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Development and Validation of the Function In Sitting Test (FIST) in Adults with Acute Stroke

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Development and Validity of the Function In Sitting Test (FIST) in Adults with Acute Stroke

by

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MANUSCRIPT

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Dedication and Acknowledgements

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Development and Validity of the Function In Sitting Test (FIST)

in Adults with Acute Stroke

Sharon L. Gorman, PT, MS, GCS

Background and Purpose: Current studies indicate that sitting balance ability is a substantial predictor of functional recovery after stroke. No gold standard for sitting balance assessment currently exists for adults post stroke. Commonly used balance measures also do not isolate sitting balance abilities. The Function In Sitting Test (FIST), a functional, performance-based test, was developed, pilot tested, and analyzed to establish a reliable and valid shorter test.

Methods: The original FIST was constructed after interviews with 15 physical therapists and review of existing balance measures. Surveys of 12 physical therapists with expertise in measurement construction, balance assessment, and/or research examined the individual FIST items and scoring scale. Thirty-one adults diagnosed with stroke in the prior 3 months pilot tested the FIST.

Results: An 83.3% return rate of expert panel surveys and weighted rank analysis reduced the number of FIST items from 26 to 17 items. Item Response Theory (IRT) analysis reduced the FIST by 3 additional items after pilot testing in adults post stroke. Person separation index of 0.978 and coefficient alpha of 0.98 indicated high internal consistency of the FIST. IRT analysis demonstrated content validity and construct validity. Concurrent validity is high via correlations to modified Rankin Scale and static and dynamic balance grades.

Discussion and Conclusions: The FIST, a 14 item, function-based tool for the assessment of seated postural control, is reliable and valid in adults post acute stroke. Intra/inter-

tester reliability and evaluative validity studies are recommended, followed by validation studies in other populations with sitting balance dysfunction.

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Background and Purpose

Approximately 795,000 persons a year suffer a stroke with an estimated 4.7 million survivors living in the US.[1, 2] Stroke is the leading cause of serious long-term disability in the US.[2] Falls due to balance deficits are one of the most common and devastating consequences after a stroke.[2, 3] Post stroke interventions to reduce falls, facilitate function, and improve quality of life rely in part on the identification of balance deficits and their quantification in an accurate and reliable manner. Over the last 10 years, assessment has focused on the standing components of balance, with a variety of standardized tests and measures created, validated, and reported in the literature.[3-8] However, no gold standard exists for the measurement of sitting balance or seated postural control in patients with neurological impairments including stroke.[9] The purpose of this methodological study was to develop a valid performance-based, functional measure of sitting balance for patients post stroke.

Despite the multitude of balance assessment tools available to clinicians, most existing tools incorporate limited or no measures specifically targeting sitting balance (Table 1).[3-9] These balance tests have been designed to primarily quantify standing and walking balance, thereby having limited use in patients with less functional skills during the acute phase after stroke.[10] When sitting balance test items are included in balance tests, the items are primarily focused on only one domain of sitting balance, such as static balance during quiet sitting. Components of sitting balance including the ability to control sitting balance statically during quiet sitting (steady state control), move oneself in sitting while maintaining seated postural control (proactive control), maintain seated postural control with external environmental perturbations (reactive control), or

incorporate function while sitting are rarely included in a balance inventory.[11] Current measures that include sitting balance items tend to examine the ability of the motor system during proactive postural control.[9, 12, 13] These assessment tools' ability to capture all aspects of sitting balance is limited. Many current tests do not include items important to sitting balance such as lateral control,[14] nor do they assess the influence of the lower extremities in sitting balance control. Assessment of postural control including the inputs of motor and sensory systems, as well as the need to examine steady state, proactive, and reactive balance control, should be reflected in any sitting balance test. Few, specific balance tests, do not have published reliability or validity data nor focus on trunk control during functional task performance. [9, 12, 13, 15]

Scoring systems for some balance assessments that include sitting balance items are often dichotomous and require large changes in function to show improvement in the score.[15, 16] Adults post stroke with lower level functional abilities do not quickly change their scores in the acute phase. The score cannot be used as an indicator of improved function in the short term.[8, 17] Also, these tests are long, precluding practical clinical use with adults having acute strokes, lower functional abilities, and limitations in endurance.[16]

Current balance measures are also not appropriate or sensitive for patients with significant impairments post stroke because they cannot perform the complex, advanced mobility tasks included in the test, such as standing or ambulating independently. Thus documentation of continued improvement after a stroke becomes difficult, if not impossible, and can limit continued insurance coverage of rehabilitation services. [18] Therapists are forced to rely on subjective descriptions of progress in basic transfers,

sitting stability, safety, and assistance needed.[9, 13, 15, 19] A measure of specific sitting balance dysfunction may be more suited as a measure in lower functioning persons in the acute phase after stroke.

Multiple studies have found sitting balance to be a valid predictor for functional recovery after stroke.[8, 20-22] Significant predictors of functional return after stroke include basic tasks performed in sitting that require balance.[23-25] People who had poor or impaired sitting balance were less likely to be discharged to home settings or to live independently after a stroke.[26] The creation of a functional, reliable, and valid measure of sitting balance could be useful in the prediction of functional recovery after stroke, especially in the acute phase. Improved measurement of sitting balance may benefit rehabilitation healthcare providers by helping to prognose functional recovery more accurately and earlier in the initial period post stroke.

The purpose of this methodological study was to develop and validate the Function In Sitting Test (FIST) for the assessment of sitting balance deficits in adults with acute stroke. The FIST is a new, performance-based balance measure aimed at comprehensive, specific, efficient, and functional assessment of sitting balance by the physical therapist at the patient's bedside. This study was designed to potentially reduce the number of test items on the FIST, to determine the FIST's internal consistency, and to describe the content, construct, concurrent, and face validity of the FIST.

Methods

This methodological study was approved by the Institutional Review Boards of San Francisco State University and Alta Bates Summit Medical Center, and the Committee for Human Research at the University of California, San Francisco (UCSF).

Study Participants

The original iteration of the FIST was created by open-ended interviews with 15 physical therapists working with persons post stroke from the San Francisco Bay Area, a review of other clinical measures of balance (Table 1), and information about documentation and quantification of sitting balance ability common in clinical settings. An expert panel of 12 physical therapists, researchers, and others with expertise in balance dysfunction also participated in this study via written feedback on the first version of the FIST to determine utility of the test items and adequacy of the scoring system. Thirty-one participants status post acute stroke with significant functional disability were recruited from the UCSF Medical Center and Alta Bates Medical Center for pilot testing. Power analysis to achieve a beta of 0.80 and to detect statistically significant correlations at the 0.50 level, with an alpha of 0.05 indicated a need for 29 participants.[27]

Wide inclusion and specific exclusion criteria were created for the post stroke participants (Table 2). Participants required a medical diagnosis of stroke during the previous three months, as this population would likely be assessed with the FIST in a clinical situation.[28] To ensure adequate floor and ceiling effects of the FIST, a large range in the level of participants' functional ability was needed so participants demonstrated a wide range of scores.[28] Participants in all settings including acute hospitals, inpatient rehabilitation units, skilled nursing facilities, outpatient facilities, and home care agencies were eligible for participation.

