Interrater Reliability of Three Versions of the Chedoke Arm and Hand Activity Inventory

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ABSTRACT

Purpose: The purpose of this study was to estimate the interrater reliability of three shortened versions of the Chedoke Arm and Hand Activity Inventory (CAHAI-7, CAHAI-8, CAHAI-9) when used with persons with acquired brain injury (ABI). The CAHAI is an assessment of upper limb function with high reliability in the stroke and ABI populations. In the stroke population, three shortened versions of the measure have established reliability. Clinicians report time constraints as a barrier to using standardized assessments; thus, establishing the reliability of the shortened versions of the CAHAI in the ABI population may increase the use of this measure. **Method:** This was an observational, parameter estimation study. The participants were recruited from an in-patient ABI rehabilitation programme. The administration of the CAHAI to six persons with ABI was video recorded, and the video recordings were assessed by six clinicians to estimate interrater reliability. A Latin square design was used to balance the order in which the raters evaluated the videos. A repeated-measures analysis of variance was performed, and the variance components were used to calculate an intra-class correlation coefficient (ICC) and standard error of measurement (SEM) with 95% confidence limits (CLs) for each of the shortened versions. **Results:** Interrater reliability was high for all three versions: CAHAI-7, ICC = 0.96 (95% CL: 0.89, 0.99; SEM 2.65); CAHAI-8, ICC = 0.96 (95% CL: 0.90, 0.99; SEM 2.72); and CAHAI-9, ICC = 0.95 (95% CL: 0.85, 0.99; SEM 3.49). **Conclusions:** These results suggest that the three shortened versions of the CAHAI demonstrate high reliability in the ABI population. These versions may be particularly useful when time constraints or patient tolerance are an issue.

Key Words: brain injury; outcome measures; reproducibility of results; upper extremity.

RÉSUMÉ

Objectif : évaluer la fiabilité interévaluateurs de trois versions abrégées du *Chedoke Arm and Hand Activity Inventory* (CAHAI-7, CAHAI-8, CAHAI-9) auprès des personnes atteintes d'un traumatisme crânien (TC). L'inventaire CAHAI, qui évalue la fonction des membres supérieurs, présente une forte fiabilité auprès des populations d'accidents vasculaires cérébraux (AVC) et de TC. Au sein de la population d'AVC, trois versions abrégées de la mesure ont une fiabilité démontrée. Les cliniciens déclarent le manque de temps comme un obstacle à l'utilisation d'évaluations standardisées. Ainsi, si la fiabilité des versions abrégées de l'inventaire CAHAI est établie au sein de la population de TC, cette mesure pourrait être utilisée davantage. **Méthodologie :** dans cette étude observationnelle d'évaluation des paramètres, les participants ont été recrutés dans un programme de réadaptation des TC pour patients hospitalisés. L'exécution de l'inventaire CAHAI auprès de six personnes ayant un TC a été vidéo-enregistrée, et six cliniciens ont évalué les vidéos pour déterminer la fiabilité interévaluateurs. Les chercheurs ont utilisé le modèle du carré latin pour équilibrer l'ordre dans lequel les évaluateurs ont évalué les vidéos. Ils ont procédé à une analyse répétée de la variance et ont utilisé les éléments de variance pour calculer le coefficient de corrélation intraclass (CCI) et la mesure d'écart-type (MÉT) aux limites de confiance (LC) à 95 % pour chacune des versions abrégées. **Résultats :** les trois versions de l'inventaire ont une fiabilité interévaluateurs élevée : CAHAI-7 : CCI = 0,96 (LC à 95 % : 0,89, 0,99; MÉT : 2,65); CAHAI-8 : CCI = 0,96 (LC à 95 % : 0,90, 0,99; MÉT : 2,72); CAHAI-9 : CCI = 0,95 (LC à 95 % : 0,85, 0,99; MÉT : 3,49). **Conclusions :** selon ces résultats, les trois versions abrégées de l'inventaire CAHAI sont très fiables auprès de la population TC. Elles peuvent être particulièrement utiles lorsque le manque de temps ou la tolérance des patients représentent un enjeu.

