage and 1 had both infarction and hemorrhage. The sample included 10 adults with a right-sided hemiparesis and 8 adults with a left-sided hemiparesis and 6 adults with lesions in brainstem and/or cerebellum.

Mini-BESTest score

The total scores of the Mini-BESTest for all participants as given by each of the raters are shown in Table 2. The total score of the participants ranged from 0 to 32, covering the whole range of available scores on the Mini-BESTest. As shown in Figure 1 the scores increased with increasing ambulatory level as measured with FACHS.

Reliability

Relative Reliability of the Mini-BESTest total score

Relative reliability of both intra- and inter-rater assessments was very high (ICC≥.98), as shown in Table 3.

Absolute Reliability of the Mini-BESTest total score

Bland-Altman plots for intra- and inter-rater agreement are shown in Figure 2. Mean difference in intra-rater agreement was 0.5 points (min-max=0.1-0.7), and for inter-rater

agreement the mean difference was 0.3 points (min-max=0.1-0.4). A total of 96.7% of participants (n=87) were within *limits of agreement* (mean difference ±1.96SD of the difference) for intra-rater assessments, and 94.3% of participants (n=85) for inter-rater assessments (mean limits of agreement: intra-rater= -2.9 and 2.9 points, inter-rater= -2.6 and 3.1 points). For the scores that fell outside the limits of agreement (n=7), these belonged to individuals in FACHS level 2 (n=3), 3 (n=1) and 4 (n=3).

Within-subject standard deviation (s_w) and SDD for intra- and inter-rater reliability of the total score of the Mini-BESTest are reported in Table 3. ANOVA calculation of within-people residual mean square was 1.093 for inter-rater analysis for all raters (A1-B1-C1), thus S_w was calculated to 1.1 from the equation $\sqrt{1.093}$. The difference between a participant's total score and "true" measurement value was then expected to be less than 2.4 points on the Mini-BESTest for 95 % of the scores ($\pm 1.96 \times 1.1$). A 2.4 score constitutes 7.5% of its maximum 32 points score. The smallest detectable difference of the total Mini-BEST score between two measurements for the same participant showed a mean value of 2.8 points or 8.8% (95% CI) if scored by the same rater, and 2.9 points or 9.1% (95% CI) if scored by different raters.

Intra-rater and inter-rater reliability of each item of the Mini-BESTest

Table 4 shows kappa or percentage of agreement values for each item. Kappa values (*k*) ranged overall from 0.33 to 1.00. For intra-rater assessments 95.6% of all items showed good or very good agreement *(k*≥.63) and 4.4% moderate agreement (*k* =.54-.56). For inter-rater assessments 73.4% of all items showed good or very good agreement (*k* ≥0.64), 24.4% moderate (*k* =.43-.59) and 2.2% poor agreement (*k* =.33). For intra-rater assessments, items

1 (sit to stand), 2 (rise to toes), 3 (stand on one leg, right) and 9 (incline, eyes closed) had values of perfect agreement (k=1), while item 12 (walk with pivot turn) showed the least pairwise agreement (k=.54). For inter-rater assessments, item 1 (sit to stand), 3 (stand on one leg) and 8 (eyes closed, foam) showed values of perfect agreement (k=1), and item 11 (walk with head turns) showed the lowest value (k=.33). For items 7 (A1-A2, C1-C2, A1-B1, A1-C1, B1-C1) and 10 (A1-A2) percentage agreements were calculated to values between 96 and 100% agreement.

Discussion

Summary of results

This study showed, for both intra- and inter-rater assessments, very high relative and absolute reliability of the Mini-BESTest total score. The majority of the individual items showed very good or good agreement, some moderate, and one item fair agreement.

Discussion of the results

Relative reliability was very high in this study (ICC≥.98), which means that the participants maintained their position in the group almost perfectly with repeated measurements (18). This is slightly higher than the values reported in a study of the Mini-BESTest in adults with Parkinson's disease (inter-rater ICC=.91) (13). The results were also slightly higher or similar to the correlations reported in other clinical balance measures; the BESTest assessed in a mixed population (inter-rater ICC=.91) (11) and the Berg Balance Scale (BBS) assessed in individuals with stroke (intra-rater ICC=.97 and inter-rater ICC≥.95) (23). However, since

the ICC value is higher if the sample encompasses a wide range in scores compared to a limited range, caution should be made when comparing values from different studies (18). Although the high ICC values mean that the participants maintained their position in the group almost perfectly with repeated measurements (18), these results should be considered together with the results of absolute reliability reported below, as no single statistical analysis provides sufficient information on reliability on its own (14, 18).

The Bland-Altman plots showed a mean difference close to 0 (intra-rater=0.5 points and inter-rater=0.3 points) and a high percentage of participants within the *limits of agreement* (intra-rater=94.3% and inter-rater= 96.7%), which indicates high agreement between the rating sessions and between the different raters. The *limits of agreement* were approximately 3 points above and 3 points below the mean difference for both intra- and inter-rater assessments, thus showing some degree of measurement error which is important to be aware of when using the Mini-BESTest to evaluate balance performance (20). As the few individuals that were outside the *limits of agreement* belonged to FACHS levels 2-4 only, it is considered somewhat more challenging to score adults with stroke that have reduced ambulatory levels than those with "normal" ambulatory level. Higher measurement errors associated with lower ambulatory levels in adults with stroke have also been reported in the Berg Balance Scale (24), and it is likely a cause of these individuals having a higher variability in motor performance, which may not fit directly into the pre-defined scoring criteria. However, as only a few of the participants were outside the limits of agreement, Mini-BESTest is considered an appropriate measure for individuals in FACHS levels 2-4.

The low within-subject standard deviation (s_w) for all raters (min-max 0.8- 2.2 points) indicates a low measurement error in the Mini-BESTest. Calculations of SDD implies that a change in score larger or equal to 2.8 points (intra-rater) and 2.9 points (inter-rater) can be interpreted as a real change (in 95% of the scores) when two measurements of the same participant are compared (21). As the Mini-BESTest was developed to evaluate balance performance, it is argued that its ability to detect change is of particular importance. Furthermore these results show that Mini-BESTest potentially is a more responsive measure than other measures evaluating balance performance in individuals with stroke (6, 24, 25).

The individual items showing the highest agreement were items 1 (sit to stand), 2 (rise to toes), 3 (stand on one leg), 7 (eyes open, firm surface), 8 (eyes closed, foam) and 9 (incline, eyes closed). Scoring of these items is based on observations of tasks with few components and/or stopwatch time. Scoring of such variables tends to show higher agreement than more complex tasks and tasks based solely on judging performance from observation (11). This may also provide an explanation as to why items 11 (walk with head turns), 12 (walk with pivot turns), 10 (change in gait speed) and 6 (compensatory stepping strategy-lateral) showed the lowest agreements. In this study the participants were mainly viewed from the front during items 10-12 (11). Given the complexity of movement strategies presented in individuals with stroke, it is possible that allowing more than one trial for these tasks, so that the raters can observe stability during gait both from the side and from the front or back, may improve the reliability of these items. However this needs further investigation. As for item 6, it is suggested that the reliability of postural responses would have been higher if the raters administered these items themselves (11), possibly because tactile information from

hands-on contact with the participant, provides added information on the stability of that person.

Intra-rater agreement was higher than inter-rater agreement of the individual items, which may point to variations in the interpretations of the score values between raters. As all raters went through the same training and none had previous experience with the Mini-BESTest this may point to the items of lowest agreement warranting further investigation, to improve the clarity of instructions for scoring the individuals with stroke. This is in concordance with results from assessment of the Dynamic Gait Index in individuals with stroke (26), which includes similar items for assessment of stability during gait.

Analysis showed similar results between the individual pairs of raters, thus it is argued that Mini-BESTest can be rated by Physical therapists with both little and many years of working experience. However, training of raters is recommended prior to using the test in clinical practice.

Discussion of the methods

The highly standardized procedures used in this study are considered a methodical strength. Video was used to eliminate any influence caused by changes in the participant's performance or the instrument (18). This involved that the person administering the test was not one of the raters, whereas in clinical practice the same person commonly both administrate and score the test at the same time. However, whether the reliability of the Mini-BESTest may have been different in a live situation should be investigated in another study.

The comprehensive analysis of rater reliability, adhering to current recommendations for evaluation of clinical balance measures (14, 18, 27), is also considered a major strength of this study. However, the sample used in this study is smaller than the recommended 50 for assessment of s_w and SDD (28). To add to the validity of the results the s_w and SDD from this study are presented with a 95% confidence interval. Other studies have reported that for clinical assessment of balance only a 90% confidence interval is necessary (24, 29).

Four weeks were used between the two rating sessions, and a video of a healthy person performing the Mini-BESTest was shown on each new day of rating to prevent that the raters either memorized the results or required new training (30). Identical ICC (1.1) and ICC (3.1) indicate that there were no systematic shift in data (19), as could have occurred if either a learning effect took place or if the raters required new training between session (18).

The modifications of the Mini-BESTest items: allowing 2 trials for the postural responses (items 4-6) and providing alternative dual-tasks for some participants (item 14). Similar modifications are also applied in a study assessing reliability of the Mini-BESTest on individuals with Parkinson's disease (13). The modifications may have increased the time the participants used to complete the Mini-BESTest, which was 15-20 minutes in this study whereas others have reported 10-15 minutes to complete the test. However, the simultaneous filming procedure also increased the length of time. The Mini-BESTest is considered a feasible measure both in terms of time to complete the test and the little equipment required.

Strategic sampling of participants and raters is a limitation to the external validity of this study (18). However, it is argued that the highly standardized procedures used and the wide group of participants and raters add to the generalizability of the results from this study. The positive association between the FACHS scores and the Mini-BESTest scores ensured assessment of the whole range of Mini-BESTest scores (27). Thus, Mini-BESTest is considered appropriate for individuals in the ambulatory levels included in this study. While the sample included a wide range of individuals with stroke in terms of demographics, ambulatory levels and the Mini-BESTest scores, individuals with major cognitive impairments were not included and the results should therefore not be generalized to this group.

