Development of a Telephone Interview Version of the Chedoke-McMaster Stroke Assessment Activity Inventory

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ABSTRACT

Purpose: To develop a telephone version of the Chedoke-McMaster Stroke Assessment Activity Inventory (CMSA-AI) and estimate the test-retest reliability, interrater reliability (between participant and proxy), and construct validity of the scores for individuals with stroke. **Methods:** Adults with stroke and their caregivers or proxies were included. Participants were assessed with the CMSA-AI at discharge from a stroke rehabilitation unit and interviewed using the telephone version (TCMSA-AI). Two months after discharge, participants were evaluated with the CMSA-AI and interviewed over the phone using the TCMSA-AI on two occasions 2–3 days apart. Proxies were interviewed with the TCMSA-AI within another 2–3 days. **Results:** The mean age of the 53 participants with stroke was 62 years; 59% were male; 43% had right-side hemiparesis; 42 completed follow-up interviews; and 18 had proxies who also participated. Test-retest reliability showed an intra-class correlation coefficient of 0.98 (95% CI: 0.96, 0.99) for the total score, 0.96 (95% CI: 0.91, 0.98) for the Gross Motor Function Index, and 0.96 (95% CI: 0.91, 0.98) for the Walking Index, and an interrater reliability (between participant and proxy) of 0.75 (95% CI: 0.28, 0.90) for total score. Spearman's rho correlation between CMSA-AI and TCMSA-AI total scores was 0.62 (lower-sided 95% CI: 0.42) at discharge and 0.90 (lower-sided 95% CI: 0.82) at 2 months after discharge. Correlations between the change scores of the CMSA-AI and TCMSA-AI were 0.50 or lower. **Conclusion:** There is potential for remote evaluation of the functional mobility of individuals with stroke in research and clinical settings.

Key Words: activities of daily living; reproducibility of results; stroke.

RÉSUMÉ

Objectif : élaborer une version téléphonique de l'inventaire des activités post-AVC Chedoke-McMaster (CMSA-AI) et estimer la fiabilité de test-retest, la fiabilité interévaluateurs (entre le participant et le mandataire), ainsi que la validité de construit de l'évaluation. **Méthode :** des adultes victimes d'un AVC ont été évalués à l'aide du CMSA-AI lors de leur congé d'une unité de réadaptation post-AVC et interviewés par téléphone au moyen de la version téléphonique (TCMSA-AI). Deux mois après leur congé, les participants ont été évalués à l'aide du CMSA-AI et interviewés au téléphone à l'aide du TCMSA-AI à deux ou trois jours d'intervalle. Les mandataires ont été interviewés à l'aide du TCMSA-AI dans les deux à trois jours suivants. **Résultats :** parmi les 53 participants victimes d'un AVC, l'âge moyen était de 62 ans; 59% étaient des hommes; 43% souffraient d'une hémiparésie du côté droit; 42 ont répondu aux entrevues de suivi; et 18 avaient des mandataires qui ont également participé. En ce qui concerne la fiabilité de test-retest, un coefficient de corrélation intraclass (intervalle de confiance de 95%) de 0,98 (0,96–0,99) a été calculé pour la note totale, de 0,96 (0,91–0,98) pour l'index de motricité globale et de 0,96 (0,91–0,98) pour l'index de marche. Quant à la fiabilité interévaluateurs (entre le participant et le mandataire), le coefficient mesuré était de 0,75 (0,28–0,90) pour la note totale. La corrélation (rho) de Spearman des notes totales CMSA-AI et TCMSA-AI s'élevait à 0,62 (limite de confiance unilatérale inférieure de 95% = 0,42) au congé et de 0,90 (0,82) deux mois après le congé. Les corrélations des variations CMSA-AI et TCMSA-AI étaient de 0,50 ou moins. **Conclusion :** l'évaluation à distance de la mobilité fonctionnelle des victimes d'un AVC présente un potentiel en contextes clinique et de recherche.