Potential participants with severe cognitive deficits were excluded from the study due to inability to follow testing procedures. Participants with medical conditions, such

as unstable angina or blood pressure, medical complications, recent total hip replacement surgery, or other conditions placing them at risk while performing the test battery were excluded from the study. Participants were not eligible for study participation if diagnosed with prior subarachnoid hemorrhage or multiple transient ischemic attacks. To be eligible for the study, participants were required to have "moderate," "moderately severe" or "severe" disability according to the modified Rankin Scale (mRS).[29] This severity level ensured that the final version of the FIST best reflected a measure appropriate for adults with a high likelihood of sitting balance dysfunction.[28] Participants were screened via a questionnaire (Appendix A) after being referred to the study to determine eligibility. Consent forms were signed by all adults post stroke who participated. The consent form allowed for surrogate consent if participants showed impaired cognition (Mini Mental Status Exam score of less than 24) determined during the general screening process.

Measurements

The initial FIST consisted of 26 items. The constructs theorized to be examined by each item were reviewed to include sensory, motor, proactive, reactive, and steady state balance factors during the creation of the FIST (Table 3). The items were created and selected from a review of other currently available measures, factors considered important for safe sitting balance, and interviews with 15 clinicians treating adults post stroke.[9, 12, 13, 15, 30-43] An ordinal scale (0-4) was created to score each individual test item (Appendix B). This original version of the FIST was critiqued by the expert panel prior to testing on participants. Twelve researchers, neurologic clinical specialists in physical therapy, and balance experts, were sent a written qualitative survey to determine content

and face validity of the FIST (Appendix C). Questions addressed the items and the scoring mechanism. Rank order analysis was used to eliminate items based on survey results of the expert panel to shorten the FIST prior to data collection in patients post stroke. This analysis shortened the FIST to 17 items, which were pilot tested on the post-stroke participants (Table 3).

All participants were tested using one of two alternate versions of the 17 item FIST which took no more than 30 minutes to complete (Appendix B). Each participant sat at the edge of a standard hospital bed without air mattresses and the proximal thigh (1/2 femur length) supported by the bed. The bed height was adjusted and a step stool was used if necessary to bring the hips and knees to approximately 90º flexion with both feet flat on the floor or stool. Participants were guarded during testing to prevent injury or falls. If requested, each participant was allowed a five to ten minute rest break mid-way through the testing procedure to prevent excessive fatigue. Additional demographic data were collected from the medical record, including the participant's age, gender, race, date of stroke onset, method of stroke diagnosis, location of stroke, prior level of physical function, and current medications (Appendix B).

Data Analysis

Descriptive statistics and frequency analysis described characteristics of the participants. Correlation analyses, factor analyses, and Item Response Theory (IRT) analyses first determined if any items could be removed from the FIST, and then examined the reliability and face, content, construct, and concurrent validity of the FIST. All statistical calculations were performed with SPSS 16.0 for Windows (SPSS Inc, Chicago, Illinois, USA) or ConQuest (Australian Council for Educational Research,

Hawthorn, Victoria, Australia). The hypothesis was that a shorter, valid, and reliable sitting balance measure for persons post-stroke could be constructed from the initial 26 item FIST.

Results

Expert Panel Survey

Twelve surveys were mailed to selected experts in balance, test construction, and neurologic physical therapy. Non-respondents were contacted once via email and once via postcard to increase the response rate. Ten surveys were ultimately returned for a response rate of 83.3%.

Weighted rankings for the 26 items were calculated (Table 4). A weighted ranking of 10 indicated that all respondents rated that item their number one inclusion choice, a -10 was their number one exclusion choice, and 0 represented a neutral opinion. Items with a weighted rank below -1 were eliminated. Nine items were eliminated with 17 items remaining for the pilot test. These 17 items were ordered by perceived or expected difficulty by the researcher and then randomly ordered to form two distinct parallel forms of the pilot FIST (Appendix B). No significant changes to the scoring system were recommended by the experts. Before pilot testing, minor editorial changes were made to the scoring system to improve clarity.

FIST Pilot Test

Demographics and Descriptive Analysis

Table 5 summarizes the demographics and characteristics of the participants. The average age of the participants was 61.45 years. Two thirds (21) of the 31 participants were male. Eight-seven percent had an ischemic stroke; 61% of the participants had left

hemiparesis. Prior to the stroke, participants were predominantly independent with activities of daily living (ADLs), instrumental ADLs, and gait. Post stroke, 74% of the participants were ranked as 'moderately severe' to 'severely' disabled on the mRS, generally more severely involved than the typical stroke population.[44] The FIST took less than 15 minutes to administer, and no participants required the optional rest break during testing.

FIST Item Reduction Analyses

Correlational Analyses

The item-to-item Spearman Rank correlation coefficients ranged between 0.614 to 0.965, and the item-to-total score correlations ranged from 0.817 to 0.933. All correlations were moderate to excellent and statistically significant ($p<0.01$).[28, 45] No items were eliminated based on the McMillian and Schumaker[46] cutoff guidelines for using correlation values to eliminate test items (>0.35 and statistical significance). Spearman Rank correlation coefficients of the total FIST score to mRS were statistically significant ($p<0.01$, Table 6) at -0.76. This negative correlation means that as participants' scores on the FIST increased, the level of disability on the mRS decreased. Static and dynamic sitting balance grades[15] demonstrated significant correlations with the FIST, ranging from 0.931 and 0.919 respectively ($p<0.01$, Table 6).

Exploratory Factor Analysis

Exploratory factor analysis was used to determine item reduction and describe domains in the FIST. Using principle component analysis with orthogonal verimax rotation, one factor was identified which explained 83.03% of the total variance of the

FIST. This factor highly loaded all 17 FIST items. Thus, this analysis did not yield useful information for item reduction (Table 7).

Item Response Theory (IRT) Analysis

Estimated respondent and item response level locations on the basis of data and different models were specified using ConQuest and weighted likelihood estimates. Initial IRT analyses discovered 3 significant misfitting items, "lift involved foot," "reach behind with involved arm," and "reach laterally with involved arm." Performance on these three items was likely confounded by the participants' motor problems. Thus, they were removed from the FIST total score for the remaining analyses, resulting in a 14 item FIST which was used for the remaining analyses.

FIST Psychometric Testing (14 item FIST)

On the 14 item FIST, 31 participants had scores ranging from 0 to 56 (out of 56 possible points). The mean score was 34.29 (SD=16.51), standard error of the mean of 2.97, and standard error of measurement of 2.03. Coefficient alpha for this 14 item FIST was 0.98, showing high internal consistency of this shortened version of the FIST.

Item-to-total Spearman Rank coefficient analyses (two tailed, $\alpha = 0.05$) were re-examined using the 14 item raw score. Item-to-total score correlations remained in the excellent range between 0.823 and 0.930 ($p<0.01$). Correlations with this 14 item total score and the static and dynamic sitting balance grades and mRS were also recalculated, with results remaining statistically significant ($p<0.01$) in the excellent to good range (Table 6). Spearman Rank coefficient correlations between expected and observed item difficulty were excellent (0.916) and between estimated respondent location and observed item difficulty was 0.97. Item mean scores, standard deviations, and item frequency

estimates were also calculated for the 14 individual items reflecting the difficulty from easiest to hardest for the 14 FIST items (Table 8).

The 14 items of this shorter FIST version maintained similar constructs via confirmatory factor analysis, utilizing the same parameters as the exploratory factor analysis with one factor extracted explaining 83.33% of the total 14 item FIST variance. All 14 items loaded highly on this single factor, "functional sitting balance ability."

