USING THE PRINCIPLES OF NEUROPLASTICITY AND MOTOR LEARNING TO IMPROVE FUNCTIONAL OUTCOMES IN STROKE SURVIVORS: TRANSLATING THE EVIDENCE INTO PRACTICE

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INCIDENCE

• Each year, approximately 795,000 people suffer a stroke.
• On average, someone in the United States has a stroke every 40 seconds.
• Stroke is the third leading cause of death in the United States. More than 140,000 people die each year from stroke in the United States.
• Stroke is the leading cause of serious, long-term disability in the United States.
• Strokes can and do occur at ANY age. Nearly one fourth of strokes occur in people under the age of 65.

(The Internet stroke center, 2015)
WHAT IS NEUROPLASTICITY?

- Neuro: Nerves and/or brain
- Plasticity: Moldable or changeable in structure
- Speaks to the adaptive capacity of the central nervous system
- Brain is not a static organ
- Brain changes throughout life and after injury
ANIMAL RESEARCH...

- Monkeys perform "monkey ADLs" bimanually
- Deafferented one of the two forelimbs
- Monkeys stopped using forelimbs
- Learned behavior? (no biologic correlate)
- Terned learned nonuse

ANIMAL RESEARCH (CONT’D)

- Apply operant conditioning to model behavior
- Force use w. restraint of nondeafferented limb
- Monkeys begin using deafferented side
- Restraint removed – monkeys perform ADLs bimanually

MICHELLE MACK: THE IMPORTANCE OF REPETITION
IS THERE EVIDENCE THAT REPETITION BASED THERAPIES CHANGE THE BRAIN? (LIEPERT, ET AL., 2001)

• TMS of the APB
• Learned nonuse before but not after
  • Behavior ↔ plasticity
• This is one example; other strategies that have shown similar effects:
  • Certain types of estim
  • Mental practice
  • Modified CI Therapies
  • Certain types of robotics

BUT, CORTICAL “PLASTICITY” NOT DUE TO ONLY TO INCREASED MOTOR ACTIVITY…

Skill acquisition (Nudo, et al., 1996)


CHANGES IN THE LESIONED HEMISPHERE (NUDO, ET AL., 1996)

No training

Training
WHY DOES THIS FINDING MATTER IN STROKE?

• What we do: The goal of rehab can change from compensation to restoration of function
• What we measure: Measurement - and what is measured
• What we say and do: Can happen years after stroke
  • The “6 month myth”
  • Reimbursement
  • “Late recovery” and “Second chance” clinics

MOTOR LEARNING INTEGRATES RESEARCH FROM:

• Psychology
• Neurology
• Physical Education
• Rehabilitation

PRINCIPLES OF TASK ORIENTED APPROACH

• Practice of a movement results in improvement in that movement
• Large amounts of practice are required to truly master a motor skill
• Learning requires problem solving, not rote repetition
• Learning does not happen in the absence of feedback
• Optimal learning occurs with high levels of motivation and engagement
• Variable practice conditions are optimal for learning and generalization
• Mass practice promotes better learning than distributed practice
• Whole task practice is more effective than partial task practice
PRINCIPLES OF EXPERIENCE DEPENDENT PLASTICITY

- Use it or lose it
- Use it and improve it
- Specificity
- Repetition matters
- Intensity matters
- Time matters
- Salience matters
- Age matters
- Transference
- Interference

FACTORS FOR RECOVERY

Intensity
- Repetition
- Duration
- Distribution/Frequency
- Effort
- Difficulty

Manner
- Task Segmentation
- Specificity/Functionality
- Variability
- Initiation
- Shaping

Psychological Factors
- Motivation

Information
- Instructions
- Feedback

INTENSITY: OVERVIEW

- Repetition
- Duration
- Distribution/Frequency
- Effort
- Difficulty

- Repeated performance of a movement/task
- Time of a single therapy session or entire therapy
- Amount of rest between repetitions or therapy sessions
- Active participation of the patient (physical and mental)
- Level of challenge during therapy sessions
INTENSITY: OVERVIEW

\[
\text{Intensity} = \text{Frequency} \times \text{Duration} \times \text{Effort} \times \text{Difficulty of task}
\]

INTENSITY: REPETITIONS

**Power law of practice**
The degree of performance improvement depends on the amount of practice.

**More is better**
Increasing the amount of task repetitions results in cortical changes and better functional improvement.

**How much is enough?**
Evidence from animal and human studies suggests a much higher amount of repetitions for upper and lower limbs compared to the current therapy standard.
Practice Duration

Duration of practice is a key factor in meaningful training after stroke, and additional practice is better.

Average therapy session

In the US the average length of a therapy session is 38 minutes.

Optimal practice duration

According to Wang et al. the threshold duration for optimal outcome in stroke inpatients is 3 hours of therapy per day.

Benefits of rest periods

Frequent and longer rest periods between repetitions (distributed practice) improve learning compared to no rests (massed practice) in healthy subjects.

Trade-off

Massed practice enables increased amounts of training per time. On the other hand resultant fatigue and tiredness of massing practice increase the chance of injury.

Importance of physical effort

Active generation of controlled movements are necessary for effective learning.

Disadvantage of too much assistance

Movement assistance can reduce physical effort and therefore diminish skill learning.

Optimal cognitive demands

Increasing levels of mental effort up to a point are generally beneficial for learning. Overwhelming patients on the other hand interferes with learning.
Challenge beyond present capabilities
Learning is optimal when difficulty is out of “comfort zone”.
More complex tasks enhance short and long term neuronal changes

Enable training in optimal conditions
Support and guidance can help to avoid “over challenge”.

**Just Right Challenge**

Basic Knowledge - A Movement Therapy Perspective

MANNER: OVERVIEW

- Task segmentation
- Specificity / functionality
- Variability
- Initiation
- Shaping

Training a simplified version or only a part of a movement
Training of specific, essential tasks used in daily life
Amount of diversity or randomness contained in a task performance
Timing of the therapy start
Continuously adjustment of task difficulty combined with reinforcement

Therapy should start early, focus on practice of tasks used in daily life and include a high amount of variability.

MANNER: TASK SEGMENTATION

Types of task segmentation
Fractionalization: Breaking bilaterals tasks into two unilateral parts.
Progressive part practice: Separate task into several subparts.
Simplification: Reducing complexity of the task or parts of it.

