

Fugl-Meyer Assessment of Sensorimotor Function After Stroke

Standardized Training Procedure for Clinical Practice and Clinical Trials

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Background and Purpose—Outcome measurement fidelity within and between sites of multi-site, randomized, clinical trials is an essential element to meaningful trial outcomes. As important are the methods developed for randomized, clinical trials that can have practical utility for clinical practice. A standardized measurement method and rater training program were developed for the total Fugl-Meyer motor and sensory assessments; inter-rater reliability was used to test program effectiveness.

Methods—Fifteen individuals with hemiparetic stroke, 17 trained physical therapists across 5 regional clinical sites, and an expert rater participated in an inter-rater reliability study of the Fugl-Meyer motor (total, upper extremity, and lower extremity subscores) and sensory (total, light touch, and proprioception subscores) assessments.

Results—Intra-rater reliability for the expert rater was high for the motor and sensory scores (range, 0.95–1.0). Inter-rater agreement (intraclass correlation coefficient, 2, 1) between expert and therapist raters was high for the motor scores (total, 0.98; upper extremity, 0.99; lower extremity, 0.91) and sensory scores (total, 0.93; light touch, 0.87; proprioception, 0.96).

Conclusions—Standardized measurement methods and training of therapist assessors for a multi-site, rehabilitation, randomized, clinical trial resulted in high inter-rater reliability for the Fugl-Meyer motor and sensory assessments. Poststroke sensorimotor impairment severity can be reliably assessed for clinical practice or rehabilitation research with these methods. (*Stroke*. 2011;42:427-432.)

Key Words: motor impairment ■ physiotherapy ■ rehabilitation ■ sensory impairment ■ stroke recovery

Outcome measurement selection is a critical element in the design and execution of therapeutic clinical trials, regardless of whether the trial is designed to determine the effectiveness of a drug, technological device, or rehabilitation intervention.¹ Best practice strategies in rehabilitation for poststroke clinical practice and randomized, clinical trials (RCT) include the selection of outcomes measures with sound psychometric properties based on a conceptual framework of health and disability, such as the International Classification of Functioning, Disability, and Health.² Thus, the sequelae of stroke, such as motor and sensory loss, are body function impairments that contribute to activity limitations and participation restrictions for a person who survives a stroke.

One of the most widely recognized and clinically relevant measures of body function impairment after stroke is the Fugl-Meyer (FM) assessment.³ Of its 5 domains (motor, sensory, balance, range of motion, joint pain), the motor domain, which includes an assessment of the upper extremity (UE) and lower extremity (LE), has well-established reliability and validity as an indicator of motor impairment severity across different stroke recovery time points.^{4,5} Consistently, greater motor severity as indicated by lower UE and LE FM motor scores is correlated with lower functional ability, such as spontaneous arm use for feeding, dressing and grooming,⁶ or walking at functional gait speeds.⁷ Recently, a study using motor-evoked potentials and diffusion tensor imaging demonstrated that the Fugl-Meyer UE motor score was a reliable

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clinical measure associated with corticospinal tract integrity and prognosis for motor impairment recovery after stroke.⁸ It is likely that the FM motor score may be a clinical measure indicative of white matter damage in corticospinal tract fibers.

The psychometric properties of the FM sensory domain are less robust.⁵ The sensory domain of the FM is seldom used in clinical practice or reported in rehabilitation clinical trials even though sensory loss is a predictor of poor functional recovery after sensorimotor stroke.⁹ A reliable and valid clinical measure to determine severity of light touch and proprioception impairments is needed; however, there is no widespread agreement on a consistent method to measure sensory impairment after stroke. The lack of published procedures may be a cause for the low intratester and intertester reliability reported for the sensory FM score.

Several rehabilitation intervention RCT have used the FM UE motor subscore either as the primary end point^{10,11} or as a stroke severity stratification variable.^{6,12} However, there are no published standardized procedures on implementation of the total motor assessment that describe both the UE and LE motor subscales or total sensory assessment with its light touch and proprioception subscales. Furthermore, individual psychometric studies of various FM motor^{13,14} or sensory subscores¹⁵ are conducted within single clinical sites or with few therapists. More importantly, there are no studies that have described the standardization procedures used by an RCT to ensure FM motor and sensory measurement fidelity across multiple raters within and between multiple regional sites across the life of the trial. Thus, we describe the process to develop the standardized procedure for the FM motor and sensory assessments, training program, and competency assessment for study raters within and across the community-based clinical sites, and the subsequent reliability.

Subjects and Methods

Data were collected from trial physical therapists and a subset of enrolled stroke participants from the Locomotor Experience Applied Post-Stroke (LEAPS) clinical trial between July and December 2006.¹⁶ All LEAPS participants signed an Institutional Review Board-approved informed consent including consent to be videotaped. LEAPS is a single-blinded, multi-site RCT that has completed prospective enrollment of 408 participants within 45 days after stroke across 5 community-based rehabilitation clinics. Fifteen individuals with unilateral hemiparetic stroke, 17 licensed physical therapists across the 5 clinical sites, and 1 expert physical therapist with 30 years of experience in stroke rehabilitation as the "gold standard" rater (K.S.) participated.

FM Motor and Sensory Assessment

The motor and sensory FM assessments are scored on a 3-point ordinal scale (0–2). The FM motor assessment is used to measure voluntary limb movement. It includes the UE subscale (33 items; score range, 0–66) and the LE subscale (17 items; score range, 0–34) for a total motor FM score of 100. The FM sensory assessment is used to measure limb sensation. Sensation is assessed as absent, impaired, or normal for light touch (2 items each for UE and LE; score range, 0–8) and proprioception (4 items each for UE and LE; score range, 0–16) for a total sensory FM score of 24.

Procedures

Outcome measurement fidelity between and within the LEAPS clinical sites includes 3 phases: phase I, develop manual of proce-

dures; phase II, train study personnel; and phase III, reliability assessment.

Phase I: Develop Manual of Procedures

During the LEAPS pre-enrollment phase, principal investigators developed a manual of procedures that described the standardized data collection method for all outcome measurement tools, including the FM motor and sensory assessments. In collaboration with the study principal investigators, the manual of procedures was refined as clinical research coordinators (CRC) and site lead physical therapists field-tested the manual of procedures. Because there are no published methods for the FM motor and sensory assessment that have established intratester and intertester reliability, the procedures were developed from original sources,^{3,17} a nonpublished manual of procedures from the EXCITE trial,⁶ an international consultant (Carol Richards, personal communication, February, 2, 2006), and LEAPS principal investigators (K.S., P.D.) with extensive research and clinical expertise with the FM assessment (see Appendix A and Appendix B available online at <http://stroke.ahajournals.org>).

Phase II: Train Study Personnel

The CRC and lead physical therapists from each region participated with study investigators in a 2-day in-person training program. CRC and lead physical therapists provided training at the home site for additional personnel hired; annual monitoring was conducted by the CRC for the duration of the trial. Therapist raters completed a training program that included: (1) practice for 1 month; (2) on-site coaching and feedback by site lead physical therapist and regional CRC; and (3) competency testing in which videotapes were submitted to the alternate regional CRC for review. Therapists were required to perform at $\geq 90\%$ accuracy to serve as a LEAPS assessor.

Phase III: Reliability Assessment

A reliability study was conducted to determine whether the highly structured, standardized LEAPS FM training procedures resulted in uniform performance of raters. Therefore, a sample of trained therapist raters (TR) was consecutively selected from the 5 sites to compare as a uniform group to an expert rater (ER).¹⁸ Each individual rater was videotaped during a regularly scheduled trial assessment that included the FM. Videotapes were sent to an administrative site to be scored by the ER on a blank data collection form. Approximately 12 months after the original ER assessments, 5 randomly selected tapes were rescored and analyzed for the intratester reliability of the ER.