Mini-BESTest is considered a unique measurement tool in that it provides a conceptual framework to evaluate and direct specific treatment for individuals with a variety of balance disorders. However, further studies examining the validity of the Mini-BESTest in individuals with stroke are warranted.

Conclusions

This study is the first to assess intra- and inter-rater reliability of the Mini-BESTest in individuals with stroke. This study showed, for both intra- and inter-rater assessments, very high reliability of the Mini-BESTest total score in individuals with stroke. While the majority of the individual items showed very good or good agreement, some showed moderate, and one item fair agreement.

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References

1. Weerdesteyn V, de Niet M, van Duijnhoven HJR, Geurts ACH. Falls in individuals with stroke. Journal of Rehabilitation Research and Development. 2008;45(8):1195 — 214.

2. de Oliveira CB, de Medeiros IR, Frota NAF, Greters ME, Conforto AB. Balance control in hemiparetic stroke patients: Main tools for evaluation. Journal of Rehabilitation Research and Development. 2008;45(8):1215-26.

3. Finch E, Brooks D, Stratford PW, Mayo NE. Physical rehabilitation outcome measures; a guide to en hanced clinical decision making. 2 ed. Ontario: Canadian Physiotherapy Association; 2002.

4. Shumway-Cook A, Wollacott M. Motor Control: Translating Research into Clinical Practice. 3rd ed. Baltimore: Lippincott Williams & Wilkins; 2007.

5. Franchignoni F, Horak FB, Godi M, Nardone A, Giordano A. Usig psychometric techniques to improve the balance evaluation systems test: the mini-bestest. J Rehabil Med. 2010(42):323-31.

6. Pollock CL, Eng JJ, Garland SJ. Clinical measurement of walking balance in people post stroke: a systematic review. Clinical Rehabilitation. 2011;25(8):693-708.

7. Bergstrom M, Lenholm E, Franzen E. Translation and validation of the Swedish version of th mini-BESTest in subjects with Parkinson´s disease or stroke: A pilot study. Physiotherapy Theory and Practice. 2012:6 pages.

8. Podsialdo D, Richardson S. The timed "Up and Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1992;39:142-8.

9. Berg KO, Wood-Dauphinee SL, Williams JI, Maki B. Measuring balance in the elderly: validation of an instrument. Can J Public Health. 1992;83(2):7-11.

10. Mancini M, Horak FB. The relevance of clinical balance assessment tools to differentiate balance deficits. Eur J Phys Rehabil Med. 2010;46(2):239-48.

11. Horak FB, Wrisley DM, Frank J. The Balance Evaluation Systems Test (BESTest) to Differentiate Balance Deficits. Physical Therapy. 2009;89:484-98.

12. Leddy AL, Crowner BE, Earhart GM. Functional Gait Assessment and Balance Evaluation System Test: Reliability, Validity, Sensitivity and Specificity for Identifying Indviduals With Parkinson Disease Who Fall. Physical Therapy. 2011;91(1):102-13.

13. Leddy AL, Crowner BE, Earhart GM. Utility of the Mini-BESTest, BESTest, and BESTest Sections for Balance Assessments in Individuals With Parkinson Disease. JNPT. 2011;35:90-7.

14. Moe-Nilssen R, Nordin E, Lundin-Olsson L. Criteria for evaluation of measuremnt properties of clinical balance measures for use in fall prevention studies. Journl of Evaluation in Clinical Practice. 2008;14.

15. Viosca E, Martinez JL, Almagro PL, Gracia A, Gonzalez C. Proposal and validation of a new functional ambulation classification scale for clinical use. Arch Phys Med Rehabil. 2005(86):1234-8.

16. Viosca E, Lafuente R, Martinez JL, Almagro PL, Gracia A, Gonzalez C. Walking recovery after an acute stroke: Assessment with a new functional classification scale and barthel index. Arch Phys Med Rehabil. 2005;86:1239-44.

17. Shumway-Cook A, Brauer S, Wollacott M. Predicting the probability for falls in community-dwelling older adults using the timed up and go test. Physical Therapy. 2000;80:897-903.

18. Carter RE, Lubinsky J, Domholdt E. Rehabilitation Research: Principles and Applications. 4th ed. St. Louis: Elsevier Saunders; 2011.

19. Shrout PE, Fleiss JL. Intraclass Correlations: Uses in Assessing Rater Reliability. Psychological Bulletin. 1979;86(2):402-28.

20. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurements. Lancet. 1986;1:307-10.

21. Bland JM, Altmann DG. Measuremnt error. BMJ. 1996;313:744.

22. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33(1):159-74.

23. Blum L, Korner-Bitensky N. Usefulness of the Berg Balance Scale in Stroke Rehabilitation: A Systematic Review. Physical therapy. 2008;88(5):559-66.

24. Stevenson TJ. Detecting change in patients with stroke using the Berg Balance Scale. Australian Journal of Physiotherapy. 2001;47:29-38.

25. Lin J-H, Hsu M-J, Hsu H-W, Wu H-C, Hsieh C-L. Psychometric Comparisons of 3 Functional Ambulation Measures for Patients With Stroke. Stroke. 2010;41:2021-5.

26. Jonsdottir J, Cattaneo D. Reliability and validity of the dynamic gait index in persons with chronic stroke. Arch Phys Med Rehabil. 2007;88:1410-5.

27. Küçükdeveci AA, Tennant A, Grimby G, Franchignoni F. Strategies for assessment and outcome measurement in physical and rehabilitation medicine: An eductational review. J Rehabil Med. 2011;43:661-72.

28. Rankin G, Stokes M. Reliability of assessment tools in rehabilitation: as illustration of appropriate statistical analyses. Clin Rehabil. 1998;12:187-99.

29. Donoghue D, Stokes EK. How much change is true change? The minimum detectable change of the Berg Balance Scale in elderly people. J Rehabil Med. 2009;41(5):343-6.

30. Sæther R, Jørgnsen L. Intra- and inter-observer reliability of th Trunk Impairment Scale for children with cerebral palsy. Research in Developmental disabilities. 2011;32(2):727-39.

Table 1. Characteristics of the participants (n=30) according to ambulatory levels

Ambulatory level	Woman	Men	Age in years			Months after stroke
	(n)	(n)	Mean	SD	(min–max)	(mean)
Subjects without stroke	3	3	40.2	8.3	(32-55)	-
FACHS score 2	4	2	64.2	13.7	(48-85)	44.5
FACHS score 3	2	4	61.2	9.9	(51–71)	57.2
FACHS score 4	1	5	58.5	20.7	(19–78)	105.3
FACHS score 5	4	2	54.5	10.2	(41–67)	9.7

FACHS=Functional Ambulation Classification of the Hospital of Sagunto. N=number. SD=standard deviation. Min-max= minimum to maximum values.

Table 2. Total scores of the MiniBESTest for all participants (n=30) according to raters

Rater	Mean	SD	Min–max
A1	18.5	8.4	1–31
A2	19.2	8.8	1–31
B1	18.4	9.3	0–31
B2	18.2	9.2	1–31
C1	18.1	8.9	0–31
C2	17.5	9.2	0–32

A1=the first rating of rater A. A2=the second rating of rater A. B1= the first rating of rater B. B2=the second rating of rater B. C1=the first rating of rater C. C2=the second rating of rater C. SD=standard deviation. Min-max=minimum-maximum values.

Table 3. Intra- and inter-rater reliability of the total score of the Mini-BESTest

Raters	ICC(1,1)	95% CI	ICC(3,1)	95% CI	S_w	SDD
Intra-rater						
A1-A2	0.98	0.96–0.99	0.98	0.96–0.99	1.2	3.3
B1-B2	0.99	0.98–1.00	0.99	0.98–1.00	0.8	2.2
C1-C2	0.99	0.98–1.00	0.99	0.97–0.99	1.1	3.0
Inter-rater						
A1-B1	0.99	0.97–0.99	0.98	0.97–0.99	1.1	3.1
A1-C1	0.98	0.96–0.99	0.98	0.96–0.99	1.2	3.3
B1-C1	0.99	0.98–1.00	0.99	0.98–1.00	0.8	2.2
A1-B1-C1	0.99	0.98–1.00	0.99	0.98–1.00	1.1	3.1

ICC=intraclass correlation coefficient. CI = confidence interval. S_w=within subject standard deviation.

SDD=smallest detectable difference for 95% of pairs of observations

Table 4. Intra- and inter-rater reliability of each item on the Mini-BESTest

Item	Rater A1–A2 *k*	Rater B1–B2 *k*	Rater C1–C2 *k*	Rater A1–B1 *k*	Rater A1–C1 *k*	Rater B1–C1 *k*
Anticipatory Postural adjustments						
1. Sit to stand	0.84	1.00	0.84	0.84	1.00	0.84
2. Rise to toes	0.80	1.00	0.85	0.65	0.75	0.80
3. Stand on one leg						
Left	0.90	1.00	0.95	0.90	0.85	0.95
Right	0.95	0.95	0.85	1.00	0.90	0.90
Postural responses						
4. Compensatory stepping correction - forward	0.63	0.84	0.89	0.54	0.64	0.80
5. Compensatory stepping correction - backward	0.75	0.75	0.90	0.90	0.80	0.90
6. Compensatory stepping correction - lateral						
Left	0.63	0.64	0.67	0.74	0.47	0.50
Right	0.79	0.90	0.80	0.79	0.75	0.85
Sensory orientation						
7. Eyes open, firm surface	100%	0.82	96%	100%	96%	96%
8. Eyes closed, foam surface	0.94	0.94	0.88	1.00	0.94	0.94
9. Incline - eyes closed	1.00	1.00	0.80	0.92	0.85	0.93
Balance during gait						
10. Change in gait speed	100%	0.77	0.73	0.47	0.59	0.58
11. Walk with head turns - horizontal	0.56	0.69	0.67	0.54	0.33	0.58
12. Walk with pivot turn	0.78	0.69	0.54	0.43	0.59	0.59
13. Step over obstacles	0.94	0.89	0.83	0.77	0.83	0.83
14. Timed up and go with dual task	0.90	0.74	0.84	0.69	0.68	0.79