Acquired brain injury (ABI) encompasses both traumatic brain injury (TBI) and non-traumatic causes such as tumours, encephalitis, and anoxic injuries.^{1,2} ABI has been estimated to occur in as many as 790 of every 100,000 people per year worldwide;^{3,4} for example, it is estimated that 1%–2% of the US population is living

with a TBI-related disability.^{1,5,6} The variability of the diagnosis is a result of differing inclusion criteria and definitions of what constitutes an ABI or TBI.⁷ ABI is often associated with comorbidities—for example, estimates indicate that as many as 70% of individuals have sustained concomitant injuries.^{4,8}

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Regardless of whether an ABI is caused by traumatic or non-traumatic events, the clinical course is similar.⁹ The extent of damage to the brain and resulting clinical presentation, however, vary greatly from person to person depending on the severity and location of the injury. For example, around the world, ABI affects more than 10 million people,^{4,10–13} approximately one-quarter of whom will have impaired upper limb (UL) function.^{4,11–13} UL function is an important aspect of performing activities of daily living such as self-care, feeding, and dressing and can contribute to quality of life.^{14,15} Good-quality, reliable outcome measures are critical for evaluating and quantifying UL function to determine patient progress and treatment effectiveness; however, several studies have identified the fact that clinicians use outcome measures inconsistently.^{16–18}

Factors affecting the use of outcome measures include the environment, patient, and clinician; lack of time and lack of resources are two of the most commonly identified factors.^{17,18} Thus, time efficiency has been cited as a major reason for developing shortened versions of assessment tools.^{19,20}

Environmental factors affecting the use of outcome measures include availability of the measure, space to administer it, and social norms in the clinical setting. Availability may be linked to the cost of and need for specialized equipment or training,¹⁷ and a lack of those resources can significantly reduce the use of standardized assessments in routine practice. Furthermore, outcome measures that require considerable space or special modifications to the environment are not feasible in some practice settings.¹⁸ However, encouraging the use of standardized assessment through benchmarks, audits, and best practice guidelines,¹⁶ or social pressure from colleagues, can shape the clinical environment in favour of using outcome measures.¹⁷ Because cost and specialized equipment are barriers, measures that are readily available and affordable, and that use items that are easily obtainable, will have greater uptake in practice settings.¹⁸

Patients themselves can influence the ease with which standardized measures are completed. A commonly identified barrier is patient tolerance for lengthy assessments. Some patients, particularly in the more acute phases of recovery, have significant drowsiness or fatigue and decreased physical endurance, all of which affect the efficiency with which clinicians use and complete assessments.¹⁸ Multiple sessions may be required, or a patient may need frequent rest breaks, and these increase the time required for a clinician to complete an assessment. In addition, patients with communication, behavioural, or sensory-perceptual issues may require modifications or increased time to complete an outcome measure. Individuals with these deficits may perform better on assessments that use everyday tasks that are more intuitive and rely less on high-level cognitive or communication skills to measure function.²¹ Measures that are concise,

easy to use, and meaningful to a patient are more likely to be completed by time-constrained clinicians.^{16,17}

Clinicians' knowledge of the availability of an assessment and its corresponding psychometric properties can influence the selection of an appropriate measure.^{16–18} In addition, the ability to skillfully administer a test is critical to adopting a measure as part of routine practice.¹⁶ Role modelling and mentoring can also play a part because clinicians who have colleagues with skill and experience in administering an assessment are more likely to use it themselves.¹⁷ This suggests that peer mentoring, training, and education can affect the routine use of outcome measures.

Clinicians of all disciplines consistently rate the time needed to administer and re-administer outcome measures as one of the barriers to using them.¹⁶ The current health care system demands a high patient-to-clinician ratio,¹⁸ and staffing shortages, high patient caseloads, and the demands of non-patient care also put pressure on resources. Clinicians report that the time spent using outcome measures is often at the expense of other types of patient care, including treatment,¹⁶ and using objective standardized assessments for each patient at admission, discharge, or reassessment can be time intensive.^{16,18} Despite time being a barrier across the continuum of care, clinicians report that they would find the time to complete an outcome measure, if it was indicated by a clear need or benefit, by prioritizing the measure or deferring other tasks.¹⁸ Therefore, investigating the psychometric properties of outcome measures that are brief or have shortened versions can help remediate some of these clinician barriers.

To date, ABI best practice guidelines have not recommended UL function outcome measures. However, common measures of upper extremity function are recommended in the neurological literature, such as the Canadian Stroke Best Practice Guidelines,²² and include the Action Research Arm Test, Wolfe Motor Function Test, Box and Block Test, Nine-Hole Peg Test, and Chedoke Arm and Hand Inventory (CAHAI). An evidence-based review of moderate to severe brain injury²³ suggested that evaluating and measuring UL impairment and function is a component of best practice; however, no valid or reliable measures of UL function specific to ABI were identified. When an outcome measure is not available for a patient group, a frequent strategy is to select a tool that is valid and reliable in a similar population, and the stroke literature has identified many UL measures with sound psychometric properties.^{24,25} One such measure is the CAHAI (intra-class correlation coefficient [ICC] = 0.98; 95% confidence limit [CL]: 0.96, 0.99). The CAHAI has three shortened versions that have demonstrated high inter-rater reliability in the stroke population: the CAHAI-7 (ICC = 0.96), CAHAI-8 (ICC = 0.97), and CAHAI-9 (ICC = 0.97).²⁰

