Stroke
JOURNAL OF THE AMERICAN HEART ASSOCIATION
American Stroke Association
A Division of American Heart Association

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Stroke 2005, 36:2493-2496: originally published online October 13, 2005
doi: 10.1161/01.STR.0000185928.90848.2e
Stroke is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 72514
 Print ISSN: 0039-2499. Online ISSN: 1524-4628

Reliability and Validity of the Upper-Extremity Motor Activity Log-14 for Measuring Real-World Arm Use

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Background and Purpose—In research on Constraint-Induced Movement (CI) therapy, a structured interview, the Motor Activity Log (MAL), is used to assess how stroke survivors use their more-impaired arm outside the laboratory. This article examines the psychometrics of the 14-item version of this instrument in 2 chronic stroke samples with mild-to-moderate upper-extremity hemiparesis.

Methods—Participants (n=41) in the first study completed MALs before and after CI therapy or a placebo control procedure. In addition, caregivers independently completed a MAL on the participants. Participants (n=27) in the second study completed MALs and wore accelerometers that monitored their arm movements for 3 days outside the laboratory before and after an automated form of CI therapy.

Results—Validity of the participant MAL Quality of Movement (QOM) scale was supported. Correlations between pretreatment-to-posttreatment change scores on the participant QOM scale and caregiver MAL QOM scale, caregiver MAL amount of use (AOU) scale, and accelerometer recordings were 0.70, 0.73, and 0.91 ($P<0.01$), respectively. Internal consistency ($\alpha>0.81$), test–retest reliability ($r>0.91$), stability, and responsiveness (ratio >3) of the participant QOM scale were also supported. The participant AOU and caregiver QOM and AOU scales were internally consistent, stable, and sensitive, but were not reliable.

Conclusions—The participant MAL QOM scale can be used exclusively to reliably and validly measure real-world, upper-extremity rehabilitation outcome and functional status in chronic stroke patients with mild-to-moderate hemiparesis. **(*Stroke*. 2005;36:2493-2496.)**

Key Words: arm ■ function ■ rehabilitation ■ treatment outcome ■ stroke

The Motor Activity Log (MAL)[1,2] is a scripted, structured interview that was developed by Taub et al[1] to measure the effects of Constraint-Induced Movement (CI) therapy on use of the more-impaired arm outside the laboratory in individuals with stroke. Measures of functional independence cannot be used for this purpose because changes on these tests could be attributable to improvements in hemiparetic arm function or compensatory strategies.[2] The importance of measuring real-world arm use separately when assessing the effects of upper-extremity rehabilitation is indicated by, among other reasons, findings that CI therapy has a substantially larger effect on more-impaired arm use in daily life than on more-impaired arm motor ability, as measured by laboratory-based motor performance tests.[2] We examine the reliability and validity of the original, 14-item version of the MAL in 2 independent samples of individuals who were >1 year after stroke.

Methods

Participants

Participants (n=41; Table 1) in the first sample (study 1) were chronic stroke patients with mild-to-moderate motor impairment of their hemiparetic arm assigned to treatment and placebo control groups in a clinical trial of CI therapy.[3] The control group received general fitness training (ie, lower extremity strength, balance, and stamina exercises; cognitive games; and relaxation sessions) for the same number of hours and with the same amount of therapist supervision as the CI therapy group.[3] Principal inclusion criteria were the ability to actively extend the wrist >20° and actively extend the metacarpophalangeal and interphalangeal joints of all digits at least 10° and the presence of substantial deficits in real-world, more-impaired arm use (MAL score <2.5).[1,3] The treatment and control groups did not have significant differences in initial more-impaired arm motor ability (Wolf Motor Function Test)[4] or real-world use (MAL). Participants in the second sample (study 2; n=27; Table 1) were enrolled in a separate clinical trial of an automated form of CI therapy (AutoCITE) with the same inclusion and exclusion criteria as in study 1.[5]

Received July 22, 2005; accepted August 15, 2005.

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Presented in part at the American Heart Association 5th Scientific Forum on Quality of Care and Outcomes Research in Cardiovascular Disease and Stroke, Washington, DC, May 2004.