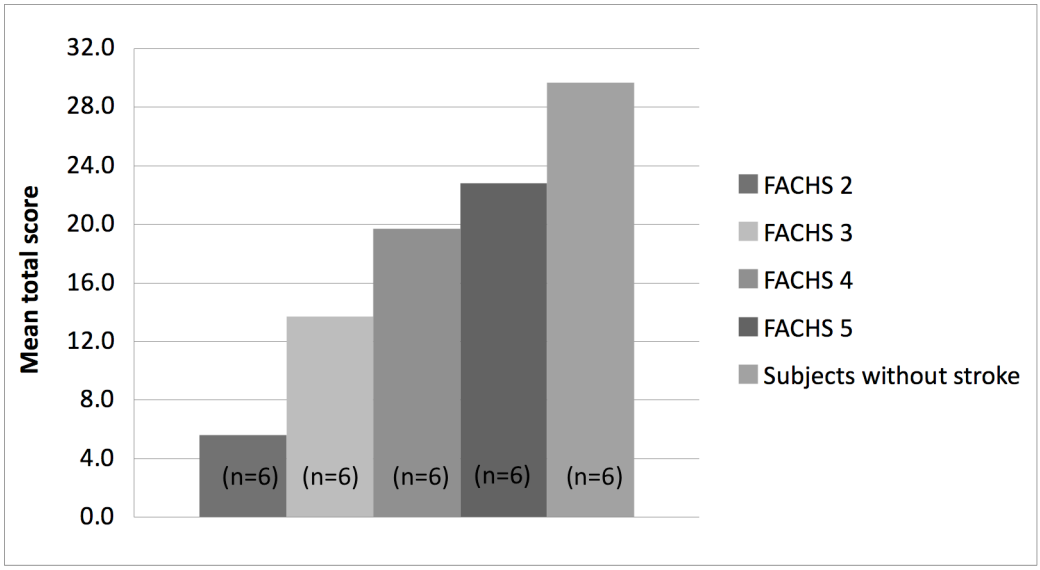
Intra-rater (A1–A2, B1–B2, C1–C2) and inter-rater (A1–B1, A1–C1, B1–C1) agreement expressed in *k* (kappa) or % (percentages agreement).

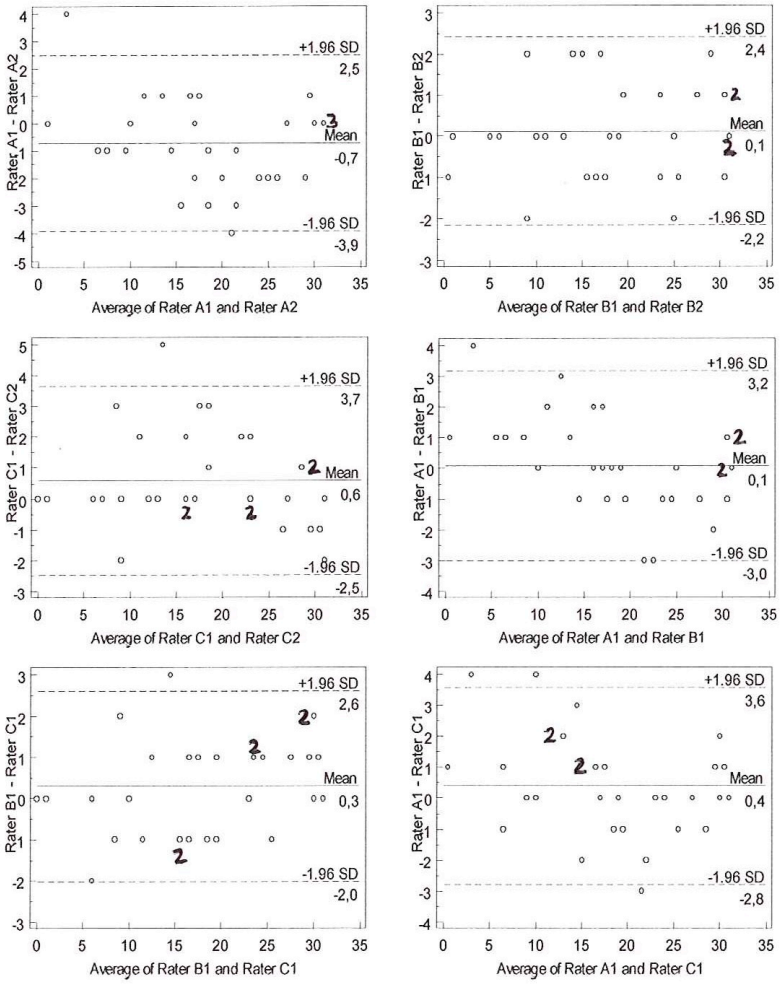
Figure 1.

Mean Mini-BESTest sum scores according to ambulatory level, where participants with stroke (n=24) are described according to Functional Ambulation Classification of the Hospital of Sagunto (FACHS) scores 2-5 (n=6 in each level).

Figure 2.

Bland-Altman plots of the difference against the average of the total Mini-BESTest score of each participant (n=30), presented as pair wise intra-rater (A1-A2, B1-B2, C1-C2) and inter-rater (A1-B1, A1-C1, B1-C1) assessments. A value near an open circle represents the number of subjects at this position, and where the value is not specified, an open circle represents one subject.


Mean total score
32.0
28.0
24.0
20.0
16.0
12.0
8.0
4.0
0.0
(n=6)
(n=6)
(n=6)
(n=6)
(n=6)
FACHS 2
FACHS 3
FACHS 4
FACHS 5
Subjects without stroke


Rater A1 - Rater A2
+1.96 SD
2,5
Mean
-0,7
-1.96 SD
-3,9
Average of Rater A1 and Rater A2
Rater B1 - Rater B2
+1.96 SD
2,4
Mean
0,1
-1.96 SD
-2,2
Average of Rater B1 and Rater B2
Rater C1 - Rater C2
+1.96 SD
3,7
Mean
0,6
-1.96 SD
-2,5
Average of Rater C1 and Rater C2
Rater A1 - Rater B1
+1.96 SD
3,2
Mean
0,1
-1.96 SD
-3,0
Average of Rater A1 and Rater B1
Rater B1 - Rater C1
+1.96 SD
2,6
Mean
0,3
-1.96 SD
-2,0
Average of Rater B1 and Rater C1
Rater A1 - Rater C1
+1.96 SD
3,6
Mean
0,4
-1.96 SD
-2,8
Average of Rater A1 and Rater C1

Appendix: Mini-BESTest

Examiner: _____ Date:_____
Subject: _____

MINI BESTest- of DYNAMIC BALANCE
Balance Evaluation – Systems Test
Copyright 2009

Subjects should be tested with flat-heeled shoes OR shoes and socks off.
If subject must use an assistive device for an item, score that item one category lower. If subject requires physical assistance to perform an item, score the lowest category (0) for that item.

1. SIT TO STAND
(2) Normal: Comes to stand without use of hands and stabilizes independently.
(1) Moderate: Comes to stand WITH use of hands on first attempt.
(0) Severe: Impossible to stand up from chair without assistance –OR- several attempts with use of hands.

2. RISE TO TOES
(2) Normal: Stable for 3 sec with maximum height
(1) Moderate: Heels up, but not full range (smaller than when holding hands)-OR-noticeable instability for 3 s
(0) Severe: ≤ 3 sec

3. STAND ON ONE LEG
Left *Time in sec Trial 1:*_____*Trial 2:*_____
(2) Normal: 20 s
(1) Moderate: < 20 sec
(0) Severe: Unable

Right *Time in sec Trial 1:* _____*Trial 2:*_____
(2) Normal: 20 s
(1) Moderate: < 20 sec
(0) Severe: Unable

4. COMPENSATORY STEPPING CORRECTION- FORWARD
(2) Normal: Recovers independently a single, large step (second realignment step is allowed)
(1) Moderate: More than one step used to recover equilibrium
(0) Severe: No step, OR would fall if not caught, OR falls spontaneously

5. COMPENSATORY STEPPING CORRECTION- BACKWARD
(2) Normal: Recovers independently a single, large step
(1) Moderate: More than one step used to recover equilibrium
(0) Severe: No step, OR would fall if not caught, OR falls spontaneously

6. COMPENSATORY STEPPING CORRECTION- LATERAL
Left
(2) Normal: Recovers independently with 1 step (crossover or lateral OK)
(1) Moderate: Several steps to recovers equilibrium
(0) Severe: Falls, or cannot step

Right
(2) Normal: Recovers independently with 1 step (crossover or lateral OK)
(1) Moderate: Several steps to recovers equilibrium
(0) Severe: Falls, or cannot step

7. EYES OPEN, FIRM SURFACE (FEET TOGETHER)
*Time in sec:*_____
(2) Normal: 30s
(1) Moderate: < 30s
(0) Severe: Unable

8. EYES CLOSED, FOAM SURFACE (FEET TOGETHER)
*Time in Sec:*_____
(2) Normal: 30s
(1) Moderate: < 30s
(0) Severe: Unable

Examiner: _____ Date:_____
Subject: _____

9. INCLINE- EYES CLOSED
*Time in sec:*_____
(2) Normal: Stands independently 30 sec and aligns with gravity
(1) Moderate: Stands independently <30 SEC -OR- aligns with surface
(0) Severe: Unable to stand >10 sec -OR- will not attempt independent stance

10. CHANGE IN GAIT SPEED
(2) Normal: Significantly changes walking speed without imbalance
(1) Moderate: Unable to change walking speed or imbalance
(0) Severe: Unable to achieve significant change in speed AND signs of imbalance

11. WALK WITH HEAD TURNS – HORIZONTAL
(2) Normal: performs head turns with no change in gait speed and good balance
(1) Moderate: performs head turns with reduction in gait speed
(0) Severe: performs head turns with imbalance

12. WALK WITH PIVOT TURNS
(2) Normal: Turns with feet close, FAST (≤ 3 steps) with good balance
(1) Moderate: Turns with feet close SLOW (≥4 steps) with good balance
(0) Severe: Cannot turn with feet close at any speed without imbalance

13. STEP OVER OBSTACLES
(2) Normal: able to step over box with minimal change of speed and with good balance
(1) Moderate: steps over shoe boxes but touches box OR displays cautious behavior by slowing gait.
(0) Severe: cannot step over shoe boxes OR hesitates OR steps around box

14. TIMED UP & GO (ITUG) WITH DUAL TASK *TUG: _____sec; Dual Task TUG: _____sec*
(2) Normal: No noticeable change between sitting & standing in backward counting & no change in gait speed for TUG.
(1) Moderate: Dual task affects either counting OR walking.
(0) Severe: Stops counting while walking OR stops walking while counting.