Benefits of part training
Serial tasks containing distinct segments can be learned more effective in parts
Segmentation of complex tasks can enhance performance in stroke patients

Benefits of whole training
Continuous tasks such as walking and fast, discrete tasks should be learned as whole
MANNER: SPECIFICITY / FUNCTIONALITY

Benefit of task specific training
Task oriented training improves function and changes cortical activation

Make it more real!
Practice with real objects significantly improves reaching kinematics

Transfer of practice
Practice conditions need to match the real life situation as close as possible

MANNER: VARIABILITY

Benefits of variable practice
Task variability improves learning and increases the ability to perform new tasks

Forgetting helps remembering
Alternating randomly between training of multiple tasks (random practice) seems to be more effective than constant practice (blocked practice) in improving motor function in stroke patients

MANNER: INITIATION

Very early, intense therapy might be harmful
Some animal studies have shown worse outcomes if therapy started with high intensity right after a stroke

Window of opportunity
There is evidence that early rehabilitation leads to better outcomes but no optimal time ranges have been established. Recovery decreases the longer therapy is delayed

Benefits of early mobilization
Early mobilization reduces medical complications and decreases time to achieve functional walking
MANNER: SHAPING

Benefits of shaping
Shaping is an important way for enhancing recovery success, especially in the upper limbs.

Shaping can be combined with constraining of the unaffected limb to further increase effectiveness.

Optimal motivation level
Shaping is important to avoid frustration but also to avoid boredom.

PSYCHOLOGICAL FACTORS: OVERVIEW

Psychological Factors
- Motivation
  - Motivation is a practice and perform task.

PSYCHOLOGICAL FACTORS: MOTIVATION

Effect of Motivation
Patient motivation is a key factor for a positive rehabilitation outcome.

Low Motivation
Lack of motivation is a major cause of failure to benefit from rehabilitation.

In addition, rehabilitation staff and family members report low motivation as one of the most debilitating symptoms they deal with in rehabilitation.
PSYCHOLOGICAL FACTORS: MOTIVATION

Making the task seem important
Adding meaning to exercises can serve as an intrinsic motivator and enhance performance

Effect of Goal-setting
Specific goals that are adjusted during practice lead to improved learning compared to telling people to do their best.

Benefits of positive feedback
Positive feedback has a motivational effect that can enhance learning

INFORMATION: OVERVIEW

Information given before practice to facilitate correct performance

Information
• Instructions
• Feedback

Effect of instructions
The way instructions change a subject's focus can have detrimental effects on performance and learning

Usage of instructions
Only convey general ideas which are essential for first trials. Add more instructions progressively due to limited amount of instructions that can be remembered

Optimal schedule
Interspersing active practice with visual demonstration of the task improves learning compared to just giving a block of demonstrations before practice
INFORMATION: FEEDBACK OVERVIEW

- Feedback plays an essential role for movement control and learning
- Can be visual, auditory, olfactory, gustatory, somatosensory
- Used to compare an actual movement with the desired movement to detect errors and guide optimal movement form
- Feedback is required to learn unfamiliar tasks

INFORMATION: GUIDANCE

A procedure used to direct (either physically, verbally and/or visually) learners through task performance in an effort to reduce errors or reduce fear.

Schmidt and Wrisberg, 2008

Effect of Guidance
Guidance in general detrimental for learning, but interspersed with active practice guidance can be beneficial

Benefit of Guidance
Useful for preventing injury and reduce fear
Probably most useful for early practice and low tasks
Learning of complex tasks can benefit from guidance

ERRORLESS LEARNING VS ALLOWING ERROR

- Evidence shows that allowing for error increases the patient’s ability to carryover task completion
- ***As therapists we need to learn to be quiet more and allow the patient to make mistakes
HOW DO WE INTEGRATE THESE CONCEPTS INTO PRACTICE?

THE P.R.A.C.T.I.C.E. PRINCIPLES: COMMON INGREDIENTS FOR EFFICACIOUS STROKE REHABILITATION

• Part whole practice
• Repetitive, task specific, and goal focused
• Activities should be meaningful to client
• Client driven – goals and content of practice
• Train in a practical way
• Emphasize accomplishments and awareness – copious, diverse feedback, self efficacy, home programs

Page & Peters, Stroke, 2014

AN ADDITIONAL GAP: TIME AVAILABLE VERSUS TIME USED FOR ACUTE, REPETITIVE PRACTICE

• Pts within 14 days after stroke
• Observed them for 2 consecutive days at 10-minute intervals between 8 AM and 5 PM
BERNHARDT ET AL, 2004 (CONT’D)

• 53% of the time, patients were resting, talking, or eating in bed
• Patients were alone for 60.4% of the time
• Patients were in or at beside for 88.5% of observations.
• 0.2% of time is spent in the therapy room

ASSESSMENT OF MOTOR FUNCTION

• Observing functional, valued activities and timing, videotaping them
• B&B, ARAT, AMAT
• Quantifying quality of performance (0,1,2,3,...)
• Measuring distance walked, reached, etc.
• Self-reported/Other-reported skills: i.e. stroke impact scale, motor activity log

THE NFL COMBINE APPROACH

• Observing functional, valued activities and timing, videotaping them
• B&B, ARAT, AMAT
• Quantifying quality of performance (0,1,2,3,...)
• Measuring distance walked, reached, etc.
• Self-reported/Other-reported skills: i.e. stroke impact scale, motor activity log

Important: Train, Manualize
MOTOR ACTIVITY LOG

• Self report that measures perceived quality as well as quantity of use of affected limb

• A great way to measure changes in learned non-use

Motor Activity Log (UE MAL) Score Sheet

<table>
<thead>
<tr>
<th>Amount Scale (AS)</th>
<th>How Well Scale (HW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - Did not use my weaker arm (not used).</td>
<td>0 - The weaker arm was not used at all for that a (never).</td>
</tr>
<tr>
<td>.5 - Occasionally used my weaker arm, but only very rarely very much.</td>
<td>.5 - The weaker arm was moved during that activity but was no help (very poor).</td>
</tr>
<tr>
<td>1.5 - Slightly used my weaker arm but for the majority of the time the affected arm (poor).</td>
<td>2.5 - The weaker arm was of some use during that activity but needed some help from the stronger arm or moved very slowly or with difficulty (poor).</td>
</tr>
<tr>
<td>2.5 - Used my weaker arm a lot but as if the affected arm is paralyzed.</td>
<td>3 - The weaker arm was used for the purpose indicated but movements were slow or were with only some effort (fair).</td>
</tr>
<tr>
<td>3.5 - Used my weaker arm almost as much as before the stroke (slightly paralyzed).</td>
<td>4 - The movements made by the weaker arm were almost normal, but were not quite as fast or accurate as normal (almost normal).</td>
</tr>
<tr>
<td>4.5 - Used my weaker arm as often as before the stroke (same as pre-stroke).</td>
<td>5 - The ability to use the weaker arm for that activity was as good as before the stroke (normal).</td>
</tr>
</tbody>
</table>
FUGL MEYER

- Assesses motor function – free and easy to use
- Based on Brunstrom levels
- Scoring:
  - 0- cannot do movement
  - 1- can do partial movement
  - 2- can do full movement

OTHER ASSESSMENTS

- Box and Blocks
- Arm Mobility Arm Test (AMAT)
- Action Research Arm Test (ARAT)
INTERVENTION

• Door knobs
• Faucets
• Light switches

Because H.E.P. Doesn’t stand for “Hand ‘em Photocopies”!