As the health care system strives to deliver efficient and evidence-based care, there is a growing need for health professionals to incorporate reliable and valid standardized outcome measures into their practice.¹ The Chedoke-McMaster Stroke Assessment (CMSA) is a mea-

sure that is used to assess both the physical impairment (Impairment Inventory) and the functional mobility (Activity Inventory [CMSA-AI], formerly known as the Disability Inventory) of clients with stroke and other neurological impairments.² The CMSA was built on

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theories of motor recovery and postural control and the *International Classification of Impairment, Disability and Handicap* (now the *International Classification of Functioning, Disability and Health*).^{3,4}

The CMSA-AI is used clinically as an evaluative measure to assess change in function over time.^{5,6} It measures a client's functional mobility and includes two indices: the Gross Motor Function Index (with 10 items, including bed mobility and transfers) and the Walking Index (with 5 items, including indoor and outdoor walking and stairs).² The maximum score on the CMSA-AI is 100; it has 14 items scored on a 7-point scale, and a 2-point score is awarded for age-appropriate walking distance. A comprehensive manual outlines the administration of and scoring guidelines for the CMSA.⁵ Although the CMSA-AI was developed to assess clients with stroke in a rehabilitation setting, it has been shown to apply just as well to a wide range of clients: those in an acute neurological setting,⁷ those with vascular brain damage (primarily stroke),⁸ those with traumatic brain injury,⁹ and those attending a geriatric day program.¹⁰ Tools available for those learning to administer the CMSA include a standardized, 1-day training workshop;¹¹ video-conferencing;¹² and a bilingual CD-ROM for self-directed learning.¹³

In the past decade, rehabilitation clinicians have sought out high-quality evidence on which to base their clinical decisions.¹⁴ Clinicians have placed increasing importance on patient-reported outcomes (PROs) and engaging clients in reporting their functional abilities, thereby confirming the value of client-centredness that is critical to client-centred care.¹⁵ PROs enable clients to identify the status of their health conditions directly, without any interpretation by others,¹⁶ and to provide information about the consequences of their disease as well as the impact of various interventions on their health and functioning. PROs are often the outcomes of greatest significance for clients.

We thought that a telephone interview version of the CMSA-AI could provide a time- and cost-effective follow-up for clients discharged from clinical settings, especially those who live far away from clinical sites. Self-report versions of two other activity measures have been developed and tested and have shown promising results. The telephone version of the Clinical Outcome Variables Scale (TCOVs) has been shown to take only 5 minutes, compared with the 35 minutes needed for the Clinical Outcome Variables Scale (COVs),¹⁷ and agreement between the TCOVs and COVs has been shown to be high (intra-class correlation coefficient, or ICC = 0.98).¹⁷ Another clinical advantage of a telephone version of the CMSA-AI is that activity is reported from the client's perspective, thereby confirming client-centred practice. The client's perspective has been stressed as an important aspect of the FIM.¹⁸

As a result of the sequelae of stroke, some individuals may not be able to participate in a telephone interview; they may have aphasia or cognitive difficulties. It therefore becomes important to assess whether a proxy can reliably complete an assessment on behalf of a person with stroke. The responses of clients and their proxies have been investigated for both the FIM and the Stroke Impact Scale (SIS).^{19–21} In a telephone version of the FIM for individuals post-stroke, proxy-client agreement was high for the mobility (ICC = 0.88) and locomotion (ICC = 0.84) subscales.¹⁹ Proxy-client agreement (ICCs) on the SIS domains varied from 0.50 to 0.83 in one study²¹ and from 0.17 to 0.79 in another;²⁰ physical domains such as mobility and self-care had the highest agreement, with lower agreement for self-perceived concepts, such as emotional status and cognitive domains.^{19,22,23} Proxies tend to rate the impact of stroke on individuals as more severe than do the individuals themselves.^{20,21}

The purpose of this study was to develop a telephone interview measure of functional mobility that clinicians can use in follow-up assessments with their clients with stroke or their proxies. The specific research objectives were to

1. Estimate the content validity of the TCMSA-AI in the context of individuals with stroke post-rehabilitation.
2. Estimate test-retest reliability of the TCMSA-AI scores for individuals with stroke.
3. Estimate the standard error of measurement (SEM) derived from the test-retest reliability study.
4. Estimate the interrater reliability of the TCMSA-AI between individuals with stroke and their proxies.
5. Estimate the longitudinal construct validity of the TCMSA-AI change scores with observed CMSA-AI change scores for individuals with stroke.
6. Estimate the minimal detectable change at 90% CI (MDC₉₀).
7. Examine the feasibility of the TCMSA-AI with respect to ease of use and time to complete.

METHODS

The study consisted of two parts: development of the TCMSA-AI and examination of its psychometric properties.