Both rating scale and partial-credit models[15, 47] were tested. The partial-credit model fit the data significantly better, according to the G^2 likelihood ratio test (x^2_{39}=56, p=0.0381), indicating that the respondent response levels were different across items rather than the same. Only 3 poorly fitting items (out of 14) fell within the criterion boundaries with estimated locations associated with a weighted mean square between 0.75 and 1.34 and a weighted mean *t* statistic between -1.96 and +1.96.[48] These 3 exceptions met acceptable *t* statistic ranges, but fell outside the acceptable weighted mean square values. The exceptions included the "nod no" item (weighted mean square= 0.65 with *t*= -1.1), the "anterior nudge" item (weighted mean square=0.67 with *t*= -0.9), and the "lateral reach with uninvolved arm" item (weighted mean square = 1.60 with *t*= 1.6). The 1-parameter, partial-credit, unidimensional model was used for estimating item and respondent locations and their standard errors. Figure 1 plots the frequency of respondents and frequency of individual item values at each estimate location. The person separation reliability was 0.978, indicating high confidence and small error in the estimated locations of the respondents in this study.

Discussion

Item Reduction

The primary aim of this study was to develop, test, and analyze the FIST, a sitting balance measure, using a multistep process to reduce the number of test items while maintaining its internal consistency and validity in adults post acute stroke (Figure 2). Physical therapy clinician input regarding current methods being used to assess seated postural control and balance was reviewed. An expert panel provided input on the first version of the FIST to reduce the number of items. This second version of the FIST was pilot tested adults post-stroke, a population known to have sitting balance dysfunction. Lastly, data were analyzed utilizing multiple methods.

The FIST was successfully reduced to 14 items from an original 26. Expert panel ranking reduced the FIST from 26 items to 17 items, and IRT analysis after pilot testing successfully identified 3 additional items that did not fit the partial-credit model, resulting in a 14 item FIST. These 3 items most likely did not fit the model because they required the participant to use the involved extremity while stabilizing the trunk ("lift involved foot," "lateral reach with involved arm," and "reach behind with involved arm"). These items were retained for pilot testing to avoid bias in item selection and allow consensus and pilot testing to identify items with a poor fit. The elimination of these 3 items led to a final revision to the directions for the FIST reflecting that the person being tested may use their stronger limb, their least affected limb, or their dominant limb (Appendix D). This final version the FIST can be utilized in assessment of other patient populations with sitting balance dysfunction without difficulty imposed by requiring the use of an impaired limb.

Reliability

The high coefficient alpha and person separation reliability demonstrated the high degree of reliability of the FIST. Additionally, the confirmatory factor analysis determined that all 14 items of the FIST loaded highly on one factor, "functional sitting balance ability," that explained nearly 84% of the variance of the total FIST score. These results indicated strong internal consistency and reliability of the FIST, demonstrating that these 14 items were related to functional use of sitting balance.

Face, Content, and Construct Validity

Face and content validity of the FIST are supported by the consensus of the expert panel on selected items. This information was used primarily to eliminate items not related to sitting balance. Only 3 items were further eliminated after pilot testing, and all of them potentially confounding items due to their requirement to use the involved side in adults post stroke. These results demonstrated that the pilot test data and expert panel opinions hd a high degree of cohesiveness. The factor analysis identification of one factor representing "functional sitting balance ability" strengthened the evidence for high face and content validity of the 14 item FIST.

On the 14 item FIST, three items were deemed poorly fitting with the partial-credit IRT model ("nod no," "anterior nudge," lateral reach with the uninvolved arm"). These first two items fell below the threshold meaning that they are easier to predict than would be expected. The "lateral reach with the uninvolved arm" item had a higher value indicating that it is more difficult to predict a respondent's performance on this item that is harder to perform. Additionally, only the weighted mean square values fell out side of the recommended range, while the *t* values were acceptable and within one standard deviation. Only when both values fall outside of the recommended ranges should an item

be considered for removal from the test.[48] Considering these three ill fitting items in light of the high internal consistency of the FIST, strong evidence exists overall for high content and face validity of the 14 item FIST.

The range of total FIST scores (0 to 56 points) obtained by a small sample of 31 participants showed that the full range of available points is attainable. Figure 1 demonstrates how the individual item estimates covered the range of adults tested in this pilot and that the content of the FIST spanned the abilities of the participants.[48] The vertical line represents the construct of sitting balance function expressed in logits which relate sitting balance ability to the probability of response. Figure 1 shows a flat distribution for the respondents' locations, indicating that respondents had a wide range of sitting balance abilities as determined by the FIST. On the right hand side of the vertical line, the location estimates of the items are shown. Each item location indicates the sitting balance ability a generic person must have if there is a 0.50 probability of that person getting the same score on that item. Figure 1 shows that the location of the item estimates cover the same range as the location of the respondent estimates, demonstrating that FIST spans the content of sitting balance ability both for the participants in this pilot study, but also across the 14 items on the FIST. Thus, the content of the FIST spans a variety of sitting balance abilities that supports the content validity of the FIST in this population.[48]

Construct validity of the FIST is supported by examination of the difficulty of the items on the FIST (Table 8). The FIST was purposefully constructed to include a range of items that varied in their difficulty, and this is supported by the high degree of correlation between the expected item difficulty determined *a priori* by the researcher

and the observed item difficulty calculated after pilot testing. The excellent correlation between respondent location estimates and observed item difficulty further demonstrate the underlying validity of the FIST to capture the construct of sitting balance or seated functional postural control.

Concurrent Validity

Given the lack of a gold standard for testing seated postural control, it is difficult to show concurrent validity of the FIST. The high degree of correlation of the 14 item FIST total score and respondent location estimates with static and dynamic functional balance grades helps to support concurrent validity of the FIST with one of the most commonly used methods of measuring sitting balance (Table 6).[15] The good correlations of FIST score and respondent location estimates with mRS, as a representation of disability after a stroke, does help support the concurrent validity of the FIST.

Consistency with other studies

The FIST demonstrates a high degree of internal consistency. Comparisons between two measures of function, the Modified Rivermead Mobility Index and Motor Assessment Scale in the acute/sub-acute stroke population, showed high internal consistency and consistency with each other *except* for the sitting balance items on both scales. [15, 49] The authors proposed that perhaps these two measures' sitting balance items "may be measuring a different construct of mobility" rather than sitting balance.[49(pg 132)] The FIST may be better at quantification of sitting balance given its high degree of validity and reliability.

Current measures of balance have a low ratio of sitting balance items to the total number of test items.[13] This low ratio can lead to difficulty using these tests for lower

level functioning adults post stroke. The FIST is a more appropriate measure for these disabled adults since it consists solely of sitting balance test items that were validated in a group of persons post stroke with less function.

Only three clinical tools are currently available to evaluate trunk musculature in providing seated postural stability.[50] These tools do not address the complex interactions between postural control and functional skills. The FIST uses commonly required functional movements to assess sitting balance and examines the activity level of the International Classification of Functioning, Disability, and Health (ICF) Model,[51] related to the ability of a person to perform functional activities. These other measures primarily identify impairments of trunk musculature at the body functions/structures level of the ICF Model. While the FIST can identify difficulty with sitting balance at the activity level, it cannot tell a therapist which body functions/structures are responsible for the functional balance deficits. Using the FIST in conjunction with other trunk control measures may help therapists to more readily identify sitting balance dysfunction and its underlying causes. The FIST adds a different method of examination at the activity level that will benefit therapists considering comprehensive outcomes and examination schema for their patients/clients with sitting balance problems.