Examiner: _____ Date:_____
Subject: _____

INSTRUCTIONS:

1. SIT TO STAND

Examiner Instructions: Note the initiation of the movement, and the use of hands on the arms of the chair or their thighs or thrusts arms forward.

Patient: Cross arms across your chest. Try not to use your hands unless you must. Don't let your legs lean against the back of the chair when you stand. Please stand up now.

2. RISE TO TOES

Examiner Instructions: Allow the patient to try it twice. Record the best score. (If you suspect that subject is using less than their full height, ask them to rise up while holding the examiners' hands.) Make sure subjects look at a non-moving target 4-12 feet away.

Patient: Place your feet shoulder width apart. Place your hands on your hips. Try to rise as high as you can onto your toes. I'll count out loud to 3 seconds. Try to hold this pose for at least 3 seconds. Look straight ahead. Rise now.

3. STAND ON ONE LEG

Examiner Instructions: Allow the patient two attempts and record the best. Record the no. of seconds they can hold posture up to a maximum of 30sec. Stop timing when subject moves their hand off hips or puts a foot down. Make sure subjects look at a non-moving target 4-12 feet ahead.

Patient: Look straight ahead. Keep your hands on your hips. Bend one leg behind you . Don't touch your raised leg on your other leg. Stay standing on one leg as long as you can. Look straight ahead. Lift now.
(Repeat other side)

4. COMPENSATORY STEPPING CORRECTION-FORWARD

Examiner Instructions: Stand in front to the side of patient with one hand on each shoulder and ask them to push forward. (Make sure there is room for them to step forward). Require them to lean until their shoulders and hips are in front of their toes. Suddenly release your push when the subject is in place and providing constant pressure to a level just before the heels lift off. The test must elicit a step. NOTE: Be prepared to catch patient.

Patient: Stand with your feet shoulder width apart, arms at your sides. Lean forward against my hands beyond your forward limits. When I let go, do whatever is necessary, including taking a step, to avoid a fall.

NOTE: Be prepared to catch patient.

5. COMPENSATORY STEPPING CORRECTION - BACKWARD

Examiner Instructions: Stand in back to the side of the patient with one hand on each scapula and ask them to push backward. (Make sure there is room for them to step backward.) Require them to lean until their shoulders and hips are in back of their heels. Release your push when the subject is in place, and providing constant pressure to a level just before the heels lift off. Test must elicit a step. NOTE: Be prepared to catch patient.

Patient: Stand with your feet shoulder width apart, arms down at your sides.Lean backward against my hands beyond your backward limits. When I let go, do whatever is necessary, including taking a step, to avoid a fall.

NOTE: Be prepared to catch patient.

6. COMPENSATORY STEPPING CORRECTION- LATERAL

Examiner Instructions: Stand behind the patient, place one hand on either the right (or left) side of the pelvis, and get them to lean their whole body into your hand. Require them to lean until the midline of pelvis is over the right (or left) foot and then suddenly release your hold. NOTE: Be prepared to catch patient if necessary!

Patient: Stand with your feet together, arms down at your sides. Lean into my hand beyond your sideways limit. When I let go, step if you need to, to avoid a fall.

NOTE: Be prepared to catch patient.

Examiner: _____ Date:_____
Subject: _____

SENSORY ORIENTATION

7. EYES OPEN, FIRM SURFACE

Examiner Instructions: Record the time the patient was able to stand to a maximum of 30 seconds.

Patient: Place your hands on your hips. Place your feet together until almost touching. Look straight ahead. Each time, stay as stable as possible until I say stop.

8. EYES CLOSED, FOAM SURFACE

Examiner Instructions: Use medium density Temper® foam, 4 inches thick. Assist subject in stepping onto foam. Tell patient to "Close Eyes" Record the time the patient was able to stand in each condition to a maximum of 30 seconds. Have the subject step off the foam between trials. Include leaning or hip strategy during a trial as "instability."

(Shumway-Cook A and Horak FB. Assessing the influence of sensory interaction on balance. Physical Therapy. 66: 1548 1550, 1986.)

Patient: Place your hands on your hips. Place your feet together until almost touching. Look straight ahead. Each time, stay as stable as possible until I say stop.

9. INCLINE, EYES CLOSED

Examiner Instructions: Aid the patient onto the ramp. Once the patient closes their eyes, begin timing and record and average both times. Note if sway is greater than when standing on firm, level, surface with eyes closed (Item 15 B) or if there is poor alignment to vertical. Assist includes a cane or light touch any time during the trial.

Patient: I will be timing this next assessment. Please stand on the incline ramp with your toes toward the top. Place your feet shoulder width apart. Keep arms at your sides. Place your hand on your hips. I will start timing when you close your eyes.

10. CHANGE IN SPEED

Examiner Instructions: Allow the patient to take 3-5 steps at their normal speed, and then say "fast", after 3-5 fast steps once say "slow". Allow 3-5 slow steps before they stop walking.

Patient: Begin walking at your normal speed, when I tell you "fast" walk as fast as you can. When I say "slow", walk very slowly.

11. WALK WITH HEAD TURNS- HORIZONTAL

Examiner Instructions: Allow the patient to reach their normal speed, and give the commands "right, left" every 3-5 steps. Score if you see a problem in either direction. If patient has severe cervical restrictions allow combined head and trunk movements (enbloc).

Patient: Begin walking at your normal speed, when I say "right", turn your head and look to the right. When I say "left" turn your head and look to the left. Try to keep yourself walking in a straight line.

Examiner: _____ Date:_____
Subject: _____

12. WALK WITH PIVOT TURNS

Examiner Instructions: Demonstrate a pivot turn. Once the patient is walking at normal speed, say "turn and stop." Count the steps from turn" until the subject is stable. Instability may be indicated by wide stance width, extra stepping or trunk motion.

Patient: Begin walking at your normal speed. When I tell you to "turn and stop", turn as quickly as you can to face the opposite direction and stop. After the turn, your feet should be close together.

13. STEP OVER OBSTACLES

Examiner Instructions: Place the box (9" or 22.9 cm height) 10 ft. away from where the patient will begin walking. Use a stopwatch to time gait duration to calculate average velocity by dividing the number of seconds into 20 feet.

Patient: Begin walking at your normal speed. When you come to the shoe boxes (9" or 22.9 cm height), step over them, not around them and keep walking

14. TIMED UP & GO WITH DUAL TASK

Examiner Instructions: Use the TUG score to determine the effects of dual taking.
1) TUG: Have the patient sit with their back against the chair. Time the patient from the time you say "Go" until they return to sitting in chair. Stop timing when the patient's buttocks hit the chair bottom. The chair should be firm with arms to push from if necessary.

2) TUG with Dual Task: While sitting, determine how fast and accurately the patient can count backwards by 3's from a number between 90-100. Then, ask them to count from a different number and after a few numbers say "go". Time the patient from the time you say "go" until they return to the sitting position.

Patient:

1) TUG: When I say "Go", stand up from chair, walk at your normal speed across the tape on the floor; turn around, and come back to sit in the chair. Continue counting backwards the entire time.

2) TUG with Dual Task: Count backwards by 3's starting at _____. When I say "Go", stand up from chair, walk at your normal speed across the tape on the floor; turn around, and come back to sit in the chair. Continue counting backwards the entire time.

11. LIST OF APPENDICES

1. Functional Ambulation Classification Scale of the Hospital of Sagunto (FACHS)
2. Norwegian translation of *the instructions to patients* on the Mini-BESTest
3. Filming procedure
4. Testing procedure
5. Recruitment procedure
6. Letter to the participants
7. Instructions for authors, from the Physical Therapy journal
8. Approval from the Regional Committee for Medical Health Research Ethics (2)
9. Request and informed consent form, for adults with stroke
10. Request and informed consent form, for adults without stroke

Appendix 1

Functional Ambulation Classification Scale
(Viosca, Martinez, Almagro, Gracia, & Gonzalez, 2005)

Score	Description
0	(Nonambulation): Absolute walking incapacity, even with external help.
1	(Nonfunctional ambulation): Dependant walking, which requires the permanent help of others. The patient must be firmly supported by 1 or 2 people, and/or walking is possible only within a therapy session at home, or at the hospital, between parallel bars. This is the only functional level that is not independent and is therefore called nonfunctional.
2	(Household ambulation): Walking is only possible indoor, on flat, horizontal surfaces, usually within a known and controlled area such as in the home.
3	(Surroundings of the house/ neighborhood ambulation): Patients are able to walk indoors and outdoors on uneven surfaces, and they are able to climb an occasional step or chair. Therefore the patient is able to walk in the street, albeit with a limited and restricted walking distance.
4	(Independent community ambulation): Patients are able to walk on all types of irregular surfaces. They can ascend and descend steps or stairs, ramps, curbs etc. They have a considerable, even unrestricted, walking distance, so much so that they are capable of shopping for food and accomplishing other basic chores. However, they are not considered normal walkers because they have aesthetic abnormalities, such as an obvious limp.
5	(Normal ambulation): Walking is completely normal in both distance and appearance, both at home and outside and with an unlimited distance. There is no aesthetic anomaly or limp. They can tiptoe, walking on their heels and in tandem.