Development of the TCMSA-AI

The content validity process has been described as having two stages, development and judgment quantification.²⁴ The development stage consists of three steps; the first two steps, determining item content and item generation, were completed in developing the CMSA-AI, the original observed measure. The third step involved putting items into a usable form. Given that the TCMSA-AI is completed by interview and the CMSA-AI by observation, the structure and format of the measure needed to be revised so that it would be conducive to a verbal interview process. The decision tree format used in the

FIM manual²⁵ was used as a guide for the new format. Each item was rewritten, maintaining the content and intent of the administration manual,⁵ and then integrated into a decision tree that allows the interviewer to ask a yes–no question. The answer to the yes–no question leads either to another question or to a final score based on the 1–7 scale used by the CMSA–AI. The decision tree format was adapted during three iterations by RB and PAM, and instruction guidelines for the interview version were developed.

Once the decision tree format and instruction guidelines had been agreed on, six physiotherapy experts, each with at least 5 years of experience using the CMSA–AI, were invited to participate in the judgment quantification stage, which included verifying the items and the instrument as a whole. The physiotherapy experts were asked to compare the administration and scoring guidelines of the CMSA–AI and TCMSA–AI, complete a feedback form regarding the administration and scoring procedures for each item and the overall measure, and suggest any clarification that the instruction guidelines needed. The form had one question for each item of the TCMSA–AI that asked the experts whether the item reflected the intent of the original CMSA–AI item; it also asked them to provide suggestions to improve the brief introduction to the item, the information provided for the interviewer, and the layout and design of the decision trees. Our experts were expected to take 1 to 2 hours to complete the survey and compare the draft administration and scoring guidelines with those of the original version.

Finally, comments from all experts were reviewed by the authors, and changes to the wording and scoring process of the TCMSA–AI were made. The revised version of the TCMSA–AI was then returned to the experts for their final review and approval.

Examining the psychometric properties of the TCMSA–AI

Adults with stroke were recruited before discharge from the local stroke rehabilitation unit. To be included in this aspect of the project, they had to be able to understand verbal communication and answer questions by telephone; be able to return for a follow-up assessment at 2 months after discharge; and have a caregiver, family member, or friend who would be able to participate as a proxy (for a sub-sample of the participants).

Clients who were inpatients at a large urban rehabilitation centre and who met the inclusion criteria were asked by their treating physiotherapists whether they were interested in taking part in the study. The study staff then met with each interested person and provided further information about the study. If the person consented to participate in the study, the first TCMSA–AI was conducted 2–3 days before the person was discharged from the stroke rehabilitation unit. The CMSA–AI was also completed within 2–3 days before discharge by the treating physiotherapist as part of usual treat-

ment; therefore, the order of assessment varied. All study staff and participating physiotherapists from the rehabilitation centre had attended a training workshop for the CMSA–AI and had obtained scoring competency. Study staff also received training on the TCMSA–AI.

At 2 months after discharge, each participant completed the CMSA–AI with study staff when attending the follow-up clinic with the physiatrist (SP). The participant was then called at home at a convenient time within 2–3 days to complete the TCMSA–AI, and this was repeated within another 2–3 days (to examine test–retest reliability). For each participant with a proxy, the proxy was called to complete the TCMSA–AI within 2–3 days of the participant's completing the TCMSA–AI.

Ethics approval was obtained from the Health Research Ethics Board of the University of Manitoba.

Analysis

Statistical analyses were carried out using IBM SPSS Statistics version 22 (IBM Corp., Armonk, NY). Characteristics of clients and proxies were described with frequencies, percentages, means, and standard deviations as appropriate.

Sample size calculations were as follows: For test–retest reliability and proxy–participant agreement, assumptions were that the observed r would be 0.90 or more, with a lower one-sided 95% CI of 0.10 (i.e., r acceptable ≥ 0.80). Therefore, 22 participants were required for test–retest reliability, and 22 participant–proxy pairs were required for proxy–participant agreement. For longitudinal construct validity of change scores, assumptions were that the observed r would be 0.80 or higher, with a lower one-sided 95% CI of 0.10 (i.e., r acceptable ≥ 0.70). Therefore, 53 participants were required.

Evaluation of test–retest reliability was carried out using the TCMSA–AI scores at 2 months after discharge and 2–3 days later. A type 2,1 ICC was used to estimate the relative reliability of the scores.²⁶ Absolute reliability was also calculated using the SEM. Proxy–participant agreement on the TCMSA–AI at 2 months was also estimated with an ICC and SEM, using the participant and proxy TCMSA–AI scores at the 2-month follow-up.