Data Analysis

Mean and standard deviation for the total, UE, and LE motor scores and total, light touch, and proprioception sensory scores were calculated. Intraclass correlation coefficient (ICC) was used to assess reliability (SAS version 9.1). The 2-way mixed approach (ICC 3, 1) with absolute agreement was used to assess intra-rater reliability for the ER observations. The 2-way random approach (ICC 2, 1) with absolute agreement was used to compare the 17 TR direct and ER video observations for the inter-rater reliability analysis. As suggested by Richman,¹⁹ reliability estimates ≥ 0.8 to 1.0 indicate high reliability, estimates 0.60 to 0.79 indicate moderate reliability, and estimates < 0.60 indicate questionable reliability. A post hoc analysis with modified Bland and Altman plots was used to assess the magnitude and direction of bias in measurement agreement between TR and the ER.²⁰

Results

Fifteen participants with stroke participated (characteristics at 5 to 45 days in Table 1). Two participants were assessed by 2 different therapists at screening and prerandomization time-points; thus, 15 patients resulted in 17 assessments. Seventeen trial physical therapists participated (clinical experience, 12.6 ± 6.4 ; range, 2–21 years; 25% were board

Table 1. Participant Stroke Characteristics

Characteristics	N=15
Mean age (range), yr	62.8 (44–87)
Mean time after stroke onset (range), d	31.3 (10–71)
Gender	10 women/5 men
Stroke characteristics	
Type	14 ischemic/1 hemorrhagic
Side of hemiparesis	9 right/6 left
Fugl-Meyer (scores)*	
Total motor score (0–100)	53.4 (14–92)
Upper extremity subscore (0–66)	30.4 (5–63)
Lower extremity subscore (0–34)	23.1 (8–33)
Total sensory score (0–24)	18.7 (2–24)
Light touch subscore (0–8)	5.7 (0–8)
Proprioception subscore (0–16)	13.0 (0–16)

*Scored by expert rater.

certified clinical specialist in neurological physical therapist. The ER had 30 years of clinical experience as a physical therapist with extensive teaching and research experience in stroke neurorehabilitation, including specific expertise in the FM assessment.

Reliability

The ICC and 95% CI for the FM motor and sensory scores for the intra-rater and inter-rater analyses are presented in Table 2. Intra-rater reliability for the ER was high for the motor (total motor, 0.99; UE, 0.95; LE, 0.99) and sensory assessments (total sensory, 0.96; light touch, 1.0; proprioception, 0.95), confirming gold standard competence.

Inter-rater agreement between expert and therapist raters was high for the total motor score (ICC, 0.98; 95% CI,

0.93–0.99) and UE motor subscore (ICC, 0.99; 95% CI, 0.97–1.0) and within the moderate to high range for the LE motor subscore (ICC, 0.91; 95% CI, 0.69–0.97). Inter-rater agreement was high for the total sensory score (ICC, 0.93; 95% CI, 0.83–0.98) and proprioception subscore (ICC, 0.96; 95% CI, 0.90–0.99) and within the moderate to high range for the light touch subscore (ICC, 0.87; 95% CI, 0.69–0.95).

Bland and Altman plots were used to illustrate the magnitude and direction of bias (ie, tendency to overscore or underscore) between TR and ER (Figure). For motor assessments (total motor, UE motor, LE motor), TR tended to assign lower scores compared to ER. The TR total motor and LE motor scores were statistically significantly lower ($P < 0.05$ from paired *t* test) than ER. Only 1 outlier, exceeded the 95% CI of the difference between TR and the ER, is identified in the total motor plot. For all sensory assessments (total sensory, light touch, proprioception), there was high consistency between the TR and the ER scores. One outlier was identified from each of the light touch and proprioception plots.

Discussion

We describe the standardized measurement methods, training program, and reliability results for the FM motor and sensory assessments used across 5 community-based clinical sites of a multi-site, rehabilitation RCT. We demonstrate that a training program that includes instruction, practice, and competency assessment of trial personnel can be effective. After training, therapists in this study performed with high agreement compared to an expert rater for both the FM motor and sensory assessments. Our reliability results are higher than what has been previously reported, which we attribute to standardized measurement methods and adequate training to ensure rater competence across the duration of the trial.

Clinical Trial Fidelity

A recent revision to the CONSORT (Consolidated Standards of Reporting Trials) statement outlines specific reporting criteria for nonpharmacologic intervention trials such as rehabilitation, surgery, or technical procedures in which complex trial designs, populations, interventions, and outcome measures are typical.²¹ Operationally, a manual of procedures is developed to describe the data collection tools and methods, training programs, and procedures to ensure personnel compliance and adherence over the course of a multi-site, multi-year RCT. Procedure manuals are time-consuming to develop but are seldom published, which limits the benefit to others even though the work is accomplished through funded RCT. In the Appendices, we provide the data collection tool and procedures for implementation and scoring of the total FM motor and sensory scale used in the LEAPS trial. Care was taken to cross-validate our version to a recent source²² so that the intent of the original Fugl-Meyer UE and LE motor assessment is reflected. To our knowledge, this study is the first to provide a reliable procedure for light touch and proprioception sensory assessment.

One goal of clinical trials in community settings is to facilitate the translation of research to practice. This study is an example of a collaborative project with shared input between LEAPS investigators and clinicians; the outcome

Table 2. Intra-rater and Inter-Rater Reliability

Fugl-Meyer Assessment Domain	Intra-rater Reliability (ER)*		Inter-rater Reliability (ER Compared to TR)†	
	ICC (3, 1)	95% CI	ICC (2, 1)	95% CI
Motor				
Total	0.99	0.83–1.0	0.98	0.93–0.99
Upper extremity	0.95	0.66–1.0	0.99	0.97–1.0
Lower extremity	0.99	0.91–1.0	0.91	0.69–0.97
Sensory				
Total	0.96	0.70–1.0	0.93	0.83–0.98
Light touch	1.0	1.0–1.0	0.87	0.69–0.95
Proprioception	0.95	0.63–1.0	0.96	0.90–0.99

ER indicates expert rater; ICC, intraclass correlation coefficient; TR, therapist rater.

*Intra-rater comparison: ER original videotaped assessments and random sample reviewed 12 mo later.

†Inter-rater comparison between the ER and sample of 17 (TR) from all trained trial therapists across the 5 regional clinical sites (Brooks Rehabilitation Center, Jacksonville, FL, n=4; Centinela Regional Medical Center, Los Angeles, CA, n=3; Florida Hospital, Orlando, FL, n=3; Long Beach Memorial Medical Center, Long Beach, CA, n=3; Sharp Memorial Medical Center, San Diego, CA, n=4).