Viosca, E., Martinez, J. L., Almagro, P. L., Gracia, A., & Gonzalez, C. (2005). Proposal and validation of a new functional ambulation classification scale for clinical use. *Arch Phys Med Rehabil*(86), 1234-1238.

Appendix 2

Mini-BESTest: arbeidsoversettelse av instruksjoner til forsøkspersoner		
Deltest	**Instruksjon til tester**	**Instruksjon til forsøksperson**
1. Sit to stand/ Sittende til stående	Legg merke til hvordan bevegelsen starter, og hvordan hendene brukes i forhold til armlener/lår mot stol	Kryss armene foran brystet. Prøv og ikke bruke armene, med mindre du er nødt til det. Ikke la føttene dine støttes mot stolen når du reiser deg opp. Nå kan du reise deg opp.
2. Rise to toes/ Stå på tærne	Gi pasienten 2 forsøk. Registrer beste resultat (hvis du tror at pas kan komme høyere opp på tærne be han/henne om å holde dine hender). Vær sikker på at pasienten fokuserer på en gjenstand 2-3 m borte.	Plasser føttene i hoftebreddes avstand. Hold hendene på hoftene. Snart vil jeg b deg om å reise deg opp på tærne så høyt som mulig. Prøv og holde deg oppe på tærne mens jeg teller høyt til tre. Se rett frem. Kom opp på tærne nå.
3. Stand on one leg/ Stå på en fot	Gi pasienten 2 forsøk. Registrer det beste resultatet. Mål hvor lenge pasienten kan holde stillingen i opptil 30 sek. Stopp tidtakingen dersom personen tar bort hendene fra hoftene ellr setter en fot ned. Vær sikker på at pasienten ser på en gjenstand 2-3 m bortenfor.	Se rett frem. Hold hendene på hoftene. Snart vil jeg be deg om å bøye opp en fot bak deg. Ikke la føttene berøre hverandre. Stå på en fot så lenge du klarer. Se rett frem. Løft nå. (Repeter på motsatt ben).
4. Compensatory stepping correction – forward/ Kompensatorisk steg korrigering - fremmover	Stå skrått foran pasienten med en hand på hver av pasientens skuldre. Be pasienten om å lene seg passivt mot din hender (pass på at det er plass til at pasienten kan ta ett skritt frem). Få pasienten til å lene seg forover til skuldre og hofter er foran tærne. Når pasienten står i stillingen slipper du plutselig. Oppgaven skal føre til at pas må ta ett steg. Vær klar til å ta i mot pasienten!	Stå med føttene i skulderbreddes avstand og armene hengende ned langs siden. Len deg forover mot hendene mine og utover din balansegrense. Når jeg slipper, gjør det som er nødvendig for og unngå å falle. Det er tillatt og ta ett steg.
5. Compensatory stepping correction – backward/ Kompensatorisk steg korrigering -	Stå skrått bak pasienten med en hand på hver av pasientens skapulae. Be pasienten om å lene seg passivt mot din hender (pass på at det er plass til at pasienten kan ta ett skritt bakover). Få pasienten til å lene seg bakover til skuldre	Stå med føttene i skulderbreddes avstand og armene hengende ned langs siden. Len deg bakover mot hendene min og utover din balansegrense. Når jeg slipper, gjør det som er nødvendig for og unngå å falle. Det er tillatt å ta ett steg.

bakover	og hofter er bak hælene. Når pasienten står i stillingen slipper du plutselig. Oppgaven skal føre til at pas må ta ett steg. Vær klar til å ta i mot pasienten!	
6. Compnsatory stepping reaction – lateral/ Kompensatorisk steg korrigering - sideveis	Stå skrått bak pasienten med en hånd på høyre el venstre side av bekkenet og be pasienten lene koppen som en blokk/stokk mot din hånd. Få pasienten til å lene seg så mye at bekkenet er over høyre/venstre fot og slipp så plutselig. Vær klar til å ta i mot pasienten!	Stå med føttene samlet og armene hengende ned. Len deg mot siden og mot hånda mi og utover din balansegrense. Når jeg slipper, ta ett steg dersom det er nødvendig for og unngå å falle.
7. Eyes open, firm surface (FT)/ Åpne øyner, fast underlag (føttene samlet)	Unngå forstyrrelser i lokalet. Ta tiden på hvor lang tid pasienten kan stå (opp til 30 sek). Svaien eller hoftestrategien under oppgaven anses som instabilitet.	Plasser hendene på hoftene. Plasser føttene inntil hverandre til de nesten berører hverandre. Se rett frem. Stå så stabilt som mulig til jeg sier stopp.
8. Eyes closed, foam surface	Unngå forstyrrelser i lokalet. Ta tiden på hvor lang tid pasienten kan stå (opp til 30	Plasser hendene på hoftene. Plasser føttene inntil hverandre til de nesten berører hverandre.

(FT)/ Lukka øyner, mykt underlag (samlede føtter)	sek). Hjelp pasienten med å komme opp å stå på skumgummiputa. Svaien eller hoftestrategien under oppgaven anses som instabilitet.	Lukk øynene (AVVIKER FRA engelsk TESTMANUAL). Stå så stabilt som mulig til jeg sier stopp.
9. Incline – eyes closed/ oppoverbakke – lukkede øyner	Hjelp pasienten opp å stå på skråbrettet. Start tidtakingen når personen lukker øynene. Gjenta oppgaven dersom pas ikke er i stand til å stå i 30 sek. og registrer gjennomsnittet av de to resultatene. Noter dersom svaien er større enn når pasienten star med lukkede øyner på gulvet, eller hvis kroppen ikke kan holdes loddrett. Støtte betyr bruk av stokk eller lett berøring på et eller annet tidspunkt under oppgaven.	Jeg vil ta tiden under den neste testen. Stå på skråbrettet med tærne pekende oppover. Plasser føttene i skulderbreddes avstand. (Hold hendene ned langs siden.) Plasser hendene på hoftene. Jeg vil starte tidtakingen når du lukker øynene. (for å sikre lik plassering er neste setning også brukt: plasser føttene rett nedenfor de øverste skruene-IKKE I ENGELSK TESTMANUAL)
10. Change in gait speed/ Forandring i	La pasienten ta 3-5 steg i eget tempo, si deretter "hurtig" og etter pas har tatt ytterligere 3-5 steg si " sakte". La	Begynn med å gå i normalt tempo. Når jeg sier "hurtig": gå så raskt som du kan. Når jeg sier "sakte": gå veldig sakte.

ganghastighet	pasienten ta 3-5 steg før han/hun stanser.	
11. Walk with head turns/ Gange med å snu på hodet	La pasienten finne sitt eget tempo, og gi ved hvert 3.-5. steg kommandoen "se til høyre/venstre" . Noter dersom du observerer problemer i en av retningen. Sjekk bevegelighet i cervical columna før testen. Dersom bevegeligheten er nedsatt kan pasienten rotere trunkus i stedet.	Begynn med å gå i normalt tempo. Når jeg sier "høyre": snu hodet og se mot høyre. Når jeg sier "venstre": snu hodet og se mot venstre. Prøv å gå rett frem hele tiden.
12. Walk with pivot turns/ Gange med helomvending	Vis en snuing på stedet. Når pasienten har begynt å gå i normalt tempo si "snu og stopp". Tell trinnene fra begynnelsen av snuingen og til pasienten står stabilt. Instabilitet kan være bredbeint fotstilling, ekstra skritt eller trunkus- og armbevegelser.	Begynn med å gå i normalt tempo. Når jeg sier " snu og stopp": Snur du deg rundt så raskt du kan slik at du sår med ansiktet vendt i motsatt retning. Etter at du har snudd, skal føttene være nært hverandre.
13. Step over obstacles/ Steg over hindring	Plasser esken 3 cm fra hvor pasienten begynner å gå fra. (Bruk en stoppeklokke for å ta tiden det tar og for å regne ut hastigheten delt på sekunder ovr 20 feet.	Begynn med å gå i normalt tempo. Når du kommer til eskene, steg over (ikke gå rundt dem) og fortsett å gå rett frem.
14. Timed up and go +/- dual task/ Reise deg opp og gå mens jeg tar tiden +/- ekstra oppgave.	1) La pasienten sitte med ryggen lent mot stolryggen. Ta tiden på pasienten fra du sier "gå" og stoppes når personens bakende berører stolsetet igjen. Stolen skal være fast og ha armlener som pasienten kan skyve seg opp fra. 2) I sittende avgjør hvor raskt og nøyaktig pasienten kan telle baklngs på 3 fra ett tall mellom 90 og 100. Så be person om å telle baklengs fra et annet tall og etter et par tall si "gå". Ta tiden på pasienten fra du sier "gå" til pasienten retunerer til sittende igjen.	1) Når jeg sier "gå": reis deg opp fra stolen, gå i normalt tempo mot og forbi tape-merket, snu og gå tilbake og sett deg i stolen. (jeg tar tiden) 2) <u>Alternativ 1</u> Du skal nå trekke tre fra 100 og fortsette å trekke 3 fra det neste tallet (i sittende). Når jeg sier " gå": reis deg opp fra stolen, gå i normalt tempo mot og forbi tape-merket på gulvet, snu rundt og kom tilbake og sett deg i stolen. Fortsett å trekke 3 fra hele tiden. Begynn på 97. <u>Alternativ 2</u> Du skal nevne jentenavn som begynner på A og fortsette og nevne jentenavn med forbokstav

		utover etter alfabetet. (Ellers som alt 1). Alternativ 3 Når jeg sier "gå". Ta med deg koppen med vann, gå i normalt tempo mot og forbi det merket på gulvet. Snu, gå tilbake og sett deg i stolen. Sett fra deg koppen på veien tilbake. (jeg tar tiden).