Seated postural control requires the ability to generate a combination of component movements to perform complex functional skills. An assessment that focuses solely on complex functional skills may be biased against lower functioning patients. Since current tests do not include component movements, therapists may not objectively obtain the type of information they need to accurately identify problems in lower functioning adults. The FIST includes items based on balance strategies[11]: 1) three items

on steady state or static sitting balance, 2) three items on reactive motor control in sitting, 3) three items on proactive, scooting movements in sitting, and 4) five proactive items where sitting balance must be maintained during body segment motion. Eleven items examine anterior/posterior control while three items are specific to lateral/rotational control in sitting. Lateral balance control may be more affected by stroke, and is more associated with clinical balance performance.[14] This combination of various movements and strategies, and simple to complex movement patterns in sitting, should improve the identification of specific areas of difficulty for patients when used in the clinical setting. Improved problem identification could potentially aid therapists in setting patient goals, designing interventions, and assessing outcomes.

Limitations of this study

A common pitfall of newly developed assessment tools is having a floor and/or ceiling effect. It was not anticipated the FIST would have floor effects as it was developed to test patients with lower level functional skills. Ceiling effects were anticipated in participants with higher levels of functional skills, and persons approaching the ceiling of the FIST would have more standing and ambulation ability. Hence, using existing balance measures weighted towards standing balance and gait abilities would be more appropriate. The modified Rankin Scale, a broad global measure of disability after stroke, was included in the data collection to ensure this pilot study assessed potential ceiling effects.[29] The use of the modified Rankin Scale allowed determination of what level of disability limits the effectiveness of the FIST. Participant scores did cover the entire range of possible scores from 0 to 56, but testing with more individuals is needed to fully describe ceiling effects. Additionally, this study limited participation to persons

with modified Rankin Scales indicative of probable or possible sitting balance dysfunction.

Sensory dependent sitting balance items were included in the original 26 item FIST, but many of these items were eliminated before pilot testing based on the expert panel input. Since these items were not pilot tested, their reliability and/or validity were not examined. The final 14 item version of the FIST contains limited sensory dependent items, which may impact the utility of the FIST in clinical practice.

This pilot test of the FIST utilized a small sample of 31 participants. Given this small sample size, no subgroup analyses were conducted, and only limited conclusions about the scoring scale could be made. Further testing with larger samples is recommended. Additionally, only one review by the expert panel was conducted.

This study only tested the validity of the FIST in an adult acute stroke population. The post stroke participants included more males, and had higher rates of motor, sensory, and speech deficits present after their stroke than typical individuals in the post stroke population (Table 5).[44] Therefore, generalizability to other age groups, medical diagnoses, or other diagnostic categories may be limited given the homogeneity of participants tested in this study.

Future research

A valid and reliable measurement tool for assessing sitting balance such as the FIST will help researchers design studies to predict functional recovery in patients during the acute phase post stroke. Inter- and intra- tester reliability of the FIST still needs to be determined. Development of standardized training materials including self-study training materials with video clip examples for scoring the FIST and score report sheets should be

developed to standardize administration procedures. Validation of the FIST in other appropriate patient populations, such as persons with multiple sclerosis, encephalopathy, Parkinson's disease, spinal cord injury, severe deconditioning, or other medical complexities would allow a broader use of the FIST. Evaluative validity of the FIST and its responsiveness to measuring change over time and effects pre- and post- intervention, should also be investigated. If the FIST shows evaluative validity, especially over short periods of time (e.g., 1-2 weeks), therapists working in the early stages of rehabilitation in acute care settings would be able to show functional sitting balance gains in persons with severe impairments. The predictive value of the FIST in determination of discharge destination, risk for falls, and long term disability are also areas that merit further exploration. The FIST may also be used to aid in the determination of the need for postural supports, restraints, and/or fall risk in acute, rehab, and skilled nursing facilities with populations having sitting balance dysfunction.

Conclusion

The Function In Sitting Test (FIST), consisting of 14 items easily examined at the bedside, is a newly developed measure of functional sitting balance in the acute post stroke adult population (Appendix D). The development of a specific test to assess seated postural control in more disabled or lower functioning persons will allow therapists to better describe the status and potential changes in sitting function in the post stroke population. Further studies including validation in divergent patient populations, examination of responsiveness to change, and determination of inter- and intra-tester reliability of the FIST are indicated.

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Table 1. Comparison of Current Tests' Abilities to Measure Sitting Balance

MEASURE	TOTAL # OF TEST ITEMS	SITTING BALANCE SPECIFIC ITEMS	MECHANISM	SCALE
Berg Balance Test [30]	14	Sit → stand Sitting unsupported	Proactive, motor Steady, sensory	Ordinal, 5 points
Trunk Control Test [32]	4	Sitting edge of bed, feet off floor Supine → sit	Steady, motor Proactive, motor	Ordinal, 3 points
Duke Mobility Skills Profile[33]	13	Sitting unsupported Sitting reach to take object Rising from chair Bed → chair	Steady, sensory Proactive, motor Proactive, motor Proactive, motor	Ordinal, 3-5 points
Functional Independence Measure (FIM)™ [12]	18	Self care 3 transfers: bed/chair/; toilet; tub/shower	Proactive, motor Proactive, motor	Ordinal, 7 points
Physical Performance & Mobility Exam[34]	6	Bed mobility Sit → stand Repeated chair stands	Proactive, motor Proactive, motor Proactive, motor	Ordinal (assistance) & Continuous (time, steps)

Trunk Impairment Scale[35]	17	Static sitting Lateral lean Lateral pelvic tilt Trunk rotation	Steady, sensory Proactive, motor Proactive, sensory Proactive, motor	Ordinal, 2-3 points
Mobility Scale for Acute Stroke Patients[36]	5	Supine → sit Sitting unsupported Sit → stand	Proactive, motor Steady, sensory Proactive, motor	Ordinal , 6 points
Fugl-Meyer Assessment—Balance subscale[37]	7	Sit without support	Steady, sensory	Ordinal, 3 points
Rivermead Mobility Index[38]	15	Supine → sit Sitting unsupported Sit→ stand	Proactive, motor Steady, sensory Proactive, motor	Dichotomous (y/n) Self-report Self-report
Motor Assessment Scale[39]	18	UE activities in supported sitting	Proactive, motor	Ordinal, 7 points
Modified Functional Reach[40]	1	Distance of forward reach in sitting	Proactive, motor	Continuous, # of inches
Performance Oriented Mobility Assessment – balance subscale[41]	11	Sitting balance Sit → stand	Steady, sensory Proactive, motor	Ordinal, 3 points

Barthel Index[42]	10	Bathing	Proactive, motor	Dichotomous
		Dressing	Proactive, motor	(y/n)
		Toilet transfers	Proactive, motor	Ordinal, 3 points
		Bed → chair	Proactive, motor	Ordinal, 3 points
				Ordinal, 4 points
Outcome and Assessment Information Set—ADL/IADL subset[43]	14	Dressing	Proactive, motor	Ordinal, 5 points
		Bathing	Proactive, motor	Ordinal, 6 points
		Toileting	Proactive, motor	Ordinal, 5 points
		Transferring	Proactive, motor	Ordinal, 6 points

Table 2. Participant Criteria

Adult post-stroke participants

Inclusion criteria:

1. Documented history of first stroke in preceding 3 months before study entry.
2. Written informed consent given by the subject or a legally authorized representative.
3. Aged 18 years or older.
4. Modified Rankin Scale of 3, 4, or 5 (moderate, moderately severe, and severe disability) s/p stroke

Exclusion criteria:

1. Severe cognitive deficits limiting ability to follow simple directions, as documented on speech-language pathology evaluation.
2. History of two or more documented transient ischemic attacks (TIAs) in medical record.
3. Medical condition(s) preventing testing procedures, such as but not limited to total hip arthroplasty due to restrictions of involved hip flexion range of motion, medical status such as subject not cleared for sitting/standing activities by physician, unstable angina, orthostatic hypotension.
4. Diagnosis of subarachnoid hemorrhage in preceding 6 months before study entry.
5. Prior diagnosis of neurodegenerative disease in medical record.