The main purpose of the CAHAI is to measure how much an affected arm and hand contribute to a bilateral

task. It does not attempt to evaluate the role of the trunk in UL function, nor does it evaluate how a person completes a task, only the contribution of the more affected UL. The development of the CAHAI has been described in detail elsewhere in the literature.^{21,26} The full 13-item version takes approximately 30 minutes to complete, and a recent study established its interrater reliability in the ABI population (ICC = 0.96; 95% CL: 0.87, 0.99).²⁷ In the stroke population, depending on the severity of impact on the UL, the shortened versions can be completed in 10–15 minutes.^{20,28} This reduction in administration time may be appealing to clinicians, and given the issues with clinician time and patient fatigue in the population with ABI, establishing the psychometric properties of the shortened versions of the CAHAI in the ABI population would be beneficial. The purpose of this study was to estimate the interrater reliability of these three shortened versions of the CAHAI in the ABI population.

METHODS

Before starting the study, ethics approval was received from the Hamilton Integrated Research Ethics Board for Hamilton Health Sciences and McMaster University.

Study design

A cross-sectional, observational, parameter-estimation study design, in which six raters reviewed six participant videos, was used to estimate the interrater reliability of three shortened versions of the CAHAI. To minimize any systematic differences resulting from the order in which the ratings were obtained, a Latin square design was applied. A Latin square design is an array with each variable occurring exactly once in each row and each column; it balances for order effect. This design allows a variable (participants' CAHAI scores) to be evaluated multiple times (by multiple raters). Using this technique, a sample size of 36 can be achieved with a reduced number of participants because the participants are assessed multiple times by multiple raters. The sample size of six raters and six participants (36 individual data points) was based on the expectation of obtaining an interrater reliability of 0.90 with a lower one-tailed 95% CL of 0.7.²⁹

Measures

Chedoke Arm and Hand Activity Inventory

The purpose of the CAHAI (see the score form in Figure 1) is to evaluate the contribution of the impaired UL when performing a bilateral task; it measures the specific motor skills necessary to complete the task (e.g., fine or gross motor, stabilization, or manipulation). The CAHAI is a standardized measure with a detailed instruction and scoring manual;^{21,26,28} it was developed after a literature review and consultation with clinicians and individuals with stroke. An advantage of the CAHAI is that it uses inexpensive, everyday materials that are accessible to clinicians. It is scored on a 7-point scale,

similar to the FIM.³⁰ For each item, the score can range from 1 (i.e., the affected limb performs less than 25% of the task) to 7 (i.e., the affected limb completes all required components); a mid-scale score represents a different percentage contribution of the affected limb or help with the task using light-touch assistance. The result is a total possible score ranging from 13 to 91.^{18,19}

The CAHAI has good psychometric properties.^{21,26,31} Studies of the CAHAI-13 in the stroke population have shown high interrater reliability (ICC 0.98; 95% CL: 0.96, 0.99), low standard error of measurement (SEM; 2.8; 95% CL: 2.3, 3.7),²⁶ internal consistency of 0.98,²¹ and a minimum detectable change of 6.3 points.²⁶ The CAHAI has convergent cross-sectional validity (ICC 0.93; 95% CL: 0.87, 0.96) with the Action Research Arm Test²⁶ and sensitivity to change (ICC 0.95; 95% CL: 0.87, 1.00).²⁶ In the ABI population, the CAHAI also has high interrater reliability (ICC = 0.96; 95% CL: 0.87, 0.99).²⁷

The three shortened versions of the CAHAI were created to increase time efficiency, and in the stroke population, they have demonstrated high interrater reliability (CAHAI-7, ICC = 0.96; CAHAI-8, ICC = 0.97; CAHAI-9, ICC = 0.97).³² To identify which items should be included in a shortened version of the CAHAI, items were ranked according to difficulty, ability to demonstrate early functional change, and representation of greatest functional UL return.²⁰ As a result, the shortened versions omit the following tasks: The CAHAI-9 omits zipping up a zipper, cleaning eyeglasses, placing a container on a table, and carrying a bag up a flight of stairs; the CAHAI-8 omits the same items as CAHAI-9 plus cutting medium-resistance putty; and the CAHAI-7 omits the same items as the CAHAI-8 and CAHAI-9 plus putting toothpaste on a toothbrush. Authors have questioned the last two items of the CAHAI-9 in particular (placing a container on a table and carrying a bag up stairs) because they do not necessarily reflect UL function but rather encompass a multitude of other motor skills; they have also questioned cleaning glasses because it is not relevant to all individuals.^{13,14}