• Occupational profile/ life history
  • What does the patient value?
  • What is frustrating them?
  • What do they want/need to do?
• Involve patient in their evaluation and goal setting
• Patient/family education
  • Use it or lose it
WHEN IS THE LAST TIME YOU ASKED YOUR PATIENT WHAT THEY WANT TO WORK ON?

You know you are an OT when you can justify trips to the casino as a way to increase ROM, strength, cognition and social emotional well being.

CONSTRAINT-INDUCED MOVEMENT THERAPY (CIT)

- Components to induce repeated practice with the affected UE include:
  - 6 hour training sessions on 10 consecutive weekdays
  - Mitt 90% of all waking hours during same 2 weeks
  - Behavioral strategies (log; shaping; behavioral contract)

- Increases more affected UE use & function in subacute & chronic CVA pts.
MODIFIED CONSTRAINT-INDUCED THERAPY: TRANSLATING “PRECLINICAL RESEARCH” TO CARE

- Therapy 3 times/week for ½ an hour
- Practice with the more affected arm for 3 hours/day 5 days/week
- Behavioral techniques (log, shaping)
- Reimbursement (acute and OP)
- Enough time (acute – 4 units of OT; OP – 2-3 units)
- Conditioning/no overtraining
- Compliance
- More UE reps → more opportunity for operant conditioning
- Distributed practice schedule

MENTAL PRACTICE

Therapy session structure

- 15 minutes – Supplemental or preparatory activities
  - Will assist with performance of designated functional task
- 15 minutes – Performance of designated functional task with challenge
- 15 minutes – Listening to mental practice recording of designated functional task
TECHNOLOGY IS CHANGING REHAB

TRANSCRANIAL DIRECT CURRENT STIMULATION

EMG ASSISTED MOVEMENT
HOW DO WE HELP POST DISCHARGE?

CONSIDERATIONS

- Half of all stroke survivors report feeling abandoned by the healthcare system following discharge from the hospital.

- Relatives perceived that they needed more information and knowledge about stroke and care/medication/rehabilitation/support.

- They also needed to be more involved in goal-setting and in identifying patient needs.
EDUCATION IS KEY

- Stroke.org
- Strokengine.ca
- Local support groups
- Social media
- Community Resources

CLINICAL TRIALS

- www.clinicaltrials.gov
- Local Universities
- Neurologists offices

QUESTIONS???
Motor Activity Log (MAL) Manual

UAB CI Therapy Research Group

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1. General
This instrument is a structured interview intended to examine how much and how well the subject uses their more-affected arm outside of the laboratory setting. Participants are asked standardized questions about the amount of use of their more-affected arm (Amount Scale or AS) and the quality of their movement (How Well Scale or HW) during the functional activities indicated. The scales are printed on separate sheets of paper and are placed in front of the participant during test administration. Participants should be told that they can give half scores (i.e., 0.5, 1.5, 2.5, 3.5, 4.5) if this is reflective of their ratings.

2. Rating Scales
Both the AS and HW scales are used during all test administrations, except for the periodic administration(s) of the MAL during treatment, when only the HW scale is used. In all administrations except those done during treatment, begin with the AS scale and ask participants to rate all tasks using the AS scale first. (See Comment 1 at the end of the manual) The tester then describes to the participant the difference between the AS and HW scales (as suggested in the instructions) and the UE MAL HW Rating Video is shown. The participant then rates all tasks performed with the HW scale. The UE MAL Demonstration Video is not shown at the screening administration (first administration) or for administrations during treatment, but it is shown again during post-treatment administration. (See Comment 5c) The tester should not ask the participant to rate the more-affected UE on the HW scale if they have already rated the more-affected UE as a 0 for the AS.

Amount Scale
0 - Did not use my weaker arm (not used).
.5
1 - Occasionally used my weaker arm but only very rarely (very rarely).
1.5
2 - Sometimes used my weaker arm but did the activity most of the time with my stronger arm (rarely).
2.5
3 - Used my weaker arm about half as much as before the stroke (half pre-stroke).
3.5
4 - Used my weaker arm almost as much as before the stroke (3/4 pre-stroke).
4.5
5 - Used my weaker arm as often as before the stroke (same as pre-stroke).
How Well Scale

0 - My weaker arm was not used at all for that activity (not used).
.5
1 - My weaker arm was moved during that activity but was not helpful (very poor).
1.5
2 - My weaker arm was of some use during that activity but needed some help from the stronger arm, moved very slowly, or with difficulty (poor).
2.5
3 - My weaker arm was used for that activity but the movements were slow or were made only with some effort (fair).
3.5
4 - The movements made by my weaker arm for that activity were almost normal but not quite as fast or accurate as normal (almost normal).
4.5
5 - The ability to use my weaker arm for that activity was as good as before the stroke (normal).

3. Asking Questions

Step One: Read the UE MAL instructions (see the Instructions for Participant – the last paragraphs of this Manual) to the participant and explain the rating scales. Answer any questions that the subject may have. The tester should remind the participant that the questions on the MAL pertain to what they actually do outside the treatment setting – not what they think they may be able to do.