Expert Panel and Clinician Panel participants

Inclusion criteria:

Knowledge and expertise in balance dysfunction, neurologic physical therapy, research, and/or motor control.

Exclusion criteria:

None

Table 3. Original FIST Item Directions and Construct Examined

Standard Directions: One trial of each test item is allowed. Verbal directions, and demonstration as needed, are given by the therapist following the directions for each item below. **Standard Starting Position:** Subject seated at edge of standard hospital bed (no overlay or specialized air mattresses) with proximal thigh (½ of femur length) in support, hips and knees flexed to 90º, and feet flat in support. Thighs should be positioned in neutral hip abduction/adduction and rotation. Hands in lap, unless needed for balance support.	
Test Item	**Construct Examined**
***1. Static sitting** Sit with your hands in your lap for 30 seconds.	Sensory, steady state
***2. Sitting, eyes closed** Close your eyes and remain sitting still with your hands in your lap for 30 seconds.	Sensory, steady state
3. Sitting, move head up and down (nod 'yes') Remain sitting steady and tall without using your hands unless you need them to help you balance. When I tell you to "look up," keep sitting straight, but tip your head and look up. Keep looking up until I tell you "look down," then keep sitting straight and tip your head down. Keep looking down until I tell you, "look straight," then keep sitting straight but return your head to the center.	Motor, proactive
***4. Sitting, move head side to side (nod 'no')** Remain sitting steady and tall without using your hands unless you need them to help you balance. When I tell you to "look right," keep sitting straight, but turn your head to the right. Keep looking to the right until I tell you "look left," then keep sitting	Motor, proactive

straight and turn your head to the left. Keep your head to the left until I tell you, "look straight," then keep sitting straight but return your head to the center.	
***5 & *6. Sitting, lift foot** (scored once for uninvolved side and once for involved side) Sit with hands in lap, lift each foot 1 inch off floor x 2.	Motor, proactive
***7. Reach forward with outstretched hand at shoulder height** Reach with uninvolved UE, involved UE remaining in your lap as far as you can while staying balanced. (Perform passively to assess ROM; must go full available ROM or until abdomen contacts anterior thighs)	Motor, proactive
***8. & *9 Turn and pick up object from behind in both directions** Turn around and pick up the object that I've placed behind you with your uninvolved hand. (Object placed in midline, one hand's breadth [fingertip to base of palm] posterior to hips, subject must turn in both directions)	Motor, proactive
***10. Pick object up off floor** Pick this object up off the floor with your uninvolved hand. (Object placed between feet)	Motor, proactive
11. Anterior pelvic weight shift Tip your pelvis forward like this. (Perform passively to assess ROM; must go full available ROM; completes full, available ROM maintaining upright upper trunk position and returns to midline)	Sensory, proactive

12. Posterior pelvic weight shift Tip your pelvis backwards like this. (Perform passively to assess ROM; must go full available ROM; completes full, available ROM maintaining upright upper trunk position and returns to midline)	Sensory, proactive
13. Lateral pelvic weight shift (scored once for uninvolved side and once for involved side) Tip your pelvis sideways like this keeping your feet on the floor. (Perform passively to assess ROM; must go full available ROM; completes full, available ROM maintaining upright upper trunk position and returns to midline)	Sensory, proactive
***14 & *15. Lateral reach with hand at shoulder height (with both upper extremities)** Reach out to the side as far as you can; try to keep your hand at the height of your shoulder. Be sure to get all your weight off the opposite side of your bottom keeping your feet on the floor. (Completes full, available ROM maintaining upright upper trunk/UE position, with contralateral trunk shortening and clearance of contralateral ischical tuberosity and returns to midline)	Motor, proactive
***16. Anterior scooting (2")** Move forward 2 inches without using your arms.	Motor, proactive
***17. Posterior scooting (2")** Move backward 2 inches without using your arms.	Motor, proactive
***18. Lateral scooting (2") in both directions** (scored once for uninvolved side and once for involved side) Move sideways 2 inches without using your arms.	Motor, proactive

***19. Sternal nudge** (light pressure x 1, at sternum) Without warning, push participant with light pressure at superior portion of sternum.	Motor, reactive
***20. Posterior nudge** (1 time, between scapular spines) Without warning, push participant with light pressure between scapular spines.	Motor, reactive
***21. Lateral nudge** (1 time in each direction, at acromion) Score twice, once on each side. Without warning, push participant with light pressure at acromion.	Motor, reactive
22. Sitting, move feet to narrow base of support Remaining stable and without using your arms, move your feet together so they touch, then move them back to where they were. You may slide your feet or pick them up.	Sensory, steady state
23 & 24. Bed to wheelchair transfer (scored once for uninvolved side and once for involved side) Transfer into a wheelchair with armrest.	Motor, proactive
25. Sit to stand transfer (hold standing ~10 seconds) Stand up without using your hands to help. Be sure to stand up as tall as you can, and then sit back down.	Motor, proactive
26. Sitting in wheelchair, quick wheelchair motion posteriorly (move wheelchair quickly 2 inches posteriorly) Stay seated and upright with your hands in your lap. (Move wheelchair without warning)	Sensory, reactive

Initial, 26 item FIST. Items in bold and marked with * remained after expert panel review and formed the 17 item FIST administered to participants in the pilot testing.

Table 4. FIST Item Weighted Ranks from Expert Panel Survey

FIST Item	Weighted Rank Score	
Static Sit	8.1	RETAINED FOR PILOT TESTING
Reach forward	7.8	
Pick item up off floor	4.6	
Lift uninvolved foot off floor	4.1	
Lateral reach with uninvolved upper extremity	3.9	
Lateral reach with involved upper extremity	2.1	
Pick up item from behind with uninvolved upper extremity	1.4	
Sit with eyes closed	1.3	
Anterior nudge	1.0	
Posterior nudge	1.0	
Anterior scooting (2”)	0.8	
Lateral nudge	0.5	
Pick up item from behind with involved upper extremity	0.5	
Lift involved foot off floor	0.2	
Posterior scooting (2”)	-0.5	
Lateral scooting (2”)	-0.7	
Shake head “no”	-1.0	
Wheelchair motion	-1.3	ELIMINATED FROM PILOT TESTING
Narrow base of support and put feet close together	-1.9	
Lateral weight shift	-2.1	
Nod head “yes”	-2.6	
Posterior weight shift	-3.4	
Sit to stand transfer	-3.5	
Anterior weight shift	-3.7	
Transfer to wheelchair to uninvolved side	-4.9	
Transfer to wheelchair to involved side	-5.1	