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Stroke **is available at http://www.strokeaha.org** **DOI: 10.1161/01.STR.0000185928.90848.2e**

TABLE 1. Demographic, Stroke-Related, and More-Impaired Arm Motor Characteristics of Participants

Characteristic	Study 1		Study 2
	CI Therapy, n=21	Control, n=20	AutoCITE, n=27
Demographic			
Age, mean y±SD	54.6±12.1	50.7±19.2	60.1±10.6
Female	10	4	6
Ethnic group			
European American	12	19	23
African American	8	1	2
Asian	1	0	2
Stroke-related			
Paresis of right side	10	9	24
Paresis of dominant side	11	9	18
Time since stroke, mean y±SD	3.6±4.5	5.3±3.9	5.5±3.7
More-impaired arm motor ability			
Wolf Motor Function Test			
Performance time, means±SD	5.3±3.1	4.1±2.5	4.8±4.5
Functional ability, mean points±SD	3.0±0.4	2.9±0.7	2.7±0.4
More-impaired arm real-world activity			
Motor Activity Log, mean points±SD			
Patient Quality of Movement scale	1.4±0.7	1.2±0.8	1.2±0.5
Patient Amount of Use scale	1.4±0.7	0.9±0.5	1.1±0.5
Caregiver Quality of Movement scale	1.1±1.1	1.0±0.5	...
Caregiver amount of use scale	1.4±1.2	0.9±0.4	...
Ratio of more-to-less-impaired arm accelerometer recordings, mean±SD	...	...	0.60±0.12

Measures

The upper-extremity MAL-14 is a structured interview[1,2] that elicits information about 14 activities of daily living (ADL; Table I, available online only at http://www.strokeaha.org). Patients are asked to rate how well (Quality of Movement [QOM] scale) and how much (Amount of Use [AOU] scale) they use their more impaired arm to accomplish each ADL. Both scales are anchored at 6 points by abbreviated phrases and longer definitions (online Table II); participants may select scores halfway between the anchors. Scale total scores are the mean of the item scores. In CI therapy studies from this laboratory, both scales are administered before and after treatment; the QOM scale alone is given daily during the intervention period. The MAL is also administered independently before and after treatment to an informant, who is usually a participant's primary caregiver.

The interview was conducted according to standardized procedures summarized in online Table III and described at length in a testing manual.[6] One procedure of note is that after the initial MAL administration, the interviewer, using scripted phrases, probed responses that differ from those given on the previous testing administration to determine whether such scores reflect an actual change. The purpose of this procedure was to prevent errors in recall, misunderstanding of the scale levels, and enthusiasm about treatment gains (ie, a halo effect) resulting in final responses that are not veridical.

Procedure

Study 1 participants and, if available, a caregiver (n=31) completed the MAL before (test 1) and after (test 2) receiving CI therapy (treatment group) or fitness training (control group). Study 2 participants completed the MAL before and after AutoCITE therapy; in addition, participants who lived in-town (n=10) wore accelerometers[7] on each wrist for 3 days.

Results

Study 1 indicated that the patient MAL QOM scale was internally consistent (Chronbach α=0.87), and was reliable, stable, and very responsive (Table 2). Convergent validity of the patient QOM scale was supported. The Intraclass Correlation (ICC) type 2,1[8] between patient and caregiver scores for test 1 was 0.52 ($P<0.01$); for changes from test 1 to 2, it was 0.7 ($P<0.0001$). The patient AOU and caregiver QOM and AOU scales were internally consistent (Chronbach $\alpha>0.82$), stable, and responsive but were not reliable (Table 2).

Study 2 supported the concurrent validity of the patient QOM scale. The Pearson correlation between this scale and the accelerometer recordings[7] for test 1 was 0.7 ($P<0.05$); for changes from test 1 to 2, it was 0.91 ($P<0.01$; Figure). Internal consistency was adequate (Chronbach α=0.81), and responsiveness was very high (Table 2).