Step Two: The project staff member should inquire about the use of the more-affected arm for each activity using the following questions:

a. Screening Evaluation (first test administration) - "Considering your activities during the past week, did you use your weaker arm to... (state the activity)?" If no, then ask why and direct the participant to the list of possible reasons why the arm was not used. For scoring on the recording form, use the codes at the bottom of the score sheet to categorize the participant's response. It is desirable to have these codes printed on a separate sheet so that it is easy for the participant to make a selection. If Yes, go to step three.

b. Pre-treatment Administration (second test administration) - "Considering your activities during the past week, did you use your weaker arm to ... (state the activity)?" If no, then ask why and direct the participant to the list of possible reasons why the arm was not used. For scoring on the recording form, use the codes at the bottom of the score sheet to categorize the participant's response. It is desirable to have these codes printed on a separate sheet so that it is easy for the participant to make a selection. If Yes, go to step three. **Note:** If the screening evaluation took place less than one week prior to pre-treatment testing, say "Since the last time you were evaluated for this project, did you... (state the activity)"
UAB Training for CI Therapy

c. Periodic MAL Administrations During Treatment- The time period covered by the MAL questions depends on the specific treatment schedule.

d. Post-treatment Testing- “Considering your activities since the last time I asked you these questions, have you used your weaker arm to... (state the activity)?” If no, then ask why and direct the participant to the list of possible reasons why the arm was not used. For scoring on the recording form, use the codes at the bottom of the score sheet to categorize the participant's response. It is desirable to have these codes printed on a separate sheet so that it is easy for the participant to make a selection. If Yes, go to step three.

e. All Other Test Administrations - "Considering your activities during the past week, did you use your weaker arm to ... (state the activity)?" If no, then ask why and direct the participant to the list of possible reasons why the arm was not used. For scoring on the recording form, use the codes at the bottom of the score sheet to categorize the participant's response. It is desirable to have these codes printed on a separate sheet so that it is easy for the participant to make a selection. If Yes, go to step three. (See Comment 2 at the end of the manual)

**Step Three: Rating the Amount of Use and How Well**

a. Amount Rating: Ask the participant, "Using the Amount Rating Scale, tell me how you would rate the amount you used your weaker arm to... (state the activity).” Once the participant selects a rating, verify their response by repeating the selected rating in the following manner; "So, you believe that you (read the description of the selected AS rating) – Is that correct?" When verifying the descriptor, at a minimum, repeat the abbreviated descriptor in the parentheses (e.g., half pre-stroke). For screening and pre-treatment testing, once they agree, record the response in the blank AS space provided for that question. For all other UE MAL administrations, after the participant’s response has been verified, the tester should proceed with probing the response. (See Step Four (b) and Comment 6).”

For pre-treatment, post-treatment, and follow-up testing, once the AS is completed, show the participant the UE MAL HW Rating Scale Video (see Comment 5c) in its entirety. Then proceed with the HW rating of the affected UE.

b. How Well Rating: Ask the subject, "Using the How Well Rating Scale, tell me how you would rate how well you used your weaker arm to... (state the activity)” For the screening evaluation and pre-treatment testing (first and second administrations), emphasize the difference between the AS and HW scales (See Comment 3). Once the participant selects a rating, verify the selected rating in the following manner; "So, you believe that you... (read the selected HW rating scale) - Is that correct?" (See Step Four(a) below) Once they agree, record the response in the blank HW space provided for that question during screening and pre-treatment administrations. For all other administrations (other than screening or pre-treatment), proceed with probing the participant’s
response for the HW scale. (See Step Four (b) below and Comment 6)

Note: During the pre-treatment testing (second test administration) and after the participant provides an HW rating, ask the subject to demonstrate an approximation of the first several activities (at least six) by saying, “Please show me how you do that activity.” (See Comment 5a)

Step Four: Verifying and Probing the Response

a. Verifying the response: Each number rating that a participant selects should be verified by restating the description verbally back to the subject in the form of a question. Both the Amount Rating and the How Well Rating scores will be verified.

Common frame of reference: During the pre-treatment testing (second test administration), the tester sets up an agreed-upon rating framework with the participant. If obvious discrepancies exist between what is observed and the rating provided, the tester should discuss the rating with the participant to develop a common frame of reference (i.e., “You rated that activity a "5". However, you moved your arm very slowly to do the activity. So, for this project that would be more like a "2". Do you agree?”). The final rating is determined by the participant.

Establishing a common frame of reference during the pre-treatment testing, before therapy has begun, is a critically important step. For suggestions on how to accomplish this, see Comment 5. The first administration of the MAL is very important and an hour or more should be devoted to it so that an appropriate frame of reference is established. This should include asking the participant to pantomime at least the first 6 activities that they score above 0 (see Comment 5a) and showing the participant the UE MAL HW Rating Scale video (See Comment 5c).

b. Probing the Response: During all test administrations (other than screening and pre-treatment), after verifying the participant’s score the tester should refer back to the scores of the immediately previous test administered to confirm that there has been a change. That score sheet should be out of view of the subject. For example, the previous MAL score sheet might be kept on a clipboard next to the tester, but covered by a piece of cardboard to shield it from the participant’s view. If a rating change occurs (increase or decrease), the tester should probe the response using the following questions:

1. “Today, you rated this activity… (state either "higher" or "lower" - whichever is accurate) than during the last test when you gave it a (repeat the previous score).” “Why is that?” or “Does this represent a real change?”

2. “So, now that you have thought about it more, how would you rate it?”
3. “So, you believe that the rating should be... (read the specified rating). Is that accurate?” If Yes, record the answer and go to the next question. If No, ask "Why?" and go back to question 2 – just above. (See Comment 6).

4. Caregiver MAL Testing
This MAL should be administered to a caregiver or significant other; the participant should not be present. The same significant other should be tested on both occasions and should preferably be someone living with the subject. The AS scale, UE MAL Demonstration video, and HW scale should be used for caregiver administrations.

5. Scoring
After administering the MAL, a mean MAL score is calculated for both scales by adding the rating scores for each scale and dividing by the number of items asked. As noted above, if during testing a subject answers No (they did not do the task), then try to determine why. Use the codes at the bottom of the forms to specify the reason. If you find that it is impossible for the subject to carry out the activity (e.g., can't comb hair because they are completely bald), the question is dropped from that and all other MALs and the mean score is calculated with the remaining items only (e.g., divide by 29 instead of 30). Otherwise, a rating score of zero is entered for “no” responses, and the mean score is calculated using the entire MAL (e.g., divide by 30). For further considerations concerning the N/A score, see Comment 4.

If a subject does an activity during treatment and then does not do it because an opportunity doesn’t present itself since the last MAL administration, the last score is carried forward. This is a conservative method of scoring since it is unlikely that performance would get worse during treatment and much more likely that it would get better. If a subject does an activity pre-treatment, but cannot do it during treatment (e.g., the hotel room where the subject is staying during treatment does not have a refrigerator that the subject would have at home), the score for that item is “not applicable” (n/a or a dot or left blank, depending on the data entry system being used). However, when the subject returns home and the activity that the subject performed pre-treatment can again be performed, scoring of that item is resumed.

If a person says that he never uses his more-affected arm for any purpose when you start administering the MAL, do not accept this assertion at face value. Instead, go through the first 10 items. If the answer to all 10 is zero, then one can assume that the initial response is substantially correct and one can assign a score of “0” to the remaining items without asking them individually.