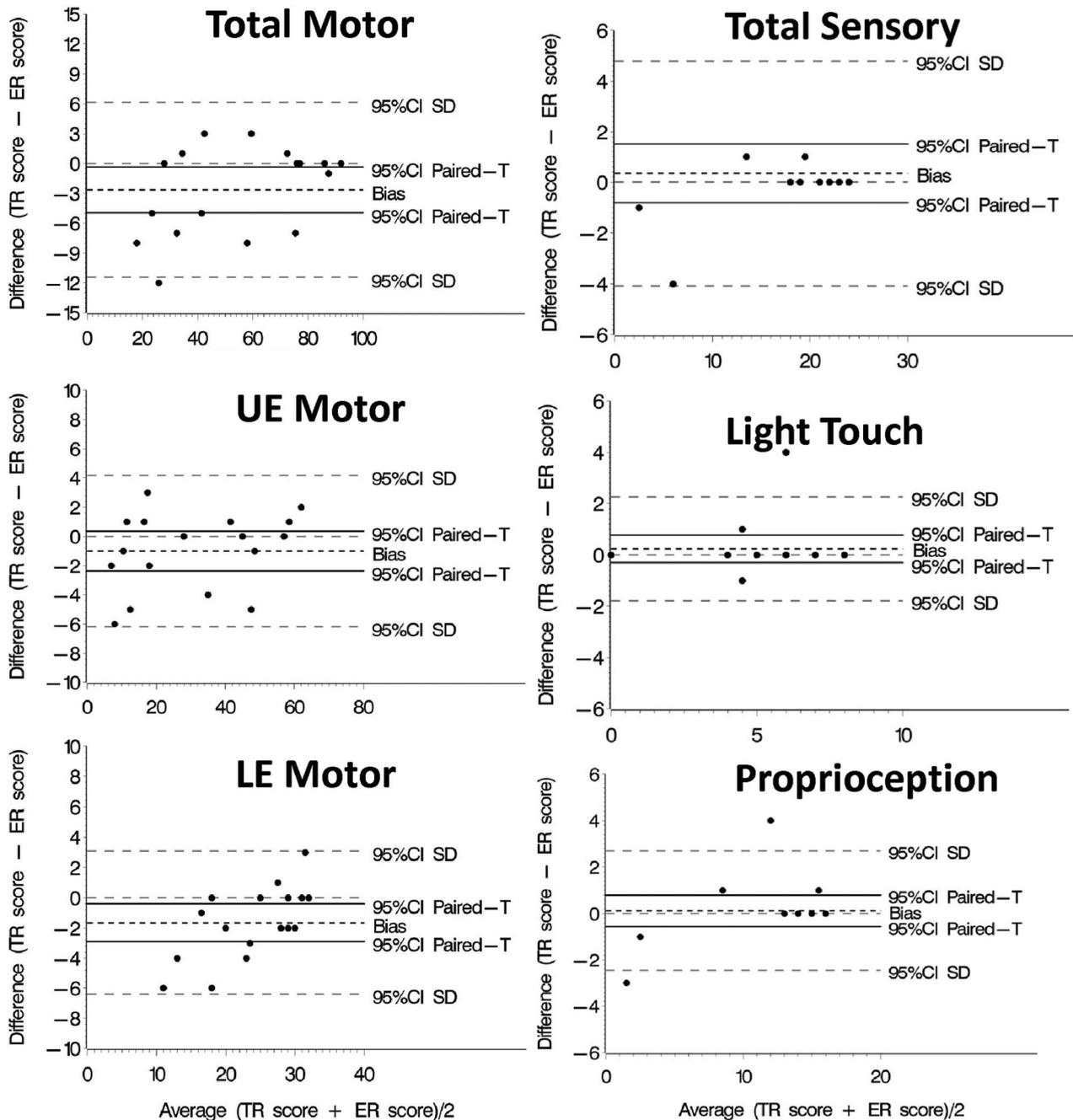


Figure. Modified Bland and Altman plots for Fugl-Meyer total, upper extremity (UE), and lower extremity (LE) motor scores (left column) and total, light touch, and proprioception sensory scores (right column). Plots illustrate the magnitude and direction of bias in measurement agreement between therapist raters (TR) and the expert rater (ER). The y-axis represents the difference between TR and ER measurements; the x-axis represents the average of TR and ER measurements. The line at zero on the y-axis is a reference line representing no bias. The line labeled “Bias” (dark dashed) represents mean bias between TR and the ER. The lines labeled “95% CI Paired-T” (dark solid) represent the 95% confidence interval using standard error from a paired *t* test. The lines labeled “95% CI SD” (light dashed) represent the 95% confidence interval using standard deviation from the difference between TR and the ER.

included meaningful and valuable communication within our trial and resulted in a tangible product, the measurement tool and procedures for the FM motor and sensory assessments that may benefit other clinical trials and practitioners.

Standardized training programs are typically used in multi-site RCT to develop competence in clinicians across all training sites. We report the ICC for the reliability between clinical measurements of newly trained clinicians compared

to an experienced rater; additionally, the Bland and Altman methods, with its associated plots, provide valuable data on the direction and magnitude of bias between individual raters.¹⁸ For clinicians being trained on a new assessment or technological method, tendencies to overscore or underscore compared to an experienced clinician can be readily identified. For individual raters who perform outside the limits of agreement, additional training can be provided.

Research and Clinical Utility

In the field of stroke rehabilitation, the FM motor assessment is recognized as a valid and reliable clinical measure of poststroke motor impairment severity.^{4,5} The FM motor assessment was developed from the original stages of motor recovery described by Brunnstrom.¹⁷ According to Brunnstrom, a person recovering from hemiparetic stroke progresses from a stage of flaccid paralysis through a stage of spastic, voluntary movement in synergy to isolated movements that are independent of patterned, synergistic movement. The clinical value of the FM assessment is that it provides a hierarchical scale of motor impairment severity; low FM scores indicate greater impairment. Movements are graded from no voluntary contraction with hypo-reflexia or hyper-reflexia progressing to voluntary patterned movements (eg, abnormal flexion or extension synergy) to the higher FM scores, with fractionated, isolated joint movements evident. Thus, a higher FM score for the UE or LE (ie, increased ability to perform isolated joint movement) is a clinical indicator of less motor impairment. More importantly, the FM motor score is predictive of functional performance in activities such as gait.⁷

Several recent studies using diffusion tensor imaging with or without transcranial magnetic stimulation demonstrate the association between corticospinal white matter tract integrity, motor severity, and motor recovery potential after stroke.^{8,23,24} Weakness (eg, grip force) and loss of movement selectivity (ie, FM motor score) increase in severity with greater damage to corticospinal tract fibers. To date, no studies have addressed the sensory impairments that result from ascending sensory tract damage.

Conclusion

A standardized method to collect clinical data on motor and sensory impairment after stroke has value both for clinical practice and research investigations of sensorimotor recovery after stroke. Our study provides a standardized, reliable version of the FM sensorimotor assessment as a measurement tool to assess sensory and motor impairment severity after stroke. The FM assessment method provided can be readily used in clinical practice or future investigations of poststroke structural integrity, impairment severity, and responsiveness to therapeutic interventions for postacute recovery after stroke.

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APPENDIX A

FUGL- MEYER ASSESSMENT OF PHYSICAL PERFORMANCE

General Procedure and Rules

PROCEDURE

Description: This assessment is a measure of upper extremity (UE) and lower extremity (LE) motor and sensory impairment.

Equipment: A chair, bedside table, reflex hammer, cotton ball, pencil, small piece of cardboard or paper, small can, tennis ball, stop watch, and blindfold.

Administration: The complete assessment usually requires 45 minutes.

GENERAL RULES

Perform the assessment in a quiet area when the patient is maximally alert.

Volitional movement assessment: This includes flexor synergy, extensor synergy, movement combining synergies, movement out of synergy, wrist, hand, and coordination/speed. For all tests of volitional motion, these guidelines are to be followed:

1. Give clear and concise instructions. Mime as well as verbal instructions permissible.
2. Have patient perform the movement with non-affected extremity first. On affected side, check for available passive range of motion (PROM) prior to asking patient to perform the movement.
3. Repeat each movement 3x on the affected side and score best performance. If full score is attained on trials 1 or 2, do not have to repeat 3 times. Only test Coordination/speed, one time.
4. Do not assist patient, however verbal encouragement is permitted.
5. Test the wrist and hand function independently of the arm. **During the wrist tests (items 7a-e), support under the elbow may be provided to decrease demand at the shoulder; however, the patient should be activating the elbow flexors during the elbow at 90 degree tests and activating the elbow extensors during the elbow at 0 degree tests. In contrast, assistance can be provided to the arm at the elbow and just proximal to the wrist in order to position the arm during the hand tests (items 8a-g).**