Items scoring below -1.0 (shaded area) were dropped prior to pilot testing

Table 5. Pilot Test Participant Demographics

CHARACTERISTIC	
Age	61.45 (SD=10.93) Range 42 to 86
Gender	male (21) = 67.7 % female (10) = 32.3%
Method of CVA diagnosis	MRI (1) = 3.2% CT (24) = 77.4% clinical diagnosis (6) = 19.4%
Side of CVA	right (12) = 38.7% left (19) = 61.3 %
Type of CVA	ischemic (27) = 87.1% embolic (4) = 12.9%
Motor deficits s/p CVA	yes (30) = 96.8% no (1) = 3.2%
Sensory deficits s/p CVA	yes (29) = 93.5% no (2) = 6.5%
Perceptual deficits s/p CVA	yes (22) = 71% no (9) = 29%
Speech-language deficits s/p CVA	yes (16) = 51.6% no (15) = 48.4%
Prior level of function: ADLs	independent (30) = 96.8% needed assist (1) = 3.2%
Prior level of function: IADLs	independent (27) = 87.1% needed assist (4) = 12.9%
Prior level of function: Gait	independent (30) = 96.8% dependent (1) = 3.2%
Prior level of function: assistive device use	none (26) = 83.9% used (5) = 16.1%
Prior level of function: gait distance	community distances (22) = 71% household distances (8) = 25.8% unable (1) = 3.2%
Modified Rankin Scale[29]	moderate disability (8) = 25.8% moderately severe disability (18) = 58.1% severe disability (5) = 16.1%

MRI=magnetic resonance imaging, CT=computed tomography, CVA=cerebral vascular accident, s/p=status post, ADLs=activities of daily living, IADLs=instrumental activities of daily living, community distances =ambulates at least 1000 ft and manage curbs, household distances = ambulates at least 300 ft regularly in the home.

Table 6. FIST and Concurrent Measure Correlations

Spearman's rho	**Static Sitting Balance Grade**	**Dynamic Sitting Balance Grade**	**modified Rankin Scale**
FIST Total Score (17 item raw score)	.937*	.919*	-.775*
FIST Total Score (14 item raw score)	.934*	.925*	-.725*
Respondent Location Estimate (logit value)	.921*	.920*	-.764*

* Correlation is significant at the 0.01 level (2-tailed)

Table 7. Factor Analyses Component Matrices

A. 17 Item FIST Exploratory Factor Analysis

Component Matrix[a]

	Component
	1
Static Sitting	.918
Sitting Eyes Closed	.900
Lift uninvolved foot	.908
Anterior nudge	.942
Reach forward	.930
Lateral nudge	.878
Pick up uninvolved from behind	.930
Nod no	.924
Pick object off floor	.923
Anterior scooting	.920
Posterior scooting	.932
Lat reach uninvolved UE	.862
Posterior nudge	.918
Lateral scooting	.913
Lift involved foot	.895
Pick up involved from behind	.906
Lat reach involved UE	.887

Extraction Method: Principal Component Analysis.

a. 1 component extracted, “functional sitting balance ability”

B. 14 Item FIST Confirmatory Factor Analysis

Component Matrix[a]

	Component
	1
Static Sitting	.927
Sitting Eyes Closed	.909
Lift uninvolved foot	.914
Anterior nudge	.950
Reach forward	.936
Lateral nudge	.886
Pick up uninvolved from behind	.936
Nod no	.934
Pick object off floor	.923
Anterior scooting	.908
Posterior scooting	.925
Lat reach uninvolved UE	.857
Posterior nudge	.926
Lateral scooting	.897

Extraction Method: Principal Component Analysis.

a. 1 component extracted, “functional sitting balance ability”

Table 8. FIST Item Difficulty

FIST Item	Item Frequency Estimate	Mean (SD, SE)
Static sitting	-2.804	3.03 (1.22, 0.22)
Nod no	-2.509	2.97 (1.22, 0.22)
Sitting, eyes closed	-2.163	2.90 (1.25, 0.22)
Anterior nudge	-0.697	2.58 (1.26, 0.23)
Posterior nudge	-0.666	2.55 (1.21, 0.22)
Lift uninvolved foot	-0.560	2.55 (1.43, 0.26)
Reach behind with uninvolved arm	-0.463	2.55 (1.39, 0.25)
Lateral nudge	-0.412	2.52 (1.51, 0.21)
Forward reach	0.714	2.23 (1.26, 0.23)
Lateral reach with uninvolved arm	0.821	2.16 (1.42, 0.25)
Pick up object from floor	0.827	2.19 (1.35, 0.24)
Posterior scoot	1.436	2.06 (1.26, 0.23)
Anterior scoot	1.541	2.03 (1.28, 0.23)
Lateral scoot	1.764	1.97 (1.33, 0.24)

Appendix A

Test of Function in Sitting Test (FIST) in Adults with Acute Stroke
General Screening Form

1. What is your age? _____

2. Have you ever been told you've had a stroke before this? _____

3. Have you been told in the last 12 months that you have had a transient ischemic attack, TIA, or pre-stroke?
   _____

4. Have you been told in the last 6 months that you have had a subarachnoid hemorrhage?
   _____

5. Do you have any pre-existing medical problems that don't allow you to sit, reach, or be out of bed (in a chair) for more than 1 hour?
   _____

Mini Mental Status Exam Screen (for determination of surrogate consent)

Activity	**Score**
ORIENTATION – one point for each answer	
Ask: "What is the: (year)(season)(date)(day)(month)?" *Ask:* "Where are we: (state)(county)(town)(hospital)(floor)?"	____
REGISTRATION – score 1,2,3 points according to how many are repeated	
Name three objects: Give the patient one second to say each. *Ask the patient to:* repeat all three after you have said them. Repeat them until the patient learns all three.	____
ATTENTION AND CALCULATION – one point for each correct subtraction	
Ask the patient to: begin from 100 and count backwards by 7. Stop after 5 answers. (93, 86, 79, 72, 65)	____
RECALL – one point for each correct answer	
Ask the patient to: name the three objects from above.	____
LANGUAGE	
Ask the patient to: identify and name a pencil and a watch. (2 points)	____

Ask the patient to: repeat the phrase “No ifs, ands, or buts.” (1 point)
Ask the patient to: “Take a paper in your right hand, fold it in half, and put it on the floor “(1 point for each task completed properly)
Ask the patient to: read and obey the following: “Close your eyes.” (1 point)
Ask the patient to: write a sentence. (1 point)
Ask the patient to: copy a complex diagram of two interlocking pentagons. (1 point)

TOTAL:

____

Modified Rankin Scale

Description	**Score (circle one)**
No symptoms at all	0
No significant disability despite symptoms; able to carry out all usual duties and activities	1
Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance	2
Moderate disability; requiring some help, but able to walk without assistance	3
Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance	4
Severe disability; bedridden, incontinent and requiring constant nursing care and attention	5

Appendix B

Pilot Test of the FIST in Adults with Acute Stroke
Data Collection Tool (Forms 1 & 2)

Progress Check:
____ General Screening conducted
Surrogate consent needed? Y/N ____
____ MR Screen Consent obtained
____ Experimental Subjects Bill of Rights given
____ Informed Consent obtained
Surrogate consent utilized? Y/N ____