Comments
Comment 1: Using the rating scales

The AS rating scale should only be used during the test administrations conducted before treatment (screening evaluation and pre-treatment testing), post-treatment, and in follow-up. It should not be used during treatment since treatment involves restraint of the less-affected arm thereby inducing greatly increased use of the more-affected arm. This would artificially inflate the appearance of a therapeutic effect and might not persist after the end of treatment. Thus, the meaning of ratings on the AS scale during treatment would be questionable.

Comment 2: Timeframes used in questions

In the screening evaluation (first test administration) and follow-up testing, ratings should be obtained for activities carried out during the previous week. The use of a one-week time frame should increase the likelihood that participant will have had opportunities to perform a representative sample of their full range of activities. However, at times, the pre-treatment (second MAL administration) will occur less than one week after the screening (first administration). In such cases, the pre-treatment testing (second administration) should involve obtaining ratings for activities carried out since the screening evaluation (first administration) (e.g., 3 days). In all other test administrations, ratings should be obtained for the time since the subject was last asked about that specific task. Since only one half of the MAL should be administered daily during the treatment period, this time frame will typically be 2 days.

Comment 3: Differentiating between the two rating scales

When both scales are being used to rate activities, particularly during screening evaluation and pre-treatment testing, it is very important to make sure that the participant understands the difference between the scales. The following phrases may be used before asking about the HW rating scale to accomplish this. “Remember that I am asking you to rate something different on this scale, the How Well Scale, than you did before on the Amount Scale. Before you were supposed to rate how much you used your more-affected arm. Now I would like you to rate how well you used your more-affected arm, if you did use it. For example, you might have used your more-affected hand to pick up a glass and drink only rarely. The Amount rating might therefore be a 1.5 or 2. However, when you did use it, your use of the hand was really quite good: let us say between fair and almost normal, or a 3.5. Is the difference between the two types of ratings I am asking you to make clear?” Go over this several times if necessary and have the person verbalize the difference between the two types of ratings to make sure they understand it.

Comment 4: Using the “N/A” code

When a task is impossible, such as combing the hair if the person is bald, the “N/A” score should be used. However, “N/A” should be used sparingly since many times a subject might
indicate that an activity is impossible, but it is actually not being performed because it is either very
difficult for the participant, inconvenient, or requires increased time for completion. It has been
found that when subjects progress through CI therapy, they will sometimes begin doing tasks that
they may have previously identified as impossible. Thus an item is to be noted as “N/A” only when
that activity is truly impossible; that item is then dropped from the test and the mean scores are
calculated with the remaining items only (e.g., divide by 29 rather than 30).

Comment 5: Establishing a context or a common frame of rating reference for the HW scale:
  a. During the pre-treatment testing, the subject should be asked to demonstrate a
number of activities (at least six activities) they have rated on the HW scale; the participant should
pantomime the activities in question. The activities for which demonstration is requested will most
usefully be activities at the beginning of the MAL; this will allow the tester to get an idea of the
subject's general frame of reference and will reduce the need for demonstration of activities on later
MAL items. During the pre-treatment administration, demonstration of the performance of an
activity should also be requested whenever the tester is unsure of what the participant means by a
rating. The demonstration should be carried out after the participant attempts to rate the activity and
only when using the HW rating scale. Observation of the pantomime of an activity allows the tester
an opportunity to discuss the participant’s HW rating in order to set an agreed-upon rating frame of
reference. Since this process should increase the likelihood that the participant understands the
intended motor referent or meaning of the HW rating scale, it should increase the comparability of
results across participants. The tester need not have the participant demonstrate every item on the
MAL if in their opinion the HW rating is consistent with the performance previously demonstrated
on a similar task (e.g., opening a refrigerator and opening a door by turning a door knob/handle).
Establishing a context should be used during pre-treatment testing only, so that experimenter bias
and demand characteristics resulting from this procedure cannot artificially increase the appearance
of a treatment effect.

b. When a clear disparity exists between the participant’s HW rating and what the tester has
observed concerning the subject's motor ability, the tester should explain the meaning of the HW
rating scale for the task in question with examples being given for each step, especially those that
focus on the HW rating in question (e.g., “You rated that activity a "3". However, you moved
your arm very slowly to do the activity. So, for this project that would be more like a “2”. Do you
agree? ”). Participants will usually be influenced by the tester’s explanation. If they are not and
they continue to reiterate the original estimate, the tester should politely continue the discussion
until the patient accepts the laboratory/clinic’s frame of reference. Thus, the MAL has aspects of
both a self-report instrument and a structured interview. Again, this process should be completed
prior to the beginning of treatment to decrease the chance that experimenter bias will influence
the HW rating scores.
c. Videotape: This laboratory has developed a UE MAL HW Rating Scale Video that provides examples of different rating levels for several UE MAL activities. This videotape is extremely helpful in establishing a common frame of reference with a patient. It should be shown in its entirety to the patient at the pre-treatment test administration and discussed thoroughly at that time. The UE MAL HW Rating Scale Video should also be shown at post-treatment testing and at follow-ups at 6, 12, and 24 months to refresh the subject’s frame of reference for the rating of MAL activities. Also, based on direct observation of behavior during therapy, if the tester believes at any time that the subject’s frame of reference has shifted, the UE MAL HW Rating Scale Video should be shown again and discussed.

Comment 6: Verifying and probing responses

Verifying the participant’s responses should be done for each administration. Each number rating that a subject selects should be verified by restating the description of that rating verbally back to the participant in the form of a question.

Probing the participant’s responses is performed for all administrations except screening and pre-treatment testing. During the standardized questioning, the subjects are not told their previous scores. However, if their report reflects a change in score, whether an increase or a decrease, the change in rating should be probed to determine whether it reflects a true change, as noted above. The most common type of situation in which probing has been found to increase response accuracy sometimes occurs approximately half way through the intervention period. Some participants become so pleased with their large and rapid improvement in motor function that they tend to magnify and overestimate it. Thus, the majority of errors made by participant represent an overestimation of the HW rating score. Probing usually results in revisions in the direction of performance decrement (i.e., a lower HW rating score), which therefore lead to a more conservative (and probably more accurate) estimate of the treatment effect than would otherwise be obtained.

During early experiments in the UAB lab (Taub et. al., 1993), probing was not carried out for the first two patients. The graphs of the daily MAL records for these two participants presented a jagged appearance, with days of decrement following days of large improvement. This variability appeared to testers not to be reflective of the reality of the situation. The improvements were frequently greater than appeared warranted and decrements seemed to underestimate performance. When the probing procedure was implemented, the curve connecting the MAL data points became smooth. However, it is important to note that the final performance was not greater than that recorded for the first two participants (where probing was not used). The project staff had the clear opinion that the smoothed curves more accurately described subjects' performance and that this was achieved by eliminating "noise" from the rating process (e.g., lack of attention by subjects during the testing, spontaneous change in the participant's frame of reference, etc.).