Fugl-Meyer Motor Assessment

Lower Extremity

Item	Procedure	Scoring
I. <u>Reflex activity</u>	<ul style="list-style-type: none"> • Patient is supine or sitting. • Attempt to elicit the Achilles and patellar reflexes. • Assess the unaffected side first. • Test affected side. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 4): <ul style="list-style-type: none"> • (0) - No reflex activity can be elicited; • (2) - Reflex activity can be elicited. Items to be scored are Achilles and patellar reflexes.
IIA. <u>Flexor synergy</u>	<ul style="list-style-type: none"> • Patient is supine. • Have patient perform movement with unaffected side first. • On the affected side, check patient's available PROM at each joint to be tested. • Start with leg fully extended at hip, knee, and ankle. Instruct the patient to "bring your knee to your chest and 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 6): <ul style="list-style-type: none"> • (0) - Cannot be performed at all • (1) – Partial motion • (2) – Full motion

	<p>pull up your toes" (therapist is observing for evidence of hip, knee, ankle flexion in order to assess the presence of all components of the flexor synergy). Therapist can cue the patient to move any missing component.</p> <ul style="list-style-type: none"> • Test 3x on the affected side and score best movement at each joint. 	<ul style="list-style-type: none"> • Items to be scored are: Hip flexion, knee flexion, ankle dorsiflexion.
<p><u>IIB. Extensor synergy</u></p>	<ul style="list-style-type: none"> • Patient is sidelying. • Have patient perform movement with unaffected side first. • On the affected side, check patient's available PROM at each joint to be tested. • Start in 90 degrees hip flexion, 90 degrees knee flexion and ankle dorsiflexion. • Instruct the patient to "push your foot down and kick down and back". (Ankle plantarflexion, knee extension, hip adduction and hip extension.) • Slight resistance should be applied in adduction which is gravity-assisted in this position to ensure patient is actively adducting. • Test 3x on the affected side and score best movement at each joint. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 8): <ul style="list-style-type: none"> • (0) – No motion • (1) – Partial motion • (2) – Full motion • Items to be scored are: Hip extension, hip adduction, knee extension, ankle plantarflexion.
<p><u>III. Movement combining synergies (in sitting)</u></p>	<p><u>3a. Knee flexion beyond 90°:</u></p> <ul style="list-style-type: none"> • Patient is sitting, feet on floor, with knees free of chair. Knee to be tested is slightly extended beyond 90° knee flexion. Calf muscles should not be on stretch. To decrease friction, patient's shoes can be removed, but socks should remain on. • Have patient perform movement with unaffected side first. • Check patient's available PROM on the affected side for this motion. • Patient is instructed to "pull your heel back and under the chair." • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – No active motion • (1) – From slightly extended position, knee can be flexed but not beyond 90° or hip flexes while attempting to flex knee • (2) – Knee flexion beyond 90°
	<p><u>3b. Ankle Dorsiflexion:</u></p> <ul style="list-style-type: none"> • Patient is sitting, feet on floor, with knees free of chair. Calf muscles should not be on stretch. • Have patient perform movement with unaffected side first. • On the affected side, check patient's available PROM at the ankle joint. • Patient is instructed to "keeping your heel on the floor, lift your foot." • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – No active motion • (1) – Incomplete active flexion (heel must remain on floor with medial and lateral borders of the forefoot clearing the floor during dorsiflexion) • (2) – Normal dorsiflexion (full within available ROM, heel remains on the floor)

<p>IV. <u>Movement out of synergy (Standing, hip at 0 degrees)</u></p>	<p>4a. Knee Flexion:</p> <ul style="list-style-type: none"> • Patient is standing, hip at 0 degrees (or full available ROM up to 0 degrees). On leg that is being tested, hip is at 0 degrees (or full available ROM up to 0 degrees), but the knee is flexed, and the patient's toes are touching the floor slightly behind. Evaluator can provide assistance to maintain balance and patient can rest hands on a table. • Have patient perform movement with unaffected side first. • Check patient's available PROM on the affected side for this motion. • Patient is instructed to "keeping your hip back, kick your bottom with your heel." • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • Scoring (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – Knee cannot flex without hip flexion • (1) – Knee flexion begins without hip flexion but does not reach to 90° or hip begins to flex in later phase of motion • (2) – Knee flexion beyond 90° (Knee flexion beyond 90 degrees with hip maintained in extension)
<p>IV. <u>Movement out of synergy (Standing, hip at 0 degrees)</u></p>	<p>4b. Ankle Dorsiflexion:</p> <ul style="list-style-type: none"> • Patient is standing, hip at 0 degrees. If patient's calf muscle length is limiting active dorsiflexion in this starting position, then leg that is being tested can be positioned forward, so the hip is at approximately 5 degrees of flexion, and calf muscles are in lengthened position. Knee must stay fully extended. Evaluator can provide assistance to maintain balance and patient can rest hands on a table. • Have patient perform movement with unaffected side first. • On the affected side, check patient's available dorsiflexion PROM. • Patient is instructed to "keeping your knee extended and your heel on the floor, lift your foot." • Test 3x on the affected side and score best movement 	<ul style="list-style-type: none"> • Scoring (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – No active motion • (1) – Partial motion (less than full available range with knee extended; heel must remain on floor with medial and lateral borders of the forefoot clearing the floor during dorsiflexion, or hip and/or knee flexes during motion while attempting dorsiflexion) • (2) – Full motion (within available dorsiflexion range with knee extended and heel on the floor)
<p>V. <u>Normal Reflexes (sitting)</u></p>	<ul style="list-style-type: none"> • This item is only included if the patient achieves a maximum score on all previous lower extremity items, otherwise score 0 . • The examiner shall elicit patellar and Achilles phasic reflexes with a reflex hammer and knee flexors with quick stretch of the affected leg and note if the reflexes are hyperactive or not. 	<ul style="list-style-type: none"> • Scoring (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) - At least 2 of the 3 phasic reflexes are markedly hyperactive • (1) – One reflex is markedly hyperactive or at least 2 reflexes are lively • (2) - No more than one reflex is lively and none are hyperactive

VI.
Coordination/speed - Sitting: Heel to opposite knee repetitions in rapid succession

- Patient positioned in sitting with eyes open.
- Starting position is with heel to be tested resting on opposite ankle.
- Have patient perform movement with unaffected side first.
- Check available PROM on the affected side.
- Patient is instructed to "Bring your heel from your opposite ankle to your opposite knee, keeping your heel on your shin bone, move as fast as possible."
- Use a stopwatch to time how long it takes the patient to do 5 full (ankle to knee to ankle) repetitions.
- Use the full achieved active ROM on the unaffected limb as the comparison for the affected limb. If active ROM of affected limb is significantly less than that of unaffected limb, patient should be scored "0" for speed.
- Repeat the same movement with the affected leg. Record the time for both the unaffected and affected sides. Observe for evidence of tremor or dysmetria during the movement
- NOTE: This item attempts to discriminate between basal ganglia, thalamic, or cerebellar strokes in which tremor or dysmetria may result as a direct result of lesion to these areas. The majority of stroke cases are in the middle cerebral artery or basilar artery distributions where we expect to observe paralysis that affects movement speed but does not cause tremor or dysmetria. In cases of complete paralysis, observe for any indication of tremor or dysmetria that may be evident in face, voice, arms or legs. If there are no indicators of tremor or dysmetria, then score these items 2 and score speed 0.