To determine longitudinal construct validity, change scores on the CMSA–AI and the TCMSA–AI from discharge to 2 months were correlated. The plan was to use Pearson's r ; however, because of non-normal data, Spearman's rho was calculated. Correlations of cross-sectional scores of the CMSA–AI and the TCMSA–AI were also completed for discharge and for the 2-month follow-up periods, respectively.

MDC₉₀ was calculated as described by Stratford.²⁷ Specifically, the SEM, calculated as the square root of the mean square error term from the reliability analysis, was multiplied by the square root of 2, which in turn was multiplied by the z value associated with a 90% confidence level ($z = 1.65$).²⁷ This can be used clinically in

Table 1 Demographics of Study Participants

	No (%) [*]
Mean (SD) age; range, y	62 (12.9); 29–86
Male	31 (58.5)
Employed	27 (50.9)
Living alone	14 (26.4)
Discharged home without help	23 (43.4)
Three or more comorbidities	30 (56.6)
Right side affected	23 (43.4)

Note: $n = 53$.^{*}Unless otherwise indicated.

that a change greater than MDC_{90} is interpreted as true change.²⁷ The floor (14) and ceiling (100) scores of the CMSA-AI and the TCMSA-AI were noted with counts and percentages.

RESULTS

Developing the TCMSA-AI

Five of the six invited expert physiotherapists participated. Two of these experts were female. The experts lived in three Canadian cities in two provinces and had, on average, 20 years of practice and had worked for 15 years with individuals with stroke and using the CMSA-AI.

The experts recommended making certain revisions to the TCMSA-AI and adding information to the instruction guidelines to improve their clarity. For example, they recommended rewording the description of the amount of assistance provided by others so that it would be easier for both the interviewer and the interviewee to understand the difference in levels; altering the decision tree format to improve clarity; and adding an introductory statement to each item to make it clearer to an interviewee and ensure that the answer reflected what the interviewee had intended. All experts agreed that the items in the telephone version maintained the intent of those in the original version. All of these suggestions

were incorporated by RB and PAM into the final version of the TCMSA-AI, which was again sent to the experts and approved. It is reproduced in Appendix 1 (online).

Examining the psychometric properties of the TCMSA-AI

The demographics of study participants are shown in Table 1. A total of 53 participants were recruited, and their average age was 62 years. During the 41 months of the study, there were 611 admissions to the stroke rehabilitation unit, and 56 individuals who fit the inclusion criteria were asked whether they were interested in participating in the study. The reasons staff gave for not approaching people included aphasia, patients' inability to attend a follow-up visit because they lived too far from the study site, and staff's lack of time to recruit patients because of their busy caseload. Of the 53 participants, 11 did not complete the follow-up assessment: 2 declined, 1 fell at home and sustained a fractured hip, 3 had no follow-up with no specified reason, 1 withdrew because of an appointment conflict, 3 did not attend the scheduled follow-up and did not reply when contacted, and 1 could not be contacted to make an appointment.

Test administration

The TCMSA-AI took approximately 13–15 minutes to complete; the CMSA-AI at follow-up took 30–45 minutes, depending on the number of items attempted. Median scores on the CMSA-AI and TCMSA-AI total and indices are shown in Table 2.

Test-retest reliability

For test-retest reliability, a total of 23 participants received two follow-up telephone calls 2–3 days apart. All ICCs were 0.96 or more, with narrow CIs (see Table 3); the table also shows SEM and MDC_{90} .

Proxy agreement

The total number of proxies who gave consent was 19: 1 declined to participate after consent, leaving 18 proxy-participant pairs available. Five proxies were male, and 13 were female. All proxies were significant others (5

Table 2 Median Scores on CMSA-AI and TCMSA-AI for Total, Gross Motor Function Index, and Walking Index

	CMSA-AI [*] ($n = 52$)		TCMSA-AI [†] ($n = 53$)		CMSA-AI [‡] ($n = 42$)		TCMSA-AI [§] ($n = 42$)		TCMSA-AI [¶] ($n = 23$)		Proxy ^{**} ($n = 18$)	
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR
Total	87.5	16.8	76.0	21.0	89.0	20.0	93.0	18.8	91.0	22.0	85.5	23.0
Gross Motor Function Index	67.5	10.3	60.0	19.0	69.0	14.0	69.5	12.0	67.0	12.0	66.0	15.0
Walking Index	21.5	10.0	19.0	8.0	21.5	10.0	25.5	12.0	24.0	12.0	22.0	9.0

^{*}Physical assessment at discharge.[†]Reported by participant at discharge.[‡]Physical assessment 2 mo after discharge.[§]Reported by participant 2 mo after discharge.[¶]Reported by participant 2–3 d after TCMSA-AI.^{**}Reported by proxy 2–3 d after TCMSA-AI.