Comment 7: Administration times
Administration of the MAL during treatment provides valuable data and tracks a patient's progress during the therapy phase. Concerns have arisen because it was felt that administration of the MAL during the treatment period might have a “treatment effect” in itself. If this were so, it would jeopardize the MAL’s credibility as an outcome measure. It was felt that the treatment effect might result from the way in which the test focuses attention on the participant's activities at home. However, it should be noted that the entire CI Therapy approach focuses attention on using the more-affected arm in the lab and at home. Consequently, the effect produced by the MAL would be minimal in relation to the treatment effects brought about by the various aspects of the CI Therapy package (i.e., prolonged and concentrated task practice, wearing a mitt for 90% of waking hours, the behavioral contract, etc.). Evidence indicating that the administration of the MAL does not have a therapeutic effect in itself has been obtained in two experiments. First, in W. Miltner's group research laboratory at the University of Jena, the MAL was administered to eight patients with chronic stroke two weeks prior to treatment and on the pre-treatment testing day. Analysis revealed no reliable difference in the rating scores obtained during these two administrations. In addition, 21 participants participating in a two-week general fitness program designed as a placebo control procedure for the UAB CI Therapy Project were given the MAL repeatedly on the same basis as experimental subjects (i.e., pre-treatment, on a daily basis during the placebo treatment, post-treatment, and in follow-up). This group did not show a significant change in MAL scores as a result of therapy.

Recently a study has been conducted indicating that the MAL is psychometrically robust: inter-test reliability for the 2 MAL scales = .99 and .96; correlation of the scales of the MAL with the Abilhand Test - .88 and .71. (Johnson A, Judson L, Morris D, Uswatte G, Taub E. The reliability and validity of the 45-item upper extremity motor activity log. Paper presented at the American Physical Therapy Association, Combined Sections Meeting, Nashville, February, 2004.)
Instructions for Participant

“The purpose of this test is to examine how much and how well you use your more-affected arm when you are not in our laboratory. You will use two separate rating scales to describe how much and how well you use your weaker arm while you are doing specific activities. Please note that you can give half ratings if that best describes your performance of the activity in question. If for some reason, you do not perform these tasks, we will try to determine why. We will first discuss how much you do each of the activities with your weaker arm and then we will discuss how well you do them when using your weaker arm. I will be showing you a film of other people who had a stroke, carrying out the activities on the questionnaire at different levels of ability. I would like you to use the ratings on the videotape as the basis for forming a judgment of how well you do these activities yourself. It is important that you realize that these questions are about what you actually do outside of the laboratory setting – not what you think you may be able to do with your weaker arm. There are no right or wrong answers; simply select the ratings you believe best describes what you do. Please understand that I must follow a script with this procedure. Do you have any questions?”

When administering the MAL during a screening evaluation, both the AS and the HW scale should be used. The UE MAL HW Rating Scale Video is not shown to participant at screening unless the tester questions the potential subject’s frame of reference for rating themselves. In these cases, the UE MAL HW Rating Scale Video may be shown to help to establish an appropriate frame of reference. Use the following introductory paragraph for the screening:

“The purpose of this test is to examine how much and how well you use your more-affected arm when you are not in our laboratory. You will use two separate rating scales to describe how much and how well you use your weaker arm while you are doing specific activities. Please note that you can give half ratings if that best describes your performance of the activity in question. If for some reason, you do not perform these tasks, we will try to determine why. We will first discuss how much you do each of the activities with your weaker arm and then we will discuss how well you do them when using your weaker arm. It is important that you realize that these questions are about what you actually do outside of the laboratory setting – not what you think you may be able to do with your weaker arm. There are no right or wrong answers; simply select the ratings you believe best describes what you do. Please understand that I must follow a script with this procedure. Do you have any questions?”
Motor Activity Log (UE MAL) Score Sheet

<table>
<thead>
<tr>
<th>Activity Description</th>
<th>Amount Scale</th>
<th>How Well Scale</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Turn on a light with a light switch</td>
<td>___</td>
<td>___</td>
<td>if no, why? (use code)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comments</td>
</tr>
<tr>
<td>2. Open drawer</td>
<td>___</td>
<td>___</td>
<td>if no, why? (use code)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comments</td>
</tr>
<tr>
<td>3. Remove an item of clothing from a drawer</td>
<td>___</td>
<td>___</td>
<td>if no, why? (use code)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comments</td>
</tr>
<tr>
<td>4. Pick up phone</td>
<td>___</td>
<td>___</td>
<td>if no, why? (use code)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comments</td>
</tr>
<tr>
<td>5. Wipe off a kitchen counter or other surface</td>
<td>___</td>
<td>___</td>
<td>if no, why? (use code)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comments</td>
</tr>
<tr>
<td>6. Get out of a car (includes only the movement needed to get body from sitting to</td>
<td>___</td>
<td>___</td>
<td>if no, why? (use code)</td>
</tr>
<tr>
<td>standing outside of the car, once the door is open)</td>
<td></td>
<td></td>
<td>Comments</td>
</tr>
<tr>
<td>7. Open refrigerator</td>
<td>___</td>
<td>___</td>
<td>if no, why? (use code)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comments</td>
</tr>
<tr>
<td>8. Open a door by turning a door knob/ handle</td>
<td>___</td>
<td>___</td>
<td>if no, why? (use code)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comments</td>
</tr>
<tr>
<td>9. Use a TV remote control</td>
<td>___</td>
<td>___</td>
<td>if no, why? (use code)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Comments</td>
</tr>
<tr>
<td>10. Wash your hands (includes lathering and rinsing hands; does not include turning</td>
<td>___</td>
<td>___</td>
<td>if no, why? (use code)</td>
</tr>
<tr>
<td>water on and off with a faucet handle)</td>
<td></td>
<td></td>
<td>Comments</td>
</tr>
</tbody>
</table>