- *Scoring Tremor* (Maximum possible score = 2):
 - (0) - Marked tremor
 - (1) – Slight tremor
 - (2) – No tremor
- *Scoring Dysmetria* (Maximum possible score = 2):
 - (0) - Pronounced or unsystematic dysmetria
 - (1) – Slight or systematic dysmetria
 - (2) – No dysmetria
- *Scoring Speed* (Maximum possible score = 2):
 - (0) - Activity is more than 6 seconds longer than unaffected leg
 - (1) – 2-5.9 seconds longer than unaffected leg
 - (2) - less than 2 seconds difference

Upper Extremity		
Item	Instructions	Scoring
I. <u>Reflex activity</u>	<ul style="list-style-type: none"> • Patient is sitting. • Attempt to elicit the biceps and triceps reflexes. • Test reflexes on unaffected side first. • Test affected side. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 4): <ul style="list-style-type: none"> • (0) - No reflex activity can be elicited • (2) - Reflex activity can be elicited
II. <u>Flexor synergy</u>	<ul style="list-style-type: none"> • Patient is sitting. • Have patient perform movement with unaffected side first. • On the affected side, check patient's available PROM at each joint to be tested. • The starting position should be that of full extensor synergy. If the patient cannot actively achieve the starting position, the limb may be passively placed extended towards opposite knee in shoulder adduction/internal rotation, elbow extension, and forearm pronation. • Instruct the patient to fully supinate his/her forearm, flex the elbow, and bring the hand to the ear of the affected side. The shoulder should be abducted at least 90 degrees. • Test 3x on the affected side and score best movement at each joint 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 12): <ul style="list-style-type: none"> • (0) - Cannot be performed at all • (1) - Performed partly • (2) - Performed faultlessly • Items to be scored are: Elevation (scapular), shoulder retraction (scapular), shoulder abduction (at least 90 degrees) and external rotation, elbow flexion, and forearm supination. <ul style="list-style-type: none"> •
III. <u>Extensor synergy</u>	<ul style="list-style-type: none"> • Patient is sitting. • Have patient perform movement with unaffected side first. • On the affected side, check patient's available PROM at each joint to be tested. • The starting position should be that the limb is passively placed at patient's side in elbow flexion and supination. The examiner must ensure that the patient does not rotate and flex the trunk forward, thereby allowing gravity to assist with the movement. The pectoralis major and triceps brachii tendons may be palpated to assess active movement. • Instruct the patient to adduct & internally rotate the shoulder, extend his arm towards the unaffected knee with the forearm pronated. • Test 3x on the affected side and score best movement at each joint. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 6): <ul style="list-style-type: none"> • (0) - Cannot be performed at all • (1) - Performed partly • (2) - Performed faultlessly • Items to be scored are: Shoulder adduction/internal rotation, elbow extension, and forearm pronation.
IV. <u>Movement combining synergies</u> The patient is asked to perform	<p>4a. Hand to lumbar spine:</p> <ul style="list-style-type: none"> • Patient is sitting with arm at side, shoulder at 0°, elbow at 0°. • Have patient perform movement with unaffected side first. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – No specific action is performed (or patient moves but does not reach

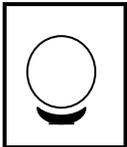
<p>three separate movements (4a, 4b, 4c).</p>	<ul style="list-style-type: none"> • Check patient’s available PROM on the affected side for this motion. • Patient is instructed to actively position the affected hand on the lumbar spine by asking them to “put your hand behind your back”. • Test 3x on the affected side and score best movement. 	<p>ASIS)</p> <ul style="list-style-type: none"> • (1) - Hand must pass anterior superior iliac spine (performed partly) • (2) - Performed faultlessly (patient clears ASIS and can extend arm behind back towards sacrum; full elbow extension is not required to score a 2)
	<p>4b. Shoulder flexion to 90°, elbow at 0°:</p> <ul style="list-style-type: none"> • Patient is sitting with hand resting on lap. • Have patient perform movement with unaffected side first. • On the affected side, check patient’s available PROM for shoulder flexion to 90° and full elbow extension. • Patient is instructed to flex the shoulder to 90°, keeping the elbow extended. The elbow must be fully extended throughout the shoulder flexor movement; the forearm can be in pronation or in a mid-position between pronation and supination. • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – Arm is immediately abducted, or elbow flexes at start of motion • (1) - Abduction or elbow flexion occurs in later phase of motion • (2) - Performed faultlessly (patient can flex shoulder keeping elbow extended)
	<p>4c. Pronation/supination of forearm, elbow at 90°, shoulder at 0°:</p> <ul style="list-style-type: none"> • Patient is sitting with arm at side, elbow flexed, and forearm in supination. • Have patient perform movement with unaffected side first. • On the affected side, check patient’s available PROM for end range of pronation and supination. • Patient is instructed to actively flex the elbow to 90° and pronate/supinate the forearm through the full available ROM. • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – Correct position of shoulder held in adduction at side of body and elbow flexion, and/or pronation or supination cannot be performed. • (1) – Active pronation or supination can be performed even within a limited range of motion, with elbow flexed at 90° and arm at side. • (2) - Complete pronation and supination with with elbow flexed at 90° and arm at side.
<p><u>V. Movement out of synergy</u></p> <p>The patient is asked to perform three separate movements (5a, 5b, 5c).</p>	<p>5a. Shoulder abduction to 90°, elbow at 0°, and forearm pronated:</p> <ul style="list-style-type: none"> • Patient is sitting with arm and hand resting at side. • Have patient perform movement with unaffected side first. • Check patient’s available PROM on the affected side for this motion. • Patient is instructed to abduct the shoulder to 90°, in a pure abduction motion, with the elbow fully extended 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – Initial elbow flexion occurs, or any deviation from pronated forearm occurs • (1) - Motion can be performed partly, or, if during motion, elbow is

	<p>and the forearm pronated.</p> <ul style="list-style-type: none"> • Test 3x on the affected side and score best movement. 	<p>flexed, or forearm cannot be kept in pronation;</p> <ul style="list-style-type: none"> • (2) - Performed faultlessly (patient can fully abduct shoulder, keeping forearm pronated with no elbow flexion)
	<p>5b. Shoulder flexion from 90°-180°, elbow at 0°, and forearm in mid-position:</p> <ul style="list-style-type: none"> • Patient is sitting with elbow extended, hand resting on knee. • Have patient perform movement with unaffected side first. • Check patient's available PROM on the affected side for this motion. • Patient is instructed to flex the shoulder above 90°, with the elbow fully extended and the forearm in the mid-position between pronation and supination. • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – Initial flexion of elbow or shoulder abduction occurs (arm is immediately abducted, or elbow flexes at start of motion) • (1) – Elbow flexion or shoulder abduction occurs during shoulder flexion (in later phases of motion) • (2) - Performed faultlessly (patient can flex shoulder above, with forearm in mid-position and no elbow flexion)
	<p>5c. Pronation/supination of forearm, elbow at 0°, and shoulder at 30°-90° of flexion:</p> <ul style="list-style-type: none"> • Patient is sitting with elbow extended, shoulder between 30°-90° of flexion. • Have patient perform movement with unaffected side first. • Check patient's available PROM on the affected side for this motion. • Patient is instructed to pronate and supinate the forearm as the shoulder remains flexed between 30-90° and the elbow is fully extended. • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – Supination and pronation cannot be performed at all, or elbow and shoulder positions cannot be attained • (1) – Elbow and shoulder properly positioned and supination performed in a limited range • (2) - Performed faultlessly (complete pronation and supination with correct positions at elbow and shoulder)
<p>VI. <u>Normal Reflexes</u> (sitting)</p>	<ul style="list-style-type: none"> • This item is only included if the patient achieves a maximum score on all previous upper extremity items, otherwise score 0. • The examiner shall elicit biceps and triceps phasic reflexes with a reflex hammer and finger flexors with quick stretch and note if the reflexes are hyperactive or not. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) - At least 2 of the 3 phasic reflexes are markedly hyperactive • (1) – One reflex is markedly hyperactive or at least 2 reflexes are lively • (2) - No more than one