CMSA-AI = Chedoke-McMaster Stroke Assessment Activity Inventory; TCMSA-AI = Telephone Chedoke-McMaster Stroke Assessment Activity Inventory; IQR = inter-quartile range.

Table 3 Reliability, SEM, and MDC₉₀

TCMSA-AI	ICC (95% CI)	SEM (95% CI)	MDC ₉₀
Person with stroke*			
Total	0.98 (0.96, 0.99)	1.7 (1.3, 2.4)	4.0
Gross Motor Function Index	0.96 (0.91, 0.98)	1.4 (1.1, 2.0)	3.1
Walking Index	0.96 (0.91, 0.98)	1.3 (1.0, 1.8)	3.0
Proxy†			
Total	0.75 (0.28, 0.90)	5.8 (4.5, 8.2)	13.6
Gross Motor Function Index	0.62 (0.15, 0.85)	4.6 (3.6, 6.5)	10.7
Walking Index	0.74 (0.44, 0.90)	2.8 (2.2, 4.0)	6.5

* $n = 23$ (test-retest reliability).

† $n = 18$ (interrater reliability).

SEM = standard error of measurement; MDC₉₀ = minimal detectable change (90% CI); TCMSA-AI = Telephone Chedoke-McMaster Stroke Assessment Activity Inventory; ICC = intra-class correlation coefficient.

husbands, 12 wives, 1 girlfriend); only 1 proxy did not live with the participant. For proxy scores, the ICC ranged from 0.62 to 0.75 with wide CIs (see Table 3). The mean differences between the proxy scores and the matched participants' TCMSA-AI scores at the 2-month follow-up were 5.3 for total score, 4.1 for the Gross Motor Function Index, and 1.2 for the Walking Index.

Construct validity

Spearman's rho correlations for CMSA-AI and TCMSA-AI totals and indices at discharge from rehabilitation are noted in Table 4; however, only the Walking Index had a correlation of more than 0.70. At the 2-month follow-up, all correlations between the CMSA-AI and the TCMSA-AI were 0.83 or higher. Correlations between the change scores on the CMSA-AI and TCMSA-AI were low, with all correlations at 0.50 or lower.

Floor and ceiling effects

No participants or proxies demonstrated floor scores at any time point. Ceiling scores were present for 5.8%–7.1% of the two CMSA-AI evaluations and 9.4%–13% of the participant TCMSA-AI evaluations. Ceiling scores for proxy evaluation were present for 5.5% of evaluations at follow-up.

DISCUSSION

The process of reformatting an observational measure of functional mobility into a client-reported interview was facilitated by clinician experts, who provided invaluable advice on the development of the TCMSA-AI based on their expertise with clients with stroke and their familiarity with the original observed version of the CMSA-AI. Furthermore, they gave support to the content validity of the TCMSA-AI format and provided practical suggestions on ways to make the content more suitable as a reported version. As a result, the new TCMSA-AI is more feasible to administer, taking at least half the time typically required to administer and score the CMSA-AI,

Table 4 Validity using Spearman's Rho Correlation Coefficients

	Correlation between CMSA-AI and TCMSA-AI (Spearman's rho)		
	At discharge	Two months after discharge	Change
Total	0.62 (0.42)*	0.90 (0.82)	0.11 (–0.20)
Gross Motor Function Index	0.58 (0.37)	0.92 (0.86)	0.22 (–0.09)
Walking Index	0.72 (0.56)	0.83 (0.70)	0.50 (0.23)

Note: $n = 42$.

* Lower one-sided 95% CI.

CMSA-AI = Chedoke-McMaster Stroke Assessment Activity Inventory; TCMSA-AI = Telephone Chedoke-McMaster Stroke Assessment Activity Inventory.

thereby making it potentially more acceptable to busy clinicians.