Date _____

Site: _____ UCSF _____ ABSMC

Medical Record # _____

Demographics: _____ Age Gender M/F

Diagnosis: date _____Method _____

Side R/L Type: ischemic/hemorrhagic/embolic/not determined

Deficits documented s/p stroke:
Sensory Motor Perceptual Speech-language

Prior Level of Function:
Assistive devices used (list):
_____

ADLs: indep needed assistance dependent

IADLs: indep needed assistance dependent

Gait: indep needed assistance dependent
community distances household distances

Medications (list):

Static Sitting Balance Grade: _____ Dynamic Sitting Balance Grade: _____

FIST Score (Form 1)	Score
Static sitting	
Anterior nudge	
Sitting, eyes closed	
Sitting, lift uninvolved foot	
Sitting, lift involved foot	
Reach forward with uninvolved outstretched hand at shoulder height	
Lateral nudge	
Turn and pick up object from behind with uninvolved hand	
Turn and pick up object from behind with involved hand	
Sitting, move head side to side (nod 'no')	
Pick object up off floor	
Reach lateral and above shoulder height with uninvolved extremity	
Anterior scooting	
Posterior scooting	
Reach lateral and above shoulder height with involved extremity	
Lateral scooting	
Posterior nudge	
Total	

FIST Scoring:

4 Independent

Completes the task independently and successfully

3 Verbal cues

Completes the task independently and successfully but may need verbal cues

2 Upper extremity support

Unable to complete task without using upper extremities for support or assistance

1 Needs Assistance

Unable to complete task successfully without physical assistance

0 Complete Assistance

Requires complete physical assistance to perform task successfully, is unable to complete task successfully with physical assistance, or dependent

FIST Score (Form 2)	Score
Static sitting	
Sitting, eyes closed	
Sitting, lift uninvolved foot	
Anterior nudge	
Sitting, lift involved foot	
Reach forward with uninvolved outstretched hand at shoulder height	
Lateral nudge	
Turn and pick up object from behind with uninvolved hand	
Turn and pick up object from behind with involved hand	
Sitting, move head side to side (nod 'no')	
Pick object up off floor	
Anterior scooting	
Posterior scooting	
Reach lateral and above shoulder height with uninvolved extremity	
Reach lateral and above shoulder height with involved extremity	
Posterior nudge	
Lateral scooting	
Total	

FIST Scoring:

4 Independent

Completes the task independently and successfully

3 Verbal cues

Completes the task independently and successfully but may need verbal cues

2 Upper extremity support

Unable to complete task without using upper extremities for support or assistance

1 Needs Assistance

Unable to complete task successfully without physical assistance

0 Complete Assistance

Requires complete physical assistance to perform task successfully, is unable to complete task successfully with physical assistance, or dependent

Appendix C. Expert Panel Survey of the Function In Sitting Test

The Function in Sitting Test (FIST) is a newly developed, functionally-based, bedside test of sitting balance. Currently, the test is 26 items long and the researchers are interested in decreasing the number of test items to shorten the test without losing validity or sensitivity.

Please comment on the scoring system for the FIST

An effort has been made to keep the scoring system flexible enough for eventual use of the FIST in multiple patient populations (i.e., stroke, spinal cord injury, multiple sclerosis, encephalopathy, etc.) and a variety of health care settings (i.e., inpatient, rehab, home health, skilled nursing facility, etc.). With these constraints in mind, please comment on the scoring levels in the space provided.

FIST Scoring:

4 = Independent

Completes the task independently and successfully

3 = Verbal Cues

Completes the task successfully and independently but may need verbal cues

2 = Upper extremity support

Unable to complete task successfully and independently without using upper extremities for support or assistance not normally required

1 = Needs Assistance

Unable to complete task successfully without physical assistance

0 = Complete Assistance

Requires complete physical assistance to perform task successfully, is unable to complete task successfully with physical assistance, or dependent

A. Please rate each test item regarding whether you consider it a function that examines how well someone balances in sitting by circling Yes or No.
B. Indicate your top five choices of items that you would include in a functional sitting balance test by placing numbers 1-10 in the box labeled "Inclusion." Placing a "1" in a box would mean you think it's the most important listed and should definitely be included in the test.
C. Indicate your top five choices of items that you should excluded from a functional sitting balance test by placing numbers 1-10 in the box labeled "Exclusion." Placing a "1" in a box would mean you think it's the least useful item and should be the first excluded from the test.

FIST Test Item	Quantifies Sitting Balance? (circle answer)	Inclusion (number top ten choices)	Exclusion (number top ten choices)
Static sitting	YES NO		
Sitting, lift involved foot	YES NO		
Sitting, lift uninvolved foot	YES NO		
Reach forward with outstretched hand at shoulder height on uninvolved side	YES NO		
Turn and pick up object from behind with involved extremity	YES NO		
Turn and pick up object from behind with uninvolved extremity	YES NO		
Pick object up off floor	YES NO		
Anterior pelvic weight shift	YES NO		
Posterior pelvic weight shift	YES NO		
Lateral pelvic weight shift	YES NO		
Reach laterally with outstretched involved hand at shoulder height	YES NO		
Reach laterally with outstretched uninvolved hand at shoulder height	YES NO		
Anterior scooting	YES NO		
Posterior scooting	YES NO		
Lateral scooting	YES NO		
Anterior nudge (once, unexpected)	YES NO		
Posterior nudge (once, unexpected)	YES NO		
Lateral nudge (once, unexpected)	YES NO		
Sitting, move feet to narrow base of support	YES NO		
Mat to wheelchair transfer on involved side	YES NO		
Mat to wheelchair transfer on uninvolved side	YES NO		
Sit to stand transfer	YES NO		
Sitting, eyes closed	YES NO		
Sitting, move head up and down (nod 'yes')	YES NO		
Sitting, move head side to side (nod 'no')	YES NO		
Sitting in wheelchair, quick wheelchair motion posteriorly	YES NO		

Appendix D. Function In Sitting Test (FIST)—final 14 item version

Standard Directions: One trial of each test item is allowed. Verbal directions and demonstration as needed are given by the therapist following the directions for each item below. **Standard Starting Position:** Person seated at edge of standard hospital bed (no overlay or specialized air mattresses) with proximal thigh (½ of femur length) in support, hips and knees flexed to 90º, and feet flat in support. Thighs should be positioned in neutral hip abduction and adduction and neutral rotation. Hands in lap, unless needed for balance support.
1. Anterior nudge (light pressure x 1, at sternum) Without warning, at any time during testing, push participant with light pressure at superior portion of sternum.
2. Posterior nudge (1 time, between scapular spines) Without warning, at any time during testing, push participant with light pressure between scapular spines.
3. Lateral nudge (1 time on dominant or stronger side, at acromion) Without warning, at any time during testing, push participant with light pressure at acromion.
4. Static sitting Sit with your hands in your lap for 30 seconds.
5. Sitting, move head side to side (nod 'no') Remain sitting steady and tall without using your hands unless you need them to help you balance. When I tell you to "look right," keep sitting straight, but turn your head to the right. Keep looking to the right until I tell you "look left," then keep sitting straight and turn your head to the left. Keep your head to the left until I tell you, "look straight," then keep sitting straight but return your head to the center.
6. Sitting, eyes closed Close your eyes and remain sitting still with your hands in your lap for 30 seconds.
7. Sitting, lift foot (scored once for least involved side, stronger side, or dominant side) Sit with your hands in lap, and lift your foot 1 inch off floor twice.