		reflex is lively, and none are hyperactive
<p><u>VII. Wrist</u></p> <p>During the wrist tests, support under the elbow to may be provided to decrease demand at the shoulder; however, the patient should be activating the elbow flexors during the elbow at 90 degree tests and activating the elbow extensors during the elbow at 0 degree tests. The patient is asked to perform five separate movements (7a, 7b, 7c, 7d, 7e).</p>	<p>7a. Stability, elbow at 90°, and shoulder at 0°:</p> <ul style="list-style-type: none"> • Patient is sitting with arm and hand resting at side. • Have patient perform movement with unaffected side first. • Check patient’s available PROM on the affected side for this motion. • Patient is instructed to dorsiflex (extend) the wrist to the full range of 15° (or full available range) with the elbow at 90° flexion and the shoulder at 0°. If full range of dorsiflexion is attained, slight resistance is given. • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) - Patient cannot dorsiflex wrist to required 15° • (1) – Dorsiflexion is accomplished, but no resistance is taken • (2) - Position can be maintained with some (slight) resistance
	<p>7b. Flexion/extension, elbow at 90°, and shoulder at 0°:</p> <ul style="list-style-type: none"> • Patient is sitting with arm and hand resting at side. • Have patient perform movement with unaffected side first. • Patient is instructed to perform repeated smooth alternating movements from 15 degrees of flexion (wrist extension) to 15 degrees of extension. • Test 3x on the affected side and score best movement 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) - Volitional movement does not occur • (1) – Patient cannot actively move through the wrist joint throughout the total range of motion • (2) – Faultless, smooth movement (repetitive through full available ROM)
	<p>7c. Stability, elbow at 0°, and shoulder at 30° flexion:</p> <ul style="list-style-type: none"> • Patient is sitting with elbow extended, hand resting on knee and forearm pronated. • Have patient perform movement with unaffected side first. • Check patient’s available PROM on the affected side for this motion. • Patient is instructed to dorsiflex (extend) the wrist to the full range of 15° (or full available range) with the elbow fully extended and the shoulder at 30° flexion. If full range of dorsiflexion is attained, slight resistance is given. • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) - Patient cannot dorsiflex wrist to required 15° • (1) – Dorsiflexion is accomplished, but no resistance is taken • (2) - Position can be maintained with some (slight) resistance
	<p>7d. Flexion/extension, elbow at 0°, and shoulder at 30° flexion:</p> <ul style="list-style-type: none"> • Patient is sitting with elbow extended, hand resting on knee and forearm pronated. • Have patient perform movement with unaffected side first. • Patient is instructed to perform repeated smooth alternating movements from maximum dorsiflexion to maximum volar flexion with the fingers somewhat flexed to the full range of 15° (or full available range) 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) - Volitional movement does not occur • (1) – Patient cannot actively move throughout the total range of motion; • (2) – Faultlessly, smooth movement (repetitive through full ROM)

	<p>with the elbow fully extended and the shoulder at 30° flex.</p> <ul style="list-style-type: none"> • Test 3x on the affected side and score best movement. <p>7e. Circumduction:</p> <ul style="list-style-type: none"> • Patient is sitting with arm at side elbow flexed to 90°, and forearm pronated. • Have patient perform movement with unaffected side first. • Check patient's available PROM on the affected side for this motion. • Patient is instructed to circumduct the wrist with smooth alternating movements throughout the full range of circumduction. • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – Cannot be performed (volitional movement does not occur) • (1) – Jerky motion or incomplete circumduction • (2) – Complete motion with smoothness (performs faultlessly, smooth, repetitive movement through full ROM)
<p>VIII. Hand</p> <p>During the hand tests, assistance can be provided to the arm at the elbow and just proximal to the wrist in order to position the arm for the grasp tasks. The patient is asked to perform seven separate movements (8a, 8b, 8c, 8d, 8e, 8f, 8g). The object is not placed in the hand but presented to the patient so that it requires sufficient opening to grasp test object, closure on object, ability to hold against a slight tug.</p>	<p>8a. Finger mass flexion:</p>  <ul style="list-style-type: none"> • Patient is sitting with arm on bedside table or lap. • Have patient perform movement with unaffected side first. • Check patient's available PROM on the affected side for this motion. • Starting from the position of finger extension (this may be attained passively if necessary), instruct the patient to fully flex all fingers. • Test 3x on the affected side and score best movement 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – No flexion occurs • (1) – Some flexion, but not full motion • (2) – Completed active flexion (compared to unaffected hand)
	<p>8b. Finger mass extension:</p>  <ul style="list-style-type: none"> • Patient is sitting with arm on bedside table or lap. • Have patient perform movement with unaffected side first. • Check patient's available PROM on the affected side for this motion. • Starting from the position of finger flexion (this may be attained passively if necessary), instruct the patient to fully extend all fingers. • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – No extension occurs • (1) – Patient can release an active mass flexion grasp • (2) – Full active extension (compared to unaffected side)
	<p>8c. Grasp I:</p> <ul style="list-style-type: none"> • Patient is sitting with arm on bedside table. • Have patient perform movement with unaffected side first. • Check patient's available PROM on the affected side for 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – Required position cannot be attained • (1) – Grasp is weak

	<p>this motion.</p> <ul style="list-style-type: none"> • Instruct the patient to extend the metacarpophalangeal joints of digits II-V and flex the proximal & distal interphalangeal joints. Test this grip against resistance. You can tell the patient “pretend you are holding the handle of a briefcase.” • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • (2) – Grasp can be maintained against relatively great resistance
	<p>8d. Grasp II:</p>  <ul style="list-style-type: none"> • Patient is sitting with arm on bedside table. • Have patient perform movement with unaffected side first. • Instruct the patient to abduct the thumb to grasp a piece of paper. Then ask the patient to perform pure thumb adduction with the scrap of paper interposed between the thumb and first digit (as in figure). Test this grip against resistance by asking the patient to hold as you attempt to pull the paper out with a slight tug. • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – Function cannot be performed • (1) – Scrap of paper interposed between the thumb and index finger can be kept in place, but not against a slight tug • (2) – Paper is held firmly against a tug
	<p>8e. Grasp III:</p>  <ul style="list-style-type: none"> • Patient is sitting with arm on bedside table. • Have patient perform movement with unaffected side first. • Instruct the patient to grasp a pen or pencil by opposing the thumb and index finger pads around the pen. The tester may support the patient’s arm but may not assist with the hand function required for the retrieval task. The pen may not be stabilized by the therapist or the patient’s other hand. To minimize excessive movement, however, a pen with a ‘pocket clip’ that prevents rolling more than 180° may be used. • Once the pencil is retrieved, instruct the patient to oppose the thumb pad against the pad of the index finger with a pencil interposed. Test this grip against resistance by asking the patient to hold as you attempt to pull the pencil out with a slight tug upwards. • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – Function cannot be performed • (1) – A pencil interposed between the thumb pad and the pad of the index finger can be kept in place, but not against a slight tug • (2) – Pencil is held firmly against a tug
	<p>8f. Grasp IV:</p>  <ul style="list-style-type: none"> • Patient is sitting with arm on bedside table. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) Function cannot be performed • (1) – A can interposed between the thumb and