There is evidence that scores on the new TCMSA-AI are reliable. The test-retest reliability was excellent for client respondents with ICCs greater than 0.95. Proxy score ICCs were substantial (between 0.61 and 0.80);²⁸ however, one should be cautious when interpreting them because of the large CI and smaller-than-recommended sample size for the proxy agreement. These findings suggest that therapists should have confidence in using a client's report about his or her functional activity 2 months after discharge from rehabilitation, and they should use proxy reports only when a client is unable to answer questions about his or her activity level. The differences between the total proxy scores and the matched client scores were all less than the minimal clinically important difference (MCID) for the total CMSA-AI score. The MCID is 8, as determined by clients;²⁹ this means that at least the difference would not constitute a significant change, as rated by clients. Using PROs is gaining in importance, and the results indicate excellent reliability, giving us confidence in using the data for both practice and research.

The SEM and MDC₉₀ were calculated and are explained below. The SEM is presented in the same measurement units as the TCMSA-AI and, for the total TCMSA-AI score, is 1.7. If the SEM is multiplied by 1.65, the 90% CI can be calculated; in this case, the 90% CI for the total score is 2.8. If, for example, a person scores 80 on the TCMSA-AI, one can be 90% confident that the person's true score—defined in a reliability context as the mean of an infinite number of measures obtained for a truly unchanged person—is between 77 and 83 (mean = 80, SD 2.8).³⁰ The MDC₉₀ for the total score is 4.0. The interpretation is that 90% of people who truly have not changed will have a random variation in their total score that is 4 points or less; as a result, a change of more than 4 would be considered real change.³⁰

Evidence for construct validity was demonstrated by cross-sectional correlations between the CMSA-AI and the TCMSA-AI, which were strong for the total and the Gross Motor Function and Walking Indices scores at 2 months after discharge and for the Walking Index at discharge. Correlations were moderate for the total score and Gross Motor Function Index at discharge.³¹ Interpreting the lower one-sided 95% CI of Spearman's rho suggests only that the follow-up times had a strong correlation. Change score correlations, used to assess longitudinal construct validity, were moderate for the Walking Index and low for the total score and Gross Motor Function Index; however, all change score correlations can be considered low when the lower one-sided 95% CI is taken into account.³¹

It would appear that determining one's own functional status after stroke is more difficult for a person while still an inpatient in a rehabilitation hospital than once he or she is home and living in the community. It may be that individuals are more aware of their own functional status once they have been living at home for approximately 2 months, which may explain the lower correlations at discharge and the poor correlations of the change scores. The best use of the TCMSA-AI may be in the community after stroke, not while a person is still in the hospital or at the time of discharge. Further research to help understand this finding is required.

The participants were a highly functioning group of individuals. They were in rehabilitation and either ready for discharge or living in the community, so it is not surprising that there were no floor effects. It is also reasonable to see ceiling effects for a few participants in this population.

Owing to the necessary design of the study, numerous people were unable to be included (e.g., they lived too far from the study site or had aphasia), but these are not reasons to avoid using the TCMSA-AI. When a person is unable to answer questions over the telephone, a proxy can answer for the person, and living far from a clinical site is a good reason to use the TCMSA-AI.

There are a few limitations to this study. Unfortunately, the sample size determined a priori was not attained for all components of the study. It is possible that the order in which the CMSA-AI and TCMSA-AI assessments were completed at the 2-month follow-up may have had some influence on the results; the observed measure was completed a few days before the telephone assessment. Some caution should be used when interpreting the ICC because the normality assumption was violated.

Future research should include evaluating change in the community setting. It should also include the feasibility of using the TCMSA-AI with people with stroke who present with lower functioning and in other populations, such as people with acquired brain injury and seniors who have been discharged from rehabilitation,

for whom the CMSA-AI has been shown to have reliable and valid scores.

Using the TCMSA-AI has several advantages. First, it takes less time to complete than the CMSA-AI. It makes the CMSA-AI more feasible by giving it a wider application, and it makes it more cost efficient, especially when an individual lives at a significant distance from the clinical facility or when face-to-face follow-up is otherwise difficult or impossible. It reduces physical demands on an individual because functional mobility is reported rather than demonstrated; this can be especially important for people who have less functional ability and need to conserve their energy for daily activities.

Using the TCMSA-AI would also be helpful in the harsh Canadian winters, when risk of falls increases, and people may prefer not to drive. Involving clients in monitoring their functional abilities in the home and in the community gives them a sense of control and acknowledges them as an integral part of the recovery process, which does not end after they are discharged from an institution. In longitudinal studies that require long-term monitoring of participants' functional activity, using telephone interview assessments such as the TCMSA-AI would be an appropriate and practical alternative.