Because of concerns that probing responses (see Measures) might bias scores upward, initial item responses were recorded on each MAL administration for the last 13 study 2 participants. Examination of responses before and after probing revealed that the median change on the QOM scale was only 0.05 points (range, 0.0 to 0.1), which is 10 times smaller

TABLE 2. Reliability, Stability, and Responsiveness of the MAL QOM and AOU Scales

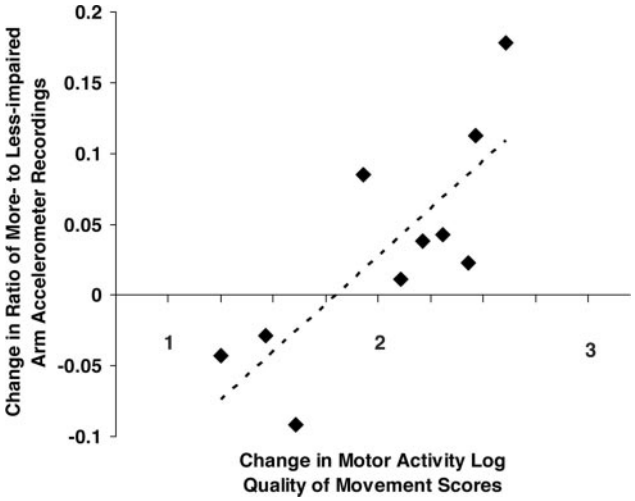
	Patient MAL		Caregiver MAL	
Variables	QOM Scale	AOU Scale	QOM Scale	AOU Scale
Study 1				
Test–retest reliability				
Pearson correlation between test 1 and 2 scores in control group (*r*)	0.91	0.44	0.50	0.61
Stability				
Change from test 1 to 2 in control group, mean±SD*	0.1±0.4	0.1±0.5	0.2±0.5	0.1±0.4
Responsiveness				
Responsiveness ratio, mean change in treatment group/SD of change in control group	4.5	3.2	3.0	4.3
Study 2				
Responsiveness				
Responsiveness ratio, mean change in study 2 treatment group/SD of change in study 1 control group	5.0	3.8	...	...

*None of the test 1 to 2 changes in the control group were statistically significant.

than what is considered a minimal clinically important difference.[9]

Discussion

The results indicate that the patient MAL QOM scale is internally consistent and highly reliable, stable, responsive, and valid for measuring arm use outside the laboratory in individuals with chronic stroke who have mild-to-moderate upper-extremity hemiparesis. Notably, agreement between patients and caregivers was higher when evaluating treatment change (ICC=0.7) than when evaluating arm use before treatment (ICC=0.52). The weaker agreement at the outset may have been because of differences in the frame of reference between members of individual patient–caregiver pairs. On a group basis, however, patients and caregivers reported similar pretreatment MAL scores (Table 1), indicating that whatever differences in frames of reference existed were distributed randomly and cancelled each other out when the data were aggregated. Another noteworthy finding was that patient QOM scale appeared to capture both how well and how much participants use their more-impaired arm to accomplish ADL. Pretreatment-to-posttreatment changes in patient QOM scores were strongly correlated with corresponding changes in both other measures of quality of more-impaired arm movement (eg, caregiver QOM; $r=0.7$) and amount of more-impaired arm activity (eg, accelerometry, $r=0.91$; caregiver AOU, $r=0.73$; patient AOU, $r=0.80$).



Validity of the MAL for measuring upper-extremity rehabilitation outcome was confirmed by study 2. The partial Pearson correlation between patient MAL QOM scores and the ratio of more- to less-impaired arm accelerometer recordings after CI therapy, controlling for pre-CI therapy values, was 0.91.

Our findings are mostly consistent with those from a recent study of the Dutch 26-item MAL (n=56), which found that the Dutch MAL was highly internally consistent, reliable, and stable.[9] This study also reported that the pretreatment MAL and Action Research Arm (ARA)[10] test scores were strongly correlated, but that pretreatment-to-posttreatment change on the MAL was not significantly correlated with change on the ARA and a single-item global change rating. This approach is flawed because the ARA is a measure of motor ability as opposed to use, and, as noted previously, CI therapy has differential effects on these 2 parameters. The single-item global change rating has not been described before its use by van der Lee et al,[9] there is no information on its validity, and it is not clear whether it assesses arm motor ability or use or both.

A limitation of this article is that caregiver and accelerometry data were available for only a subsample of the participants in each study. However, comparison of study 1 subjects with and without caregiver data (n=31 and 10, respectively) showed that there were no significant differences between them in initial MAL scores or treatment gains on the MAL. There were also no significant differences on these parameters between study 2 subjects with and without accelerometry data (n=10 and 17, respectively). Nevertheless, it is possible that subjects for whom data were complete were not representative of the entire sample in some other important way, suggesting that confirmation of these

results in a larger study would be valuable. A larger sample would also permit testing of whether differential reliability and validity was present for particular patient subgroups, such as men or women.