Appendix 3

Videoopptak av Mini-BESTest			
Deltest	**Forsøkperson**	**Tester**	**Filming** kamera på høykant minus 1b +6
1. Sit to stand	Fra sittende i stol med ben til stående	Ved siden av personen, motsatt siden av filmer	Filmes to ganger: 1. Frontalt: hele personen: ca 4 m avstand, avhengig av personens høyde. 2. Saggitalt: litt ovenfor stolsetet og ned
2. Rise to toes	Stående bak merke på gulv, stol ett stykke bak. 2 forsøk.	Ved siden av, eventuellt fremfor for å holde i hender. Tar tiden.	Midt mellom saggitalt og frontalt plan Hele personen filmes. OBS! få med hælløft.
3. Stand on one leg	Stående bak merke på gulv. Opp på en fot. 2 forsøk	Ved siden av, motsatt side av filmer. Tar tiden.	Frontalt plan Hele personen. Film så lenge personen står
4. Compensatory stepping correction - forward	Stående bak merke på gulv.	Stående fremfor på skrått, hender på personens skuldre.	Saggitalt plan Hele personen
5. Compensatory	Stående foran merke	Stående bak og på	Saggitalt plan

5. Compensatory stepping correction - backward	Stående foran merke på gulv.	Stående bak og på skrått, hender på personens skapula	Saggitalt plan Hele personen
6. Compnsatory stepping reaction – lateral	Stående med føttene samlet. Til begge sider.	Stå bak og på siden av personen	Frontalt plan Hele personen
7. Eyes open, firm surface (FT)	Puta plasseres foran person. Får hjelp til å komme opp.	Stående foran/på siden. Ta tiden.	Midt mellom saggitalt og frontalt Hele personen. Film at personen står opptil 30 sek
8. Eyes closed, foam surface (FT)	Puta plasseres foran person. Får hjelp til å komme opp. Film fra stående på matte.	Stående foran/ på siden. Ta tiden.	Midt mellom saggitalt og frontalt Hele personen. Film at personen står opptil 30 sek
9. Incline – eyes closed	Skråbrettet plasseres fremfor personen. Får hjelp til å gå opp	På siden. Støtt om nødvendig	Saggitalt plan Hele personen. Film at personen står opptil 30 sek
10. Change in gait	Begynne å gå fra bak merke til over	Følger personen	Saggitalt, stå på siden. Midt på. følge personen når han/hun går.

11. Walk with head turns	Begynne å gå fra bak merke til over merket lengst borte.	Følger personen	Frontalt/skrått. Stå i hjørnet i motsatt ende. Hele personen
12. Walk with pivot turns	Begynne å gå fra bak merke og snu se rundt i motsatt retning	Følger personn	Frontalt/skrått. Stå i hjørnet i motsatt ende. Hele personen Filme til personen har snudd seg rundt og står stille
13. Step over obstacles	Begynne å gå fra bak merket, trå over boks og krysse borterste merke	Følger personen	Frontalt/skrått. Stå i hjørnet i motsatt ende. Hele personen Spesielt viktig å få med om personen berører eska og eller senker hastighet for å gjøre trå over.
14. Timed up and go +/- dual task	Fra sittende i stol med bena bak merke til over 3 m merke og tilbake i stol.	Følger personen. Tar tiden.	Frontalt/skrått. Stå i hjørnet i motsatt ende. Hele personen Følg personen mens han/hun går til personen sitter i stolen igjen 2 ganger

Appendix 4

	TESTING – PRAKTISK GJENNOMFØRING		
Tid	Aktivitet	Hvor	Hvem
	Transport til/fra blir avtalt på forhånd.	-	Stine
15min før første person	Klargjøring av testrom (treningsal på rehab avd 2.etg), venteområde (ved inngang i 1.etg) og evt merking for å finne frem	Venteområde og testrom	Stine
5min før testing	Personen ankommer	Venteområde, med informasjon	Stine
<5min	Følge pasient til/fra testrom		Stine/assistent
<5min	Informere personen om hva som skal skje	I testrom	Stine
<5min	Registrere personlige data inkludert FACS skår.	I testrom	Stine.
15min	Gjennomføre mini-BESTest inkludert filming av gjennomføringen	I testrom	Stine instruerer i utførelsen. Assistent filmer
15min	Rydde etter siste pasient		Stine

Appendix 5

Informasjonsskriv til fysioterapeuter ang rekruttering

Hvem kan rekrutteres?

Inklusjonskriterier

- 24 personer (≥18 år) etter hjerneslag som kan: 1) gå ≥6 meter med eller uten stokk, 2) gi informert samtykke til deltakelse. (+ 6 friske kontroll)

Eksklusjonskriterier

Personer som har alvorlige kognitive og/eller kommunikasjons vansker slik at de ikke kan følge instruksjonene for gjennomføringen av testen, vil bli ekskludert.

Hvordan?

Prosedyre for rekruttering

1. Aktuelle kandidater mottar muntlig og skriftig informasjon om forespørsel om deltakelse i forskningsstudien som undersøker et nytt måleinstrument for vurdering av balanse etter hjerneslag.
   - Nødvendig informasjon om studien står i forespørselskjemaet. Les gjerne gjennom dette sammen med pasient.
   - Gi informasjon om at testing vil gjennomført ved Bodø kommune sin rehabiliteringsavdeling (Gamle Riksvei 18, 2.etg) og bli gjennomført høst 2011. Dersom behov for drosje vil dette bli dekket.
   - Fysioterapeuten undertegner 2 eksemplarer av skjemaet på at han/hun har gitt informasjon, og gir disse til pasienten sammen med ferdig frankert svarkonvolutt.

2. Personer som ønsker å delta i studien signerer forespørselskjemaene og retunerer det ene eksemplaret i ferdig frankert svarkonvolutt (dette for at personen skal få betenkningstid og hindre at personen føler seg presset til deltakelse). Det andre eksemplaret beholder personen selv. Dersom personen ønsker det kan han/hun levere underskrevet skjema direkte til deg, eller til meg når han/hun skal testes.

3. Fysioterapeuten kontakter Stine (stine_susanne@hotmail.com) med navn og telefonnummer til pasienten. Trenger også informasjon om gangfunksjonsnivå. Bruk skala på neste side (FACHS) og angi en skår fra 2-5.

4. Stine kontakter de aktuelle personene som skal delta og avtaler tidspunkt for undersøkelsen og evt. transport.

Appendix 6

Til

Deltakelse i forskningsprosjektet ”Intertester og intratester reliabilitet av mini-Balance Evaluation Systems Test for balanse etter hjerneslag”

Mange takk for at du tar deg tid til å delta i dette prosjektet som handler om balanse etter hjerneslag.

Tidspunkt for undersøkelsen:

Sted: Rehabiliteringssenteret Bodø kommune, Gamle Riksvei 18, 8008 Bodø.

Ved ankomst kan du sette deg i sofagruppen rett innenfor inngangen i 1.etg. Jeg eller Marthe (som er forskningsassistent) vil komme og hente deg der. Selve undersøkelsen vil foregå på treningssalen i 2. etg. Skulle utgangsdøren være låst når du ankommer kan du ringe på ringeklokken ”rehabiliteringsavdelingen 2.etg”.

Antrekk under undersøkelsen er shorts og t-skjorte/tynn genser (det er muligheter for å skifte på stedet) og lave sko eller uten sko og sokker. Dersom du har behov for krykke/stokk og/eller orthose må du ta dette med.

Ta gjerne kontakt med meg dersom du har spørsmål.

Med vennlig hilsen

Stine Susanne Haakonsen Dahl
Spesialfysioterapeut Bodø kommune, masterstudent ved Universitet i Tromsø.

stine_susanne@hotmail.com
Telefon:

Appendix 7

Information for Authors: Requirements for Measurement-Focused Studies

PTJ endorses the *Uniform Requirements for Manuscripts Submitted to Biomedical Journals* put forth by the International Committee of Medical Journal Editors (ICMJE). **PTJ** follows the *American Medical Association [AMA] Manual of Style*, 10th ed, published by Williams & Wilkins (Baltimore, Md). **PTJ** promotes "people-first" language. That is, patients and subjects should not be referred to by disability or condition (eg, use "patients who have had a stroke" or "patients with stroke," rather than "stroke patients" or "stroke survivors").

Formatting | Statistics | Ethical Approval/Informed Consent | Photo/Video Release | Reprinted Materials | Related Articles | Raw Data | Forms Required at Submission | Editorial Policies | Review/Publication Policies | Author Assistance | Submit Manuscript

For studies that examine the reliability of a measurement or series of measurements, sample sizes must be of adequate size to be generalized. The study must make a clear and compelling argument for how the findings would have an impact on clinical practice. Such issues as single score interpretation (SEM) and the interpretation of change scores (MDC) for the measures should be explicitly addressed.

As indicated by the objectives of the study, authors should report appropriate test results, including:

- Estimates of reliability in the same units as the test to aid in clinical interpretation (eg, for quantitative data, the ICC with 95% CI are appropriate, along with single score error estimates such as the SEM; for nominal and ordinal level data, the kappa or weighted kappa are commonly used)
- Evidence for content, criterion-based, and/or construct validity
- Information on the interpretability and clinical meaningfulness of measurements

Formatting

All manuscripts must be formatted double-spaced, with pages AND lines numbered. Please use 12-point font. Submit both a masked copy and an unmasked copy. In the masked version, please remove author names and any affiliations within the article.

Sections, in order of appearance: (1) Title page, (2) Abstract, (3) Body of article, (4) Acknowledgments, (5) References, (6) Tables, (7) Figure legends, (8) Figures, (9) Video legends, (10) Appendixes.

Title. Titles should not be vague and should reflect measured variables. For instance, instead of using "physical therapy" to refer to intervention, state specific interventions (eg, "strengthening exercises"). Titles (including subtitles) should be no longer than ***150 characters (including punctuation and spaces)***.

Abstract. Word limit: 275 words. Structure: Background, Objective, Design, Methods, Results, Limitations, Conclusions.