CONCLUSION

Rehabilitation clinicians require different versions of reliable and valid measures so that they can assess and monitor changes in functional activity after their clients are discharged home. Those clients who are unable to return for follow-up appointments in person (whether because of distance, transportation, or functional limitations) will not be lost to follow-up. Researchers need measures that can track functional mobility in a reliable and valid manner, even when a research participant lives at a distance.

This study reports the systematic manner in which a commonly used outcome measure, the CMSA-AI, which is also routinely used as an observed measure, was adapted to an interview format for use with community-dwelling stroke survivors or their proxies. The test-retest reliability of the TCMSA-AI scores was excellent, with ICCs greater than 0.95, indicating that the TCMSA-AI is a feasible and reliable option for recording a client's functional ability after inpatient rehabilitation. The results for the proxy-reported scores suggest that using proxies is possible; however, we suggest using proxy scores only when a stroke survivor is unable to answer questions. The validity of the TCMSA-AI scores is demonstrated by strong correlations between the CMSA-AI and the TCMSA-AI for the total score and the Gross Motor Function and Walking Indices scores at the 2-month follow-up. When deciding on the timing of follow-up assessments, we recommend 2 months because other timelines have not yet been evaluated.

Further research is needed to gather additional evidence for the TCMSA-AI, including longitudinal change, its application to different client populations, and determination of the best setting in which to use it.

KEY MESSAGES

What is already known on this topic

The Chedoke-McMaster Stroke Assessment (CMSA) has been used for many years as an outcome measure, with valid and reliable scores for assessing impairment and activity limitations in people with stroke.

What this study adds

A new telephone interview version of the CMSA Activity Inventory has been developed that demonstrates high test-retest reliability of scores 2 months after discharge from stroke rehabilitation, allows use of proxy scores when necessary, and demonstrates high correlations with the original version at 2 months after discharge from stroke rehabilitation.