Codes for recording “no” responses:
1. “I used the unaffected arm entirely.” (assign “0”).
2. “Someone else did it for me.” (assign “0”).
3. “I never do that activity, with or without help from someone else because it is impossible.” For example, combing hair for people who are bald. (assign “N/A” and drop from list of items).
4. “I sometimes do that activity, but did not have the opportunity since the last time I answered these questions.” (carry-over last assigned number for that activity).
5. Non-dominant hand hemiparesis. (only applicable to #24; assign “N/A” and drop from list of items).
<table>
<thead>
<tr>
<th>Amount Scale</th>
<th>How Well Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Turning water on/off with knob/lever on faucet</td>
<td>____</td>
</tr>
<tr>
<td>12. Dry your hands</td>
<td>____</td>
</tr>
<tr>
<td>13. Put on your socks</td>
<td>____</td>
</tr>
<tr>
<td>14. Take off your socks</td>
<td>____</td>
</tr>
<tr>
<td>15. Put on your shoes (includes tying shoestrings and fastening straps)</td>
<td>____</td>
</tr>
<tr>
<td>16. Take off your shoes (includes untying shoestrings and unfastening straps)</td>
<td>____</td>
</tr>
<tr>
<td>17. Get up from a chair with armrests</td>
<td>____</td>
</tr>
<tr>
<td>18. Pull chair away from table before sitting down</td>
<td>____</td>
</tr>
<tr>
<td>19. Pull chair toward table after sitting down</td>
<td>____</td>
</tr>
<tr>
<td>20. Pick up a glass, bottle, drinking cup, or can (does not need to include drinking)</td>
<td>____</td>
</tr>
</tbody>
</table>

**Codes for recording “no” responses:**

1. “I used the unaffected arm entirely.” (assign “0”).
2. “Someone else did it for me.” (assign “0”).
3. “I never do that activity, with or without help from someone else because it is impossible.” For example, combing hair for people who are bald. (assign “N/A” and drop from list of items).
4. “I sometimes do that activity, but did not have the opportunity since the last time I answered these questions.” (carry-over last assigned number for that activity).
5. Non-dominant hand hemiparesis. (only applicable to #24; assign “N/A” and drop from list of items).
<table>
<thead>
<tr>
<th>Amount Scale</th>
<th>How Well Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>21. Brush your teeth</td>
<td>____</td>
</tr>
<tr>
<td><em>(does not include preparation of toothbrush or brushing dentures unless the dentures are brushed while left in the mouth)</em></td>
<td></td>
</tr>
<tr>
<td>Comments ________________________________</td>
<td></td>
</tr>
</tbody>
</table>

22. Put on makeup base, lotion, or shaving cream on face | ____ | ____ | if no, why? (use code) ________________________ |
| Comments ________________________________ |

23. Use a key to unlock a door | ____ | ____ | if no, why? (use code) ________________________ |
| Comments ________________________________ |

24. Write on paper *(If hand used to write pre-stroke is more affected, score item; if non-writing hand pre-stroke is more affected, drop item and assign N/A)* | ____ | ____ | if no, why? (use code) ________________________ |
| Comments ________________________________ |

25. Carry an object in your hand *(draping an item over the arm is not acceptable)* | ____ | ____ | if no, why? (use code) ________________________ |
| Comments ________________________________ |

26. Use a fork or spoon for eating *(refers to the action of bringing food to the mouth with fork or spoon)* | ____ | ____ | if no, why? (use code) ________________________ |
| Comments ________________________________ |

27. Comb your hair | ____ | ____ | if no, why? (use code) ________________________ |
| Comments ________________________________ |

28. Pick up a cup by a handle | ____ | ____ | if no, why? (use code) ________________________ |
| Comments ________________________________ |

29. Button a shirt | ____ | ____ | if no, why? (use code) ________________________ |
| Comments ________________________________ |

30. Eat half a sandwich or finger foods | ____ | ____ | if no, why? (use code) ________________________ |
| Comments ________________________________ |

**Codes for recording “no” responses:**

1. “I used the unaffected arm entirely.” (assign “0”).
2. “Someone else did it for me.” (assign “0”).
3. “I never do that activity, with or without help from someone else because it is impossible.” For example, combing hair for people who are bald. (assign “N/A” and drop from list of items).
4. “I sometimes do that activity, but did not have the opportunity since the last time I answered these questions.” (carry-over last assigned number for that activity).
5. Non-dominant hand hemiparesis. (only applicable to #24; assign “N/A” and drop from list of items).
Amount Scale (AS)

0 - Did not use my weaker arm (not used).

.5

1 - Occasionally used my weaker arm, but only very rarely (very rarely).

1.5

2 - Sometimes used my weaker arm but did the activity most of the time with my stronger arm (rarely).

2.5

3 - Used my weaker arm about half as much as before the stroke (half pre-stroke).

3.5

4 - Used my weaker arm almost as much as before the stroke (3/4 pre-stroke).

4.5

5 - Used my weaker arm as often as before the stroke (same as pre-stroke).

How Well Scale (HW)

0 - The weaker arm was not used at all for that activity (never).

.5
1 - The weaker arm was moved during that activity but was not helpful (very poor).

1.5
2 - The weaker arm was of some use during that activity but needed some help from the stronger arm or moved very slowly or with difficulty (poor).

2.5
3 - The weaker arm was used for the purpose indicated but movements were slow or were made with only some effort (fair).

3.5
4 - The movements made by the weaker arm were almost normal, but were not quite as fast or accurate as normal (almost normal).

4.5
5 - The ability to use the weaker arm for that activity was as good as before the stroke (normal).
Possible Reasons for Not Using the Weaker Arm for the Activity:

**Reason A.** “I used the unaffected arm entirely.”

**Reason B.** “Someone else did it for me.”.

**Reason C.** “I never do that activity, with or without help from someone else because it is impossible.” For example, combing hair for people who are bald.

**Reason D.** “I sometimes do that activity, but did not have the opportunity since the last time I answered these questions.”

**Reason E.** "That is an activity that I normally did only with my dominant hand before the stroke, and continue to do with my dominant hand now."
Additional Items for the MAL-45

- Removing bills from a wallet
- Taking individual coins out of a pocket or purse
- Removing keys out of a pocket or purse
- Using a zipper pull
- Pouring liquid from a bottle
- Buckling a belt
- Popping top of beverage can
- Removing top from a medicine bottle
- Keypad press
- Use of keyboard/computer
- Putting on or taking off watch band
- Putting on glasses
- Pumping a soap dispenser
- Swiping a credit card or a card for an ATM
- Adjusting a home or hotel air conditioner or heater
**FUGL-MEYER ASSESSMENT**  
**UPPER EXTREMITY (FMA-UE)**  
Assessment of sensorimotor function  