Body of Manuscript. Word limit: 4,500 words (excluding abstract and references). Please provide the manuscript word count on the abstract page of your manuscript. Sections: Introduction, Methods, Results, and Discussion. The Discussion section ideally should contain no more than 5 paragraphs and should address:

- statement of principal findings
- strengths and weaknesses of the study
- strengths and weaknesses in relation to other studies, discussing important differences in results
- meaning of the study: possible explanations and implications for clinicians and policymakers
- unanswered questions and future research

Acknowledgments. Acknowledgments should be formal and as brief as possible and limited to recognizing individuals who have made specific and important contributions to the work being reported.

References. 50 or fewer. References should be listed in the order of appearance in the manuscript, by numerical superscripts that appear consecutively in the text. If you use End Notes, please use version 6.0 or higher.

Tables. Tables should be formatted in Word, numbered consecutively, and placed together.

In tables that describe characteristics of 2 or more groups:

- Report averages with standard deviations when data are normally distributed.
- Report median (minimum, maximum) or median (25th, 75th percentile [interquartile range, or IQR]) when data are not normally distributed.

There should be no more than 6 tables and figures (total). Additional tables and figures can be posted online only.

For more information, see "Tips for Figures and Tables."

Figures. For peer-review purposes, figures can be attached to the manuscript after the figure legends; however, figures also should be submitted as separate, high-res graphic files in tif, jpg, eps, or pdf format, with the resolution set at a minimum of 300 dpi. The separate image files will help **PTJ** staff to produce the sharpest images both in print and online. Rule of thumb: the larger the figure (eg, 8.5" × 11"), the better. If electronic formats are not available to you, figures must be submitted as 5" × 7" camera-ready glossies and mailed to the Editorial Office. Figures should be numbered consecutively. For helpful guidelines on submitting figures online, visit Cadmus Journal Services. Lettering should be large, sharp, and clear, and abbreviations used within figures should agree with Journal style. Color photographs are encouraged, in sharp focus and with good contrast.

There should be no more than 6 tables and figures (total). Additional tables and figures can be posted online only.

Appendix 8

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK nord	May Britt Rossvoll	77620757	24.06.2011	2011/1052/REK nord
			Deres dato:	Deres referanse:
			10.05.2011	

Vår referanse må oppgis ved alle henvendelser

Lone Jørgensen
Breivika

2011/1052 Inter og intratester reliabilitet av mini- Balance Evaluation Systems Test for dynamisk balanse på voksne etter hjerneslag

Vi viser til søknad om forhåndsgodkjenning av ovennevnte forskningsprosjekt. Søknaden ble behandlet av Regional komité for medisinsk og helsefaglig forskningsetikk i møtet 16.06.2011.
Forskningsansvarlig: Gyrd Thrane
Prosjektleder: Lone Jørgensen

Prosjektomtale (original):
Balansen er ofte redusert hos personer etter hjerneslag og dette kan føre til nedsatt funksjonsnivå og økt risiko for fall. Standardiserte måleinstrumenter er viktig i behandling og rehabilitering av balanseforstyrrelser. Mini-Balance Evaluation Systems Test er et nytt måleinstrument for dynamisk balanse som det er behov for nærmere undersøkelser av. Denne studien har som hensikt å bidra i utviklingen av Mini-BESTest gjennom å undersøke intertester og intratester reliabilitet anvendt på voksne etter hjerneslag. 30 voksne (>=18 år) vil bli inkludert, derav 24 personer etter hjerneslag som kan gå >=6 meter med eller uten stokk og som kan gi informert samtykke til deltakelse, og 6 friske voksne. Testing av hver person vil bli filmet etter standardisert prosedyre. Intertester reliabilitet undersøkes ved å sammenlikne skår avgitt av 3 ulike fysioterapeuter. Intratester reliabilitet testes ved å sammenlikne skår fra samme fysioterapeut ved to anledninger. Kvantitative analyser vil bli gjort.

Komiteens vurdering
Dette er en god masteroppgave, med en god prosjektbeskrivelse. Metoden som skal brukes går ut over vanlig behandlingsopplegg og innebærer direkte kontakt mellom forsker og forskningsdeltaker. Dette skjerper kravet til at prosjektet skal kunne fremskaffe ny kunnskap om sykdom eller helse. Komiteen vurderer at prosjektet er relevant innenfor fagområdet og vil kunne fremskaffe generérbar kunnskap. Komiteen vurderer således at prosjektet oppfyller helseforskningslovens krav med hensyn til å fremskaffe ny kunnskap om helse og sykdom.

Rekruttering
Det er opplyst at pasienter informeres om studien av sin fysioterapeut. Komiteen minner om at dersom forskningsdeltakeren kan anses å være i et slikt avhengighetsforhold til den som ber om samtykke, at forskningsdeltakeren vil kunne føle seg presset til å gi samtykke, så skal det informerte samtykket innhentes av en annen som forskningsdeltakeren ikke har slikt forhold til jf helseforskningsloven § 13. Svar på forespørsel om deltakelse bør ikke innhentes i en konsultasjons-/behandlingssituasjon og det må ikke avkreves et aktivt nei-svar hvis man ikke vil delta. Det må gis betenkningstid slik at de forespurte kan rådføre seg med andre. Et eventuelt samtykke til deltakelse må kunne leveres/sendes inn på eget initiativ. Komiteen forutsetter at den forespurte, etter å ha fått informasjon om studien fra fysioterapeut, får med seg

Besøksadresse:
TANN-bygget Universitetet i Tromsø
9037 Tromsø

Telefon: 77644000
E-post: rek-nord@fagmed.uit.no
Web: http://helseforskning.etikkom.no/

forespørsel med ferdig adressert og frankert konvolutt, hjem slik at han/hun eventuelt kan sende sitt samtykke direkte til prosjektet.

Forespørsel/informasjonsskriv/samtykkeerklæring
Det må av forespørselen fremgå at det vil bli foretatt loddtrekning dersom flere enn det er plass for i studie er interesserte i å delta.

I henhold til malen skal punktene fra kapittel B (Personvern, Rett til innsyn og sletting av opplysninger) også være med i en forespørsel om deltakelse i forskningsprosjekt. Disse punktene kan stå som et eget kap B eller tas inn i hoveddelen.

Vedtak
Med hjemmel i helseforskningsloven § 10 og forskningsetikkloven § 4 godkjennes prosjektet. Før prosjektet kan igangsettes må det sendes inn revidert informasjonsskriv i tråd med komiteens merknader.

Prosjektet godkjennes under forutsetning av at de vilkårene som er anført ovenfor blir innarbeidet før prosjektet settes i gang.

Godkjenningen av prosjektet gjelder til 30.06.2013. Av dokumentasjonshensyn skal opplysningene likevel bevares inntil 30.06.2018. Opplysningene skal deretter slettes eller anonymiseres, senest innen 31.12.2018.

Opplysningene skal lagres avidentifisert, det vil si adskilt i en nøkkel- og en opplysningsfil.

Forskningsprosjektets data skal oppbevares forsvarlig, se personopplysningsforskriften kapittel 2, og Helsedirektoratets veileder for «Personvern og informasjonssikkerhet i forskningsprosjekter innenfor helse- og omsorgssektoren».

Prosjektet skal sende sluttmelding til REK nord på fastsatt skjema senest 31.12.2013.

I tillegg til vilkår som fremgår av dette vedtaket, er tillatelsen gitt under forutsetning av at prosjektet gjennomføres slik det er beskrevet i søknaden og protokollen, og de bestemmelser som følger av helseforskningsloven med forskrifter.

Dersom det skal gjøres endringer i prosjektet i forhold til de opplysninger som er gitt i søknaden, må prosjektleder sende endringsmelding til REK. Vi gjør oppmerksom på at hvis endringene er "vesentlige", må prosjektleder sende ny søknad, eller REK kan pålegge at det sendes ny søknad.

Komiteens vedtak kan påklages til Den nasjonale forskningsetiske komité for medisin og helsefag, jfr. helseforskningsloven § 10, 3 ledd og forvaltningsloven § 28. En eventuell klage sendes til REK nord. Klagefristen er tre uker fra mottak av dette brevet, jfr. forvaltningsloven § 29.

Vi ber om at tilbakemeldinger til komiteen og prosjektendringer sendes inn på skjema via vår saksportal: http://helseforskning.etikkom.no. Øvrige henvendelser sendes på e-post til post@helseforskning.etikkom.no.

Vennligst oppgi vårt referansenummer i korrespondansen.

Med vennlig hilsen,

May Britt Rossvoll
Kontorsjef
77620757

Monika Rydland Gaare
førstekonsulent

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK nord	Monika Rydland Gaare	77620756	16.09.2011	2011/1052/REK nord
			Deres dato:	Deres referanse:
			14.09.2011	

Vår referanse må oppgis ved alle henvendelser

Lone Jørgensen
Breivika

2011/1052 Inter og intratester reliabilitet av mini- Balance Evaluation Systems Test for dynamisk balanse på voksne etter hjerneslag

Vi viser til tilbakemelding av 14.09.2011 og bekrefter med dette å ha mottatt forespørsel om deltakelse til kontrollgruppe.

Ved gjennomgang av begge forespørslene, til pasienter og kontrollgruppe, ser vi at avsnittet fra malens kap. B - "Rett til innsyn og sletting av opplysninger om deg" er utelatt. Vi ber om at dette avsnittet settes inn i begge forespørslene.

Utover dette har vi ingen kommentarer til forespørslene. Vi ber om å få reviderte forespørsler i henhold til overnevnte til vårt arkiv. Prosjektet kan igangsettes.

Vi ber om at tilbakemeldinger til komiteen og prosjektendringer sendes inn på skjema via vår saksportal: http://helseforskning.etikkom.no. Øvrige henvendelser sendes på e-post til post@helseforskning.etikkom.no.

Vennligst oppgi vårt referansenummer i korrespondansen.