REFERENCES

- Sackett D, Strauss S, Richardson W, et al. Evidence-based medicine: how to practice and teach EBM. 2nd ed. Edinburgh: Churchill Livingstone; 2000.
- Gowland C, Stratford P, Ward M, et al. Measuring physical impairment and disability with the Chedoke-McMaster Stroke Assessment. *Stroke*. 1993;24(1):58–63. <http://dx.doi.org/10.1161/01.STR.24.1.58>. Medline:8418551
- Moreland J, Gowland C, Van Hullenar S, et al. Theoretical basis of the Chedoke-McMaster Stroke Assessment. *Physiother Can*. 1993;45(4):231–8.
- World Health Organization. International classification of functioning, disability and health. Geneva: World Health Organization; 2001.
- Gowland C, Van Hullenar S, Torresin W, et al. Chedoke-McMaster Stroke Assessment—development, validation, and administration manual. Hamilton (ON): McMaster University; 1995.
- Guyatt GH, Kirshner B, Jaeschke R. Measuring health status: what are the necessary measurement properties? *J Clin Epidemiol*. 1992;45(12):1341–5. [http://dx.doi.org/10.1016/0895-4356\(92\)90194-R](http://dx.doi.org/10.1016/0895-4356(92)90194-R). Medline:1460470
- Barclay-Goddard R. Physical function outcome measures in acute neurology. *Physiother Can*. 2000;52(2):138–45.
- Valach L, Signer S, Hartmeier A, et al. Chedoke-McMaster Stroke Assessment and modified Barthel Index self-assessment in patients with vascular brain damage. *Int J Rehabil Res*. 2003;26(2):93–9. <http://dx.doi.org/10.1097/00004356-200306000-00003>. Medline:12799602
- Crowe J, Harmer D, Sharp J. Reliability of the Chedoke-McMaster Disability Inventory in acquired brain injury. Presentation at: Canadian Physiotherapy Association Congress; 1996 May; Victoria, British Columbia.
- Sacks L, Yee K, Huijbregts M, et al. Validation of the Activity Inventory of the Chedoke-McMaster Stroke Assessment and the Clinical Outcome Variables Scale to evaluate mobility in geriatric clients. *J Rehabil Med*. 2010;42(1):90–2. <http://dx.doi.org/10.2340/16501977-0477>. Medline:20111850
- Miller P, Stratford P, Gowland C, et al. Comparing two methods to train therapists to use the Chedoke-McMaster Stroke Assessment. Presentation at: World Congress of Physical Therapy; 1999 May 23–28; Yokohama, Japan.
- Miller PA, Huijbregts M, French E, et al. Videoconferencing a stroke assessment training workshop: effectiveness, acceptability, and cost. *J Contin Educ Health Prof*. 2008;28(4):256–69. <http://dx.doi.org/10.1002/chp.192>. Medline:19058246
- Chedoke-McMaster Stroke Assessment. Ottawa: Canadian Physiotherapy Association; 2007.
- Law M, MacDermid J. Evidence-based rehabilitation: a guide to practice. 2nd ed. Thorofare (NJ): SLACK; 2008.
- National Quality Forum. Patient reported outcomes (PROs) in performance measurement. Washington (DC): National Quality Forum; 2013.
- Food and Drug Administration. Guidance for industry: patient-reported outcome measures: use in medical product development to support labeling claims. Rockville (MD): U.S. Department of Health and Human Services, U.S. Food and Drug Administration, Center for Drug Evaluation and Research; 2009.
- Barker RN, Amsters DI, Kendall MD, et al. Reliability of the Clinical Outcome Variables Scale when administered via telephone to assess mobility in people with spinal cord injury. *Arch Phys Med Rehabil*. 2007;88(5):632–7. <http://dx.doi.org/10.1016/j.apmr.2007.02.032>. Medline:17466733
- Jones C, Feeny D. The authors respond. *Arch Phys Med Rehabil*. 2007;88(2):266–7. <http://dx.doi.org/10.1016/j.apmr.2006.12.042>.
- Segal ME, Gillard M, Schall R. Telephone and in-person proxy agreement between stroke patients and caregivers for the functional independence measure. *Am J Phys Med Rehabil*. 1996;75(3):208–12. <http://dx.doi.org/10.1097/00002060-199605000-00013>. Medline:8663929
- Carod-Artal FJ, Ferreira Coral L, Stieven Trizotto D, et al. Self- and proxy-report agreement on the Stroke Impact Scale. *Stroke*. 2009;40(10):3308–14. <http://dx.doi.org/10.1161/STROKEAHA.109.558031>. Medline:19661469
- Duncan PW, Lai SM, Tyler D, et al. Evaluation of proxy responses to the Stroke Impact Scale. *Stroke*. 2002;33(11):2593–9. <http://dx.doi.org/10.1161/01.STR.0000034395.06874.3E>. Medline:12411648
- Epstein AM, Hall JA, Tognetti J, et al. Using proxies to evaluate quality of life. Can they provide valid information about patients' health status and satisfaction with medical care? *Med Care*. 1989;27(3 Suppl):S91–8. <http://dx.doi.org/10.1097/00005650-198903001-00008>. Medline:2921889
- Dorman PJ, Waddell F, Slattery J, et al. Are proxy assessments of health status after stroke with the EuroQol questionnaire feasible, accurate, and unbiased? *Stroke*. 1997;28(10):1883–7. <http://dx.doi.org/10.1161/01.STR.28.10.1883>. Medline:9341689
- Lynn MR. Determination and quantification of content validity. *Nurs Res*. 1986;35(6):382–5. <http://dx.doi.org/10.1097/00006199-198611000-00017>. Medline:3640358
- Uniform Data System for Medical Rehabilitation. Guide for the Uniform Data Set for Medical Rehabilitation (including the FIM™ instrument) Version 5.1. Buffalo (NY); 1997.
- Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. *Psychol Bull*. 1979;86(2):420–8. <http://dx.doi.org/10.1037/0033-2909.86.2.420>. Medline:18839484
- Stratford P. Getting more from the literature: estimating the standard error of measurement from reliability studies. *Physiother Can*. 2004;56(1):27–30. <http://dx.doi.org/10.2310/6640.2004.15377>.
- Oczkowski C, O'Donnell M. Reliability of proxy respondents for patients with stroke: a systematic review. *J Stroke Cerebrovasc Dis*. 2010;19(5):410–6. <http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2009.08.002>. Medline:20554222
- Huijbregts M, Gowland C, Gruber R. Measuring clinically-important change with the Activity Inventory of the Chedoke McMaster Stroke Assessment. *Physiother Can*. 2000;52:295–304.
- Riddle D, Stratford P. Is this change real? Philadelphia: F.A. Davis; 2013.
- Taylor R. Interpretation of the correlation coefficient: a basic review. *J Diagn Med Sonogr*. 1990;6(1):35–9. <http://dx.doi.org/10.1177/875647939000600106>.