<table>
<thead>
<tr>
<th>A. UPPER EXTREMITY, sitting position</th>
<th>none</th>
<th>partial</th>
<th>full</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. Reflex activity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexors: biceps and finger flexors</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Extensors: triceps</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal I (max 4)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>II. Volitional movement within synergies,</strong> without gravitational help</th>
<th>none</th>
<th>partial</th>
<th>full</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexor synergy: Hand from contralateral knee to ipsilateral ear. From extensor synergy (shoulder abduction/ internal rotation, elbow extension, forearm pronation) to flexor synergy (shoulder abduction/ external rotation, elbow flexion, forearm supination).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow flexion</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Forearm supination</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Shoulder abduction/external rotation (90°)</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Subtotal II (max 18)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>III. Volitional movement mixing synergies,</strong> without compensation</th>
<th>none</th>
<th>partial</th>
<th>full</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand to lumbar spine cannot be performed, hand in front of SIAS hand behind of SIAS (without compensation) hand to lumbar spine (without compensation)</td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Shoulder flexion 0°-90° elbow at 0° pronation-supination 0° immediate abduction or elbow flexion abduction or elbow flexion during movement complete flexion 90°, maintains 0° in elbow</td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pronation-supination elbow at 90° shoulder at 0° no pronation/supination, starting position impossible limited pronation/supination, maintains position complete pronation/supination, maintains position</td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Subtotal III (max 6)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>IV. Volitional movement with little or no synergy</strong></th>
<th>none</th>
<th>partial</th>
<th>full</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder abduction 0° - 90° elbow at 0° forearm pronated immediate supination or elbow flexion supination or elbow flexion during movement abduction 90°, maintains extension and pronation</td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Shoulder flexion 90°- 180° elbow at 0° pronation-supination 0° immediate abduction or elbow flexion abduction or elbow flexion during movement complete flexion, maintains 0° in elbow</td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pronation/supination elbow at 0° shoulder at 30°-90° flexion no pronation/supination, starting position impossible limited pronation/supination, maintains extension full pronation/supination, maintains elbow extension</td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Subtotal IV (max 6)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>V. Normal reflex activity</strong> evaluated only if full score of 6 points achieved on part IV</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>biceps, triceps, finger flexors 0 points on part IV or 2 of 3 reflexes marked hyperactive 1 reflex markedly hyperactive or at least 2 reflexes lively maximum of 1 reflex lively, none hyperactive</td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Subtotal V (max 2)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Total A (max 36)**                                                                         |      |         |      |
### B. WRIST

<table>
<thead>
<tr>
<th>Stability at 15° dorsiflexion</th>
<th>less than 15° active dorsiflexion</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>elbow at 90°, forearm pronated</td>
<td>shoulder at 0°, slight finger flexion</td>
<td>cannot perform volitionally</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Repeated dorsiflexion / volar flexion</td>
<td>limited active range of motion</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>elbow at 90°, forearm pronated</td>
<td>full active range of motion, smoothly</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Stability at 15° dorsiflexion</td>
<td>less than 15° active dorsiflexion</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>elbow at 0°, forearm pronated</td>
<td>shoulder at 0°, slight shoulder flexion/abduction</td>
<td>cannot perform volitionally</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Repeated dorsiflexion / volar flexion</td>
<td>limited active range of motion</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>elbow at 0°, forearm pronated</td>
<td>full active range of motion, smoothly</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Circumduction</td>
<td>cannot perform volitionally</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>jerk movement or incomplete</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>complete and smooth circumduction</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total B (max 10)**

### C. HAND

<table>
<thead>
<tr>
<th>Mass flexion</th>
<th>from full active or passive extension</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass extension</td>
<td>from full active or passive flexion</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

#### GRASP

<table>
<thead>
<tr>
<th>A – flexion in PIP and DIP (digits II-V)</th>
<th>extension in MCP II-V</th>
<th>cannot be performed</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>B – thumb adduction</td>
<td>1-st CMC, MCP, IP at 0°, scrap of paper between thumb and 2-nd MCP joint</td>
<td>cannot be performed</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>C - opposition</td>
<td>pulpa of the thumb against the pulpa of 2-nd finger, pencil, tug upward</td>
<td>cannot be performed</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>D – cylinder grip</td>
<td>cylinder shaped object (small can) tug upward, opposition in digits I and II</td>
<td>cannot be performed</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>E – spherical grip</td>
<td>fingers in abduction/flexion, thumb opposed, tennis ball</td>
<td>cannot be performed</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Total C (max 14)**

### D. COORDINATION/SPEED

<table>
<thead>
<tr>
<th>Tremor</th>
<th>marked</th>
<th>slight</th>
<th>none</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dysmetria</td>
<td>pronounced or unsystematic</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>slight and systematic</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no dysmetria</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>more than 5 seconds slower than unaffected side</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-5 seconds slower than unaffected side</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>maximum difference of 1 second between sides</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total D (max 6)**

**TOTAL A-D (max 66)**

Approved by Fugl-Meyer AR 2010
**H. SENSATION**, upper extremity  
blind-folded, compared with unaffected side

<table>
<thead>
<tr>
<th>Light touch</th>
<th>anesthesia</th>
<th>hypoesthesia</th>
<th>dysesthesia</th>
<th>normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>upper arm, forearm, palmar surface of the hand</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>absence</td>
<td>3/4 correct</td>
<td>considerable difference</td>
<td>correct 100% little or no difference</td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td>shoulder</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>small alterations in the position</td>
<td>elbow</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>wrist</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>thumb (IP-joint)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Total H (max12)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**J. PASSIVE JOINT MOTION**, upper extremity

<table>
<thead>
<tr>
<th>Sitting position, compare with unaffected side</th>
<th>only few degrees (less than 10° in shoulder)</th>
<th>decreased</th>
<th>normal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shoulder</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion (0° - 180°)</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Abduction (0°-90°)</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>External rotation</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Internal rotation</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Elbow</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Extension</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Forearm</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pronation</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Supination</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Wrist</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Extension</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Fingers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Extension</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total (max 24)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**J. JOINT PAIN** during passive motion, upper extremity

<table>
<thead>
<tr>
<th>pronounces constant pain during or at the end of movement</th>
<th>some pain</th>
<th>no pain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shoulder</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Abduction (0°-90°)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>External rotation</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Internal rotation</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Elbow</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Extension</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Forearm</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pronation</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Supination</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Wrist</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Extension</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Fingers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Extension</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total (max 24)</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL A-D (motor function)**

| A. UPPER EXTREMITY | /36 |
| B. WRIST | /10 |
| C. HAND | /14 |
| D. COORDINATION / SPEED | / 6 |
| **TOTAL A-D (motor function)** | /66 |

**H. SENSATION**

| /12 |

**J. PASSIVE JOINT MOTION**

| /24 |

**J. JOINT PAIN**

| /24 |

Approved by Fugl-Meyer AR 2010