	<ul style="list-style-type: none"> • Have patient perform movement with unaffected side first. • Instruct the patient to grasp a small can (placed upright on a table without stabilization) by opening the fingers and opposing the volar surfaces of the thumb and digits. The arm may be supported but the tester may not assist with hand function. • Once the can is grasped, test this grip against resistance by asking the patient to hold as you attempt to pull the can out with a slight tug. Test 3x on the affected side and score best movement. 	<p>index finger can be kept in place, but not against a slight tug</p> <ul style="list-style-type: none"> • (2) – Can is held firmly against a tug • NOTE: the hand must open and close on the can; it is not acceptable to have the patient grasp can by coming down from the top of the can.
	<p>8g. Grasp V:</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <ul style="list-style-type: none"> • Patient is sitting with arm on bedside table. • Have patient perform movement with unaffected side first. • Instruct the patient to perform a spherical grasp by grasping a tennis ball. The tester may support the patient's arm but may not assist with the hand function required for the retrieval task. The ball may not be stabilized by the therapist or the patient's other hand. To minimize excessive movement, the ball can be placed on an object that reduces rolling. An inverted medium-sized bottle cap placed under the ball to prevent rolling is acceptable. Once the tennis ball is grasped, test this grip against resistance by asking the patient to hold as you attempt to pull the ball out with a slight tug. • Test 3x on the affected side and score best movement. 	<ul style="list-style-type: none"> • <i>Scoring</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) Function cannot be performed • (1) – A tennis ball can be kept in place with a spherical grasp, but not against a slight tug • (2) – Tennis ball is held firmly against a tug
<p>IX. Coordination and speed - Sitting: Finger to nose (5 repetitions in rapid succession)</p>	<ul style="list-style-type: none"> • Patient positioned in sitting with eyes open. • Starting position is with hand on lap. • Have patient perform movement with unaffected side first. • Check patient's available PROM on the affected side for this motion. • Patient is instructed to "bring your finger from your knee to your nose, as fast as possible." • Use a stopwatch to time how long it takes the patient to do 5 repetitions. • Repeat the same movement with the affected arm. Record the time for both the unaffected and affected sides. Observe for evidence of tremor or dysmetria during the movement. • NOTE: This item attempts to discriminate between basal ganglia, thalamic, or cerebellar strokes in which tremor or dysmetria may result as a direct result of lesion to these areas. The majority of stroke cases are 	<ul style="list-style-type: none"> • <i>Scoring Tremor</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) - Marked tremor • (1) – Slight tremor • (2) – No tremor • <i>Scoring Dysmetria</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0)- Pronounced or unsystematic dysmetria • (1) – Slight or systematic dysmetria • (2) – No dysmetria • <i>Scoring Speed</i> (Maximum possible score = 2): <ul style="list-style-type: none"> • (0) – Activity is more than 6 seconds longer than unaffected hand • (1) – (2-5.9) seconds longer

in the middle cerebral artery or basilar artery where we expect to observe paralysis that affects movement speed but does not cause tremor or dysmetria. In cases of complete paralysis, observe for any indication of tremor or dysmetria that may be evident in face, voice, arms or legs. If there are no indicators of tremor or dysmetria, then score these items 2 and score speed 0. If active ROM of affected limb is significantly less than that of unaffected limb, patient should be scored "0" for speed.

- than unaffected side
- (2) – less than 2 seconds difference

Fugl Meyer Sensory Assessment

Light Touch

Procedure:

- For light touch assessment, area of skin to be touched, should be free of clothing and exposed.
- The procedure can be tested in the sitting or supine positions. Explain to the patient with their eyes open, "I am going to touch you with this cotton ball and I would like you to tell me if you can feel that you are being touched." Lightly touch patient with cotton ball over the unaffected muscle belly. Ask them, "Can you feel that you are being touched?" This part of the procedure confirms that the patient understands the test.
- Explain to the patient, "I am going to ask you to close your eyes. Then I am going to touch you with the cotton ball on your right/left (unaffected) side followed by your right/left (affected) side. When I ask you, tell me if you can feel the touch." Ask the patient to close their eyes. Lightly touch unaffected area with cotton ball and ask, "Do you feel this?" Lightly touch affected area with cotton ball and ask "Do you feel this?" If the patient says they feel the touch on both sides, then repeat the procedure by touching first the unaffected side immediately followed by the affected side and ask the following question. "Does 'this' (unaffected area touch) feel the same as 'this' (affected area touch)?" The intent is to determine if there are differences in the characteristics of the touch between the two sides.
- If the tester is not confident that the patient understands this procedure or that the response is inconsistent, the tester may confirm their impression by using the following procedure. With the eyes closed, touch the patient on the affected side and ask them to point to where they were touched with the unaffected side. If the patient does not recognize that they are being touched, the score would be absent. If they recognize the touch but are not accurate on the localization, the score will be impaired. If they recognize the touch and are accurate on the localization, the score will be intact.

Upper Extremity

- Upper arm: Follow above procedure by touching patient over the unaffected and affected biceps muscle belly.
- Palmar surface of the hand: Follow above procedure by touching patient over the unaffected and affected palmar surface of the hand.

Scoring :

- (0) – Absent - If the patient states that he does not feel the touch on the affected side, the score is absent.
- (1) – Impaired - If the patient states that he feels the touch on the affected side and the touch does not feel the same between affected and unaffected sides or the response is delayed or unsure, the score is impaired.
- (2) – Intact - If the patient states that he feels the touch on the affected side and the touch feels the same between affected and unaffected sides, the score is intact.

	<p>Lower Extremity</p> <ul style="list-style-type: none"> • <u>Thigh</u>: Follow above procedure by touching patient over the unaffected and affected thigh of the leg. • <u>Sole of foot</u>: Follow above procedure by touching patient over the unaffected and affected sole of the foot. 	
<p>Proprioception The objective of this test is to determine a consistent response that is accurate and timely. If unsure, the tester can add additional repetitions to determine if a missed response is true sensory loss or an error by the patient due to test length not sensory loss.</p>	<p>Procedure:</p> <ul style="list-style-type: none"> • Proprioception can be tested in the sitting or supine positions for the upper extremity and in supine for the lower extremity. Start with the unaffected limb. Explain to the patient with their eyes open, “I am going to move your arm. This is up; this is down (demonstrate test). I want you to close your eyes and tell me if I am moving you up or down.” Use the hand positions described below for each joint movement. • Move the joint through a small range of motion (approximately 10 degrees for the limb joints and 5 degrees for the digit joints of the hand and foot). Move the limb at least 3 times in random directions. If the patient is wrong on any direction, then add several more repetitions to determine if the accuracy is great than 75% (score 2) or 75% or less (score 1). • Start with the most proximal limb joint on the unaffected side. Move to the same joint on the affected side. The intent is to determine if there are differences in the perception of proprioception between the two sides. For example, if the patient identifies the movement stimulus with the same accuracy and responsiveness of the unaffected side then the score would be 2. However, if the patient is accurate but responses are delayed or unsure then the score would be 1. (At this point, you could ask the patient if the movement on this side feels the same as the other side). No perception of joint movement is scored 0. <p>Upper Extremity</p> <ul style="list-style-type: none"> • <u>Shoulder</u>: Therapist supports patient’s arm by the medial and lateral epicondyles of the humerus and at the distal ulnar and radius. Have patient look at arm. Move shoulder, saying “This is up. This is down.” I am now going to have you close your eyes and I’m going to move your shoulder in either direction. I want you to tell me “up” or “down.” Randomly move arm approximately 10 degrees, 4 times (more if needed), keeping track of correct responses. • <u>Elbow</u>: Therapist supports patient’s arm by the medial and lateral epicondyles and the distal ulnar and radius. Have patient look at elbow. Move elbow, saying “This is up. This is down.” I am now going to have you close 	<ul style="list-style-type: none"> • Scoring: <ul style="list-style-type: none"> • (0) – Absent (no sensation) • (1) – Impaired (inconsistent response or three quarters of answers are correct, but considerable difference in sensation compared with unaffected side) • (2) – Intact (all answers are correct, little or no difference).

your eyes and I'm going to move your elbow in either direction. I want you to tell me "up" or "down." Randomly move elbow approximately 10 degrees, 4 times (more if needed) keeping track of correct responses.

- **Wrist:** Therapist supports patient's wrist at the distal ulna and radius and the heads of the 2nd and 5th metacarpal. Have patient look at wrist. Move wrist, saying "This is up. This is down." I am now going to have you close your eyes and I'm going to move your wrist in either direction. I want you to tell me "up" or "down." Randomly move wrist approximately 10 degrees, 4 times (more if needed), keeping track of correct responses.
- **Thumb:** Therapist supports patient's thumb proximal to the interphalangeal joint and either side of the most distal aspect of the thumb. Have patient look at thumb. Move thumb at interphalangeal joint, saying "This is up. This is down." I am now going to have you close your eyes and I'm going to move your thumb in either direction. I want you to tell me "up" or "down." Randomly move thumb approximately 10 degrees, 4 times (more if needed), keeping track of correct responses.