Med vennlig hilsen,

Monika Rydland Gaare
førstekonsulent

Kopi til:

Besøksadresse:
TANN-bygget Universitetet i Tromsø 9037 Tromsø

Telefon: 77646140
E-post: rek-nord@fagmed.uit.no
Web: http://helseforskning.etikkom.no/

Appendix 9

Forespørsel om deltakelse i forskningsprosjektet

"Intertester og intratester reliabilitet av mini-Balance Evaluation Systems Test for dynamisk balanse etter hjerneslag"

Bakgrunn og hensikt

Dette er et spørsmål til deg om å delta i en forskningsstudie som undersøker et nytt måleinstrument for vurdering av balanse etter hjerneslag. I dette brevet får du en oversikt over hva studien og hva deltakelse i studien innebærer. Etter å ha lest dette ønskes det at du vurderer om deltakelse kan være aktuelt for deg.

Kriterier for deltakelse

For å kunne delta i studien må du ha hatt hjerneslag, være over 18 år, kunne gå alene med eller uten stokk minimum 6 meter og du må kunne gi informert samtykke til deltakelse.

Hva innebærer studien?

Studien innebærer testing av balanse gjennom ulike oppgaver i stående og gående. Testingen vil foregå i skjermede lokaler på Rehabiliteringssenteret i Bodø kommune i løpet av september-oktober 2011. Hver person vil gjennomføre en test som vil ta ca 15 min å gjennomføre for hver deltaker. To personer vil være til stede under testingen. Disse er fysioterapeut Stine Susanne Dahl (som vil instruere deg i testen) og en assistent. Videoopptak vil bli tatt av deg mens du gjennomfører testen. Videoopptakene vil senere bli vist for 3 uavhengige fysioterapeuter som deretter vil skåre testen.

Vi vil også spørre deg noen spørsmål. Opplysningene som vi vil registrere om deg er: kjønn, alder, dato for hjerneslaget, type hjerneslag, skadelokalisasjon i hjernen og generelt funksjonsnivå.

Mulige fordeler og ulemper

Det vil ikke koste deg noe å delta i studien og du vil få dekket eventuelle utgifter til transport. Erfaringer fra studien vil senere kunne hjelpe andre med balanseproblemer etter hjerneslag. Under testingen kan du når som helst be om pauser, og stol og drikke vil være tilgjengelig i rommet.

Hva skjer med videoopptaket og informasjonen om deg?

Videoopptaket og informasjonen som registreres om deg skal kun brukes slik som beskrevet i hensikten med studien. Alle personene som er involvert i gjennomføringen av studien har taushetsplikt.

Alle opplysninger og videoopptak vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger (avidentifisert). En kode knytter deg til dine opplysninger og videoopptak gjennom en navneliste som lagres separert. Det er kun autorisert personell knyttet til prosjektet som har adgang til navnelisten og som kan finne tilbake til deg. Videoopptak og opplysningene vil bli lagret avidentifisert innelåst i skap på Rehabiliteringssenteret, Bodø kommune. Dataene vil bli oppbevart inntil 30.06.2018 og slettet senest 31.12.2018.

Studien vil bli publisert som en mastergradsoppgave ved Mastergrad i klinisk nevrologisk fysioterapi ved Universitetet i Tromsø og det er Universitet i Tromsø som står som ansvarig for studien. Studien kan senere bli publisert nasjonalt eller internasjonalt i fagtidsskrift og eller på fagkongress. Når resultatene offentliggjøres vil ikke identiteten din kunne gjenkjennes.

Økonomi

Fysioterapeut Stine Susanne Dahl får økonomisk støtte til gjennomføring av studiet av Bodø kommune og Fondet til etter- og videreutdanning av fysioterapeuter. Det er ingen interessekonflikter å oppgi.

Forsikring

Pasientskadeerstatningsloven gjelder ved deltagelse i studien.

Rett til innsyn og sletting av opplysninger om deg og sletting av filmopptak

Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Du har videre rett til å få korrigert eventuelle feil i de opplysningene vi har registrert. Dersom du trekker deg fra studien, kan du kreve å få slettet innsamlede opplysninger og filmopptak, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Informasjon om utfallet av studien

Deltakerne har rett til å få informasjon om utfallet/resultatet av studien.

Frivillig deltakelse

Det er frivillig å delta i studien. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke til å delta i studien. Dette vil ikke få konsekvenser for din videre fysioterapibehandling.

I dette studiet er det behov for 24 deltakere. Dersom flere enn dette er interesserte i å delta vil det bli foretatt loddtrekning. Du vil bli kontaktet når det er klart hvem som får tilbud om å delta i studiet.

Dette informasjonsbrevet sendes deg i to kopier. Dersom du ønsker å delta, undertegner du samtykkeerklæringen på siste side og sender ett eksemplar til fysioterapeut Stine Susanne Dahl, Rehabiliteringsavdelingen Bodø kommune, Gamle Riksvei 18, 8008 Bodø. Det andre eksemplaret beholder du selv. Dersom du ønsker ytterligere informasjon om studiet, kan du

kontakte fysioterapeut Stine Susanne Dahl på telefon 40473368/ 75554360 eller e-post: stine_susanne@hotmail.com. Stine Susanne Dahl er student ved Mastergrad i klinisk nevrologisk fysioterapi ved Universitet i Tromsø og skal både gjennomføre testingen og bruke resultatene i sin mastergradsoppgave.

Samtykke til deltakelse i studien

Jeg er villig til å delta i studien

(Signert av prosjektdeltaker, dato)

Jeg bekrefter å ha gitt informasjon om studien

(Signert, rolle i studien, dato)

Appendix 10

Forespørsel om deltakelse i forskningsprosjektet

"Intertester og intratester reliabilitet av mini-Balance Evaluation Systems Test for dynamisk balanse etter hjerneslag"

Bakgrunn og hensikt

Dette er et spørsmål til deg om å delta i en forskningsstudie som undersøker et nytt måleinstrument for vurdering av balanse etter hjerneslag. I dette brevet får du en oversikt over hva studien og hva deltakelse i studien innebærer. Etter å ha lest dette ønskes det at du vurderer om deltakelse kan være aktuelt for deg.

Kriterier for deltakelse

Dette studiet inkluderer hovedsaklig personer som har gjennomgått hjerneslag. I tillegg skal det inkluderes 6 friske personer som kontrollgruppe. Dette er en forespørsel om å delta som en av de friske personene. Kriteriene for deltakelse er at du er over 18 år, at du ikke har problemer med balansen og at du kan gi informert samtykke til deltakelse.

Hva innebærer studien?

Studien innebærer testing av balanse gjennom ulike oppgaver i stående og gående. Testingen vil foregå i skjermede lokaler på Rehabiliteringssenteret i Bodø kommune i løpet av september-oktober 2011. Hver person vil gjennomføre en test som vil ta ca 15 min å gjennomføre for hver deltaker. To personer vil være til stede under testingen. Disse er fysioterapeut Stine Susanne Dahl (som vil instruere deg i testen) og en assistent. Videoopptak vil bli tatt av deg mens du gjennomfører testen. Videoopptakene vil senere bli vist for 3 uavhengige fysioterapeuter som deretter vil skåre testen.

Opplysningene vi vil registrere om deg er: skår på testen, kjønn og alder.

Mulige fordeler og ulemper

Det vil ikke koste deg noe å delta i studien og du vil kunne få dekket eventuelle utgifter til transport. Erfaringer fra studien vil senere kunne hjelpe personer med balanseproblemer etter hjerneslag. Under testingen kan du når som helst be om pauser, og stol og drikke vil være tilgjengelig i rommet.

Hva skjer med videoopptaket og informasjonen om deg?

Videoopptaket og informasjonen som registreres om deg skal kun brukes slik som beskrevet i hensikten med studien. Alle personene som er involvert i gjennomføringen av studien har taushetsplikt.

Alle opplysninger og videoopptak vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger (avidentifisert). En kode knytter deg til dine opplysninger og videoopptak gjennom en navneliste som lagres separert. Det er kun autorisert personell knyttet til prosjektet som har adgang til navnelisten og som kan finne tilbake til deg. Videoopptak og opplysningene vil bli lagret avidentifisert innelåst i skap på Rehabiliteringssenteret, Bodø kommune. Dataene vil bli oppbevart inntil 30.06.2018 og slettet senest 31.12.2018.

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Økonomi

Fysioterapeut Stine Susanne Dahl får økonomisk støtte til gjennomføring av studiet av Bodø kommune og Fondet til etter- og videreutdanning av fysioterapeuter. Det er ingen interessekonflikter å oppgi.

Rett til innsyn og sletting av opplysninger om deg og sletting av filmopptak

Hvis du sier ja til å delta i studien, har du rett til å få innsyn i hvilke opplysninger som er registrert om deg. Du har videre rett til å få korrigert eventuelle feil i de opplysningene vi har registrert. Dersom du trekker deg fra studien, kan du kreve å få slettet innsamlede opplysninger og filmopptak, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Informasjon om utfallet av studien

Deltakerne har rett til å få informasjon om utfallet/resultatet av studien.

Frivillig deltakelse

Det er frivillig å delta i studien. Du kan når som helst og uten å oppgi noen årsak trekke ditt samtykke til å delta i studien.

I dette studiet er det behov for 6 ”friske” deltakere. Dersom flere enn dette er interesserte i å delta vil det bli foretatt loddtrekning. Du vil bli kontaktet når det er klart hvem som får tilbud om å delta i studiet.

Dette informasjonsbrevet sendes deg i to kopier. Dersom du ønsker å delta, undertegner du samtykkeerklæringen på siste side og sender ett eksemplar til fysioterapeut Stine Susanne Dahl, Rehabiliteringsavdelingen Bodø kommune, Gamle Riksvei 18, 8008 Bodø. Det andre eksemplaret beholder du selv. Dersom du ønsker ytterligere informasjon om studiet, kan du kontakte fysioterapeut Stine Susanne Dahl på telefon 75554360 eller e-post: stine_susanne@hotmail.com. Stine Susanne Dahl er student ved Mastergrad i klinisk nevrologisk fysioterapi ved Universitet i Tromsø og skal både gjennomføre testingen og bruke resultatene i sin mastergradsoppgave.

Samtykke til deltakelse i studien

Jeg er villig til å delta i studien

(Signert av prosjektdeltaker, dato)

Jeg bekrefter å ha gitt informasjon om studien

(Signert, rolle i studien, dato)