It is hoped that the availability of a valid measure of more-impaired arm use outside the laboratory will encourage stroke researchers to study this parameter more intensively than they have in the past. Neurorehabilitation trials typically assess impairment and functional independence.[2] Exclusive attention to these domains does not permit evaluation of the effects of neurorehabilitation on actual use of the more-impaired extremity in daily life.[2] This issue is particularly salient given the increasing emphasis on restoring function of the more-impaired extremity, as opposed to teaching compensatory strategies. In addition, relatively little is known about the relationship between patient characteristics at the impairment level and actual use of the more impaired extremity in daily life. Instruments, such as the MAL, might be used, in conjunction with existing measures of impairment, for cross-sectional or longitudinal studies that examine how these 2 domains of motor recovery are related.

Conclusions

The patient MAL QOM scale reliably and validly assesses more impaired arm use outside the laboratory in individuals with mild-to-moderate hemiparesis after stroke. It appears to capture both how well and how much patients use their more-impaired arm to accomplish ADL, and, therefore, might simply be named the Arm Use scale. Because the patient MAL AOU scale was highly correlated with the QOM scale, it might be dropped. Although pretreatment-to-post-treatment changes in the caregiver scales were also highly correlated with patient MAL QOM scale, caregiver scores are still important as convergent data and are vital when a patient cannot complete the MAL interview (eg, patients with severe aphasia). The part of the MAL interview that involves probing responses to items that depart from the response given on the previous testing occasion does not appear to bias the scores obtained.

Acknowledgments

This research was supported by National Institutes of Health grant HD34273 and American Heart Association, Southeast Affiliate, grant 0365163B. We thank Jean Crago, MSPT, and Sonya Pearson, PTA, for their valuable input on the formulation of the MAL, and Joydip Barman, MS, for assistance with the statistical analyses.

References

1. Taub E, Miller NE, Novack TA, Cook EW III, Fleming WC, Nepomuceno CS, Connell JS, Crago JE. Technique to improve chronic motor deficit after stroke. *Arch Phys Med Rehabil*. 1993;74:347–354.
2. Uswatte G, Taub E. Implications of the learned nonuse formulation for measuring rehabilitation outcomes: lessons from Constraint-Induced Movement therapy. *Rehabil Psychol*. 2005;50:34–42.
3. Taub E, Uswatte G, King DK, Morris D, Crago JE, Chatterjee A. A placebo-controlled trial of Constraint-Induced Movement therapy for upper extremity after stroke. *Stroke*. In press.
4. Morris D, Uswatte G, Crago J, Cook EW III, Taub E. The reliability of the Wolf Motor Function Test for assessing upper extremity motor function following stroke. *Arch Phys Med Rehabil*. 2001;82:750–755.
5. Taub E, Lum PS, Hardin P, Mark V, Uswatte G. AutoCITE: automated delivery of CI therapy with reduced effort by therapists. *Stroke*. 2005;36:1301–1304.
6. Taub E, Morris D, Bowman M, Delgado A, Uswatte G. *Upper-Extremity Motor Activity Log [Manual]*. (Available from Edward Taub, Psychology Department, UAB, CH415, Birmingham, Ala); 1996.
7. Uswatte G, Foo WL, Olmstead H, Lopez K, Holand A, Simms ML. Ambulatory monitoring of arm movement using accelerometry: an objective measure of upper-extremity rehabilitation in persons with chronic stroke. *Arch Phys Med Rehabil*. 2005;86:1498–1501.
8. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. *Psychol Bull*. 1979;86:420–428.
9. van der Lee J, Beckerman H, Knol DL, de Vet HCW, Bouter LM. Clinimetric properties of the Motor Activity Log for the assessment of arm use in hemiparetic patients. *Stroke*. 2004;35:1–5.
10. van der Lee JH, Roorda LD, Beckerman H, Lankhorst GJ, Bouter LM. Improving the Action Research Arm test: a unidimensional hierarchical scale. *Clin Rehabil*. 2002;16:646–653.