8. Turn and pick up object from behind in preferred direction Turn around and pick up the object that I've placed behind you. (Object placed in midline, one hand's breadth [fingertip to base of palm] posterior to hips, subject may turn to preferred side and use either arm)
9. Reach forward with outstretched hand at shoulder height Reach with least involved/stronger/less painful arm, with your other arm remaining in your lap, as far as you can while staying balanced. (Perform passively to assess ROM; must go full available ROM or until abdomen contacts anterior thighs)
10. Lateral reach with hand at shoulder height Reach out to the side as far as you can; try to keep your hand at the height of your shoulder. Be sure to get all your weight off the opposite side of your bottom keeping your feet on the floor. (Completes full, available ROM maintaining upright upper trunk/UE position, with contralateral trunk shortening and clearance of contralateral ischical tuberosity and returns to midline, may go to preferred side, stronger side)
11. Pick object up off floor Pick this object up off the floor with your hand. (Object placed between feet, may use either hand)
12. Posterior scooting (2") Move backward 2 inches without using your arms.
13. Anterior scooting (2") Move forward 2 inches without using your arms.
14. Lateral scooting (2") (scored once for preferred direction) Move sideways 2 inches without using your arms.

FIST Scoring Scale

4 Independent
Completes the task independently and successfully

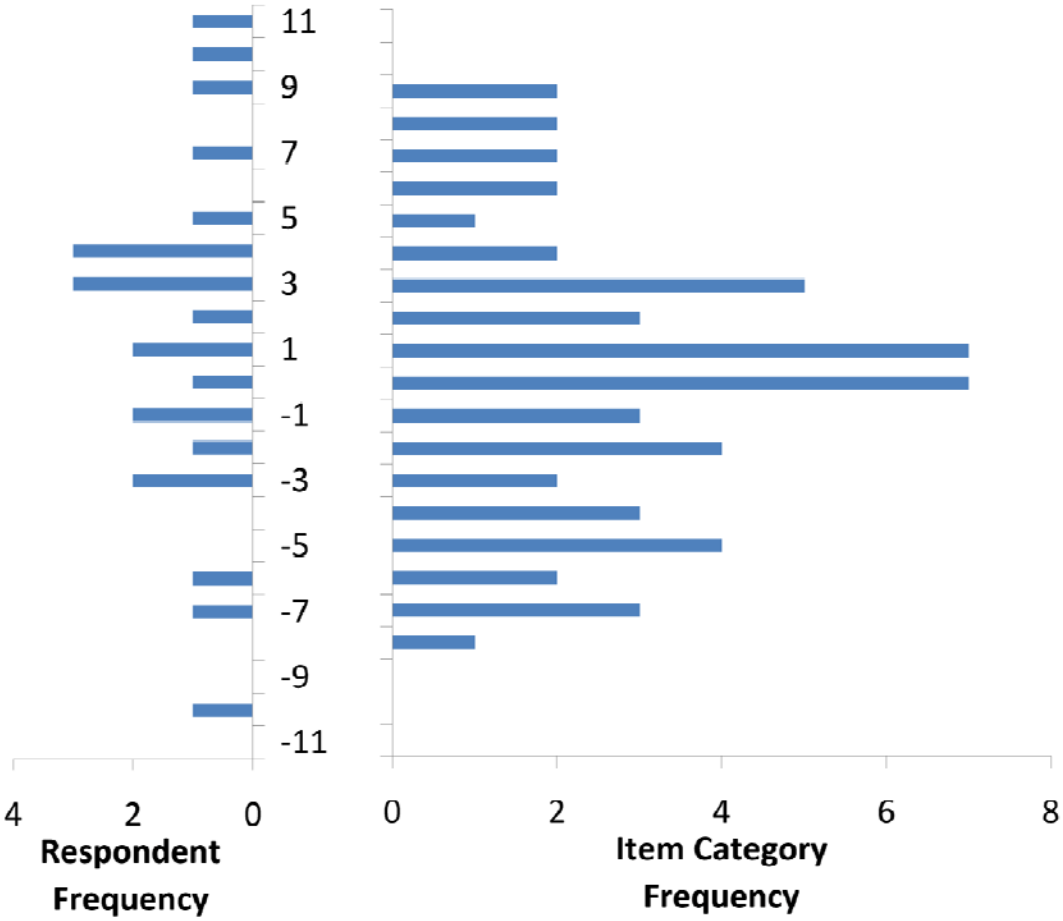
3 Verbal cues
Completes the task independently and successfully; may need verbal cues or more time

2 Upper extremity support
Unable to complete task without using upper extremities for support or assistance

1 Needs Assistance
Unable to complete task successfully without physical assistance

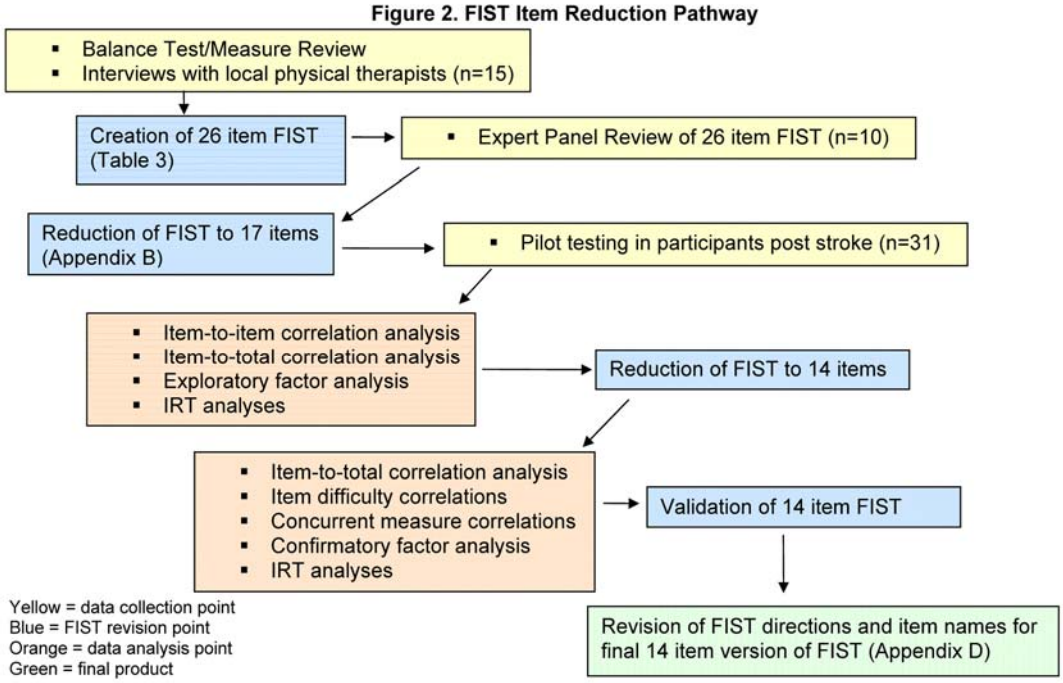
0 Complete Assistance
Requires complete physical assistance to perform task successfully, is unable to complete task successfully with physical assistance, or dependent

Figure 1. Estimated Item Category and Respondent Frequency Histogram



Respondent frequency: Frequency of logit scores calculated from raw 14 item FIST scores.
Item category frequency: Frequency of logit scores calculated from individual item scores (0-4) for each of the 14 FIST items.

Figure 2. FIST Item Reduction Pathway



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