Lower Extremity

- The hip and knee should be tested in the supine position. The ankle and toe can be tested in the supine or sitting position.
- **Hip:** Therapist supports patient's leg at the femoral condyles and the medial and lateral malleolus. Have patient look at leg. Move hip, saying "This is up. This is down." I am now going to have you close your eyes and I'm going to move your hip in either direction. I want you to tell me "up" or "down." Randomly move hip approximately 10 degrees, 4 times (more if needed), keeping track of correct responses.
- **Knee:** Therapist supports patient's leg at the femoral condyles and the medial and lateral malleolus. Have patient look at knee. Move knee, saying "This is up. This is down." I am now going to have you close your eyes and I'm going to move your knee in either direction. I want you to tell me "up" or "down." Randomly move knee approximately 10 degrees, 4 times (more if needed), keeping track of correct responses.
- **Ankle:** Therapist supports patient's leg at the medial and lateral malleoli and the heads of the 1st and 5th metatarsal. Have patient look at ankle. Move ankle, saying "This is up. This is down." I am now going to

have you close your eyes and I'm going to move your ankle in either direction. I want you to tell me "up" or "down." Randomly move ankle approximately 10 degrees, 4 times (more if needed), keeping track of correct responses.

- Toe: Therapist supports patient's toe at the interphalangeal joint and either side of the most distal aspect of the great toe. Have patient look at great toe. Move interphalangeal joint, saying "This is up. This is down." I am now going to have you close your eyes and I'm going to move your big toe in either direction. I want you to tell me "up" or "down." Randomly move great toe approximately 10 degrees, 4 times (more if needed), keeping track of correct responses.

APPENDIX B
FUGL-MEYER ASSESSMENT OF PHYSICAL PERFORMANCE

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

TEST	ITEM	SCORE		SCORING CRITERIA
VII. Wrist	Stability, elbow at 90 ⁰ , shoulder at 0 ⁰			0-Patient cannot dorsiflex wrist to required 15 ⁰ 1-Dorsiflexion is accomplished, but no resistance is taken 2-Position can be maintained with some (slight) resistance
	Flexion/extension, elbow at 90 ⁰ , shoulder at 0 ⁰			0-Volitional movement does not occur 1-Patient cannot actively move the wrist joint throughout the total ROM 2-Faultless, smooth movement
	Stability, elbow at 0 ⁰ , shoulder at 30 ⁰			0-Patient cannot dorsiflex wrist to required 15 ⁰ 1-Dorsiflexion is accomplished, but no resistance is taken 2-Position can be maintained with some (slight) resistance
	Flexion/extension, elbow at 0 ⁰ , shoulder at 30 ⁰			0-Volitional movement does not occur 1-Patient cannot actively move the wrist joint throughout the total ROM 2-Faultless, smooth movement
	Circumduction			0-Cannot be performed 1-Jerky motion or incomplete circumduction 2-Complete motion with smoothness
VIII. Hand	Finger mass flexion			0-No flexion occurs 1-Some flexion, but not full motion 2-Complete active flexion (compared with unaffected hand)
	Finger mass extension			0-No extension occurs 1-Patient can release an active mass flexion grasp 2-Full active extension
	Grasp I - MCP joints extended and proximal & distal IP joints are flexed; grasp is tested against resistance			0-Required position cannot be acquired 1-Grasp is weak 2-Grasp can be maintained against relatively great resistance
	Grasp II - Patient is instructed to adduct thumb, with a scrap of paper interposed			0-Function cannot be performed 1-Scrap of paper interposed between the thumb and index finger can be kept in place, but not against a slight tug 2-Paper is held firmly against a tug
	Grasp III - Patient opposes thumb pad against the pad of index finger, with a pencil interposed			0-Function cannot be performed 1-Pencil interposed between the thumb and index finger can be kept in place, but not against a slight tug 2-Pencil is held firmly against a tug
	Grasp IV - The patient should grasp a can by opposing the volar surfaces of the 1st and 2nd digits.			0-Function cannot be performed 1-A can interposed between the thumb and index finger can be kept in place, but not against a slight tug 2-Can is held firmly against a tug
	Grasp V - The patient grasps a tennis ball with a spherical grip or is instructed to place his/her fingers in a position with abduction position of the thumb and abduction flexion of the 2nd, 3rd, 4th & 5th fingers			0-Function cannot be performed 1-A tennis ball can be kept in place with a spherical grasp but not against a slight tug 2-Tennis ball is held firmly against a tug
IX.Coordination/ Speed- Finger from knee to nose (5 repetitions in rapid succession)	Tremor			0-Marked tremor 1-Slight tremor 2-No tremor
	Dysmetria			0-Pronounced or unsystematic dysmetria 1-Slight or systematic dysmetria 2-No dysmetria
	Speed			0-Activity is more than 6 seconds longer than unaffected hand 1-(2-5.9) seconds longer than unaffected hand 2-Less than 2 seconds difference
Upper Extremity Total				Maximum = 66

Motor Function - Lower Extremity				
TEST	ITEM	SCORE		SCORING CRITERIA
		Pre	Post	
I. Reflex Activity	Achilles			0-No reflex activity can be elicited 2-Reflex activity can be elicited
	Patellar			
II. A. Flexor Synergy (in supine)	Hip flexion			0-Cannot be performed at all 1-Partial motion 2-Full motion
	Knee flexion			
	Ankle dorsiflexion			
II. B. Extensor Synergy (in side lying)	Hip extension			0-Cannot be performed at all 1-Partial motion 2-Full motion
	Adduction			
	Knee extension			
	Ankle plantar flexion			
III. Movement combining synergies (sitting: knees free of chair)	A. Knee flexion beyond 90°			0-No active motion 1-From slightly extended position, knee can be flexed, but not beyond 90° 2- Knee flexion beyond 90°
	B. Ankle dorsiflexion			
IV. Movement out of synergy (standing, hip at 0°)	A. Knee flexion			0-Knee cannot flex without hip flexion 1-Knee begins flexion without hip flexion, but does not reach to 90°, or hip flexes during motion 2-Full motion as described
	B. Ankle dorsiflexion			
V. Normal Reflexes (sitting)	Knee flexors Patellar Achilles (This item is only included if the patient achieves a maximum score on all previous items, otherwise score 0)			0-At least 2 of the 3 phasic reflexes are markedly hyperactive 1-One reflex is markedly hyperactive, or at least 2 reflexes are lively 2-No more than one reflex is lively and none are hyperactive
VI. Coordination/speed - Sitting: Heel to opposite knee (5 repetitions in rapid succession)	A. Tremor			0-Marked tremor 1-Slight tremor 2-No tremor
	B. Dysmetria			0-Pronounced or unsystematic dysmetria 1-Slight or systematic dysmetria 2- No dysmetria
	C. Speed			0-Activity is more than 6 seconds longer than unaffected side 1-(2-5.9) seconds longer than unaffected side 2-Less than 2 seconds difference
Lower Extremity Total				Max = 34
Total Motor Score (UE + LE)				Max = 100

Sensation

TYPE OF SENSATION	AREA	SCORE		SCORING CRITERIA
		Pre	Post	
I. Light Touch	Upper Arm			0-Anesthesia 1-Hyperesthesia / dysesthesia 2-Normal
	Palm of Hand			
	Thigh			
	Sole of Foot			
II. Proprioception	Shoulder			0-No Sensation 1-75% of answers are correct, but considerable difference in sensation relative to unaffected side 2- All answers are correct, little or no difference
	Elbow			
	Wrist			
	Thumb			
	Hip			
	Knee			
	Ankle			
	Toe			
Total Sensation Score				Maximum = 24
Total Motor and Sensory Score				Maximum = 124
Comments	Pre:			
	Post:			

Fugl-Meyer Assessment of Sensorimotor Function After Stroke: Standardized Training Procedure for Clinical Practice and Clinical Trials

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