Chedoke-McMaster Stroke Assessment

We used the Chedoke-McMaster Stroke Assessment (CMSA) to determine study inclusion. The CMSA³³ is a measure developed for use in the adult stroke population and is composed of the Impairment Inventory (including motor impairment scales—hand, arm, foot, and leg) and the Activity Inventory. For this study, the arm and hand impairment scales were used. Individuals were asked to carry out a series of movements and were graded on a 7-point scale, where 1 = *severe impairment*, such as flaccid paralysis, and 7 = *typical movement*. The CMSA has excellent test-retest (ICC = 0.98), intrarater (0.98), and interrater (0.99) reliability as well as construct and concurrent validity in the stroke population.³³

Chedoke Arm and Hand Activity Inventory: Score Form

CAHAI-13 Version

Name:

Date:

Activity Scale			
1. total assist (weak U/L < 25%)	5. supervision		
2. maximal assist (weak U/L = 25-49%)	6. modified independence (device)		
3. moderate assist (weak U/L = 50-74%)	7. complete independence (timely, safely)		
4. minimal assist (weak U/L > 75%)			
Affected Limb:			Score
1. Open jar of coffee	☐ holds jar	☐ holds lid	<input type="text"/>
2. Call 911	☐ holds receiver	☐ dials phone	<input type="text"/>
3. Draw a line with a ruler	☐ holds ruler	☐ holds pen	<input type="text"/>
4. Pour a glass of water	☐ holds glass	☐ holds pitcher	<input type="text"/>
5. Wring out washcloth			<input type="text"/>
6. Do up five buttons			<input type="text"/>
7. Dry back with towel	☐ reaches for towel	☐ Grasps towel end	<input type="text"/>
8. Put toothpaste on toothbrush	☐ holds toothpaste	☐ holds brush	<input type="text"/>
9. Cut medium resistance putty	☐ holds knife	☐ holds fork	<input type="text"/>
10. Zip up the zipper	☐ holds zipper	☐ holds zipper pull	<input type="text"/>
11. Clean a pair of eyeglasses	☐ holds glasses	☐ wipes lenses	<input type="text"/>
12. Place container on table			<input type="text"/>
13. Carry bag up the stairs			<input type="text"/>
Total Score			<input type="text"/> /91
Comments			

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Figure 1 Chedoke Arm and Hand Activity Inventory score form.

Participant recruitment

Both the raters and the participants for this study were recruited from a specialized ABI in-patient rehabilitation unit at a regional tertiary-care hospital. They were recruited from a provincial programme that accepts people with more severe ABI; the typical patient is more severely affected and later post-injury than in a traditional ABI rehabilitation program. This is because these injuries often require a prolonged period before the person is medically stable and able to participate in a traditional rehabilitation programme. The programme accepts people with brain injuries of all aetiologies (including traumatic and non-traumatic causes), but not people with occlusive strokes.

A convenience sample was recruited of individuals with UL impairment as a result of an ABI (confirmed by radiological evidence), aged 16–65 years, and with a CMSA arm and hand score of 2–6 at the time of the study. Exclusion criteria consisted of behaviours that would prevent safe participation or the inability to follow a one-step command. Individuals who met the eligibility criteria were video recorded while the CAHAI was being administered, 6 weeks after being admitted to this specialized rehabilitation programme. Six weeks was chosen as the time frame for all participants to standardize the assessment date and capture a suitably variable sample. Participants received standard care for the UL throughout their admission to rehab. This included being part of the daily graded repetitive arm supplementary programme.³⁴ It also included individual motor recovery exercises, functional task-specific training, and arm ergometer and range-of-motion exercises 3–5 days per week. The usual length of stay for people in the ABI in-patient programme ranges from 2 weeks to 3 months.

Rater recruitment

The raters of the video recordings were recruited from the inpatient ABI programme and consisted of three physiotherapist clinicians and three occupational therapist clinicians. All raters had experience using the CAHAI in the ABI population and had received a half day of training (completed within the previous 5 years) in administering and scoring the measure as part of their clinical responsibilities unrelated to this study. All six raters were female. The mean number of years in practice was 18.92 (SD 11.88; range 1.50–32.00) years, with 11.83 (SD 8.84; range 1.00–22.00) years of ABI experience. Experience using the CAHAI ranged from 5 to 20 or more times.

Procedure

Treating clinicians identified consecutive admissions to the in-patient ABI rehabilitation unit and completed the CMSA bilaterally to determine the severity of motor impairment among patients and their eligibility for the study. Demographic (e.g., age and hand dominance) and injury (e.g., mechanism of injury and time since

injury) characteristics were collected for each participant, and demographic data were collected for each clinician rater (e.g., years in practice, years of ABI experience). CAHAI administration was videotaped in a single session for each participant, and the same physiotherapist administered the assessment for all participants, and an assistant videotaped it on a mobile device. As with the raters, the physiotherapist who administered the CAHAI was trained to a minimum of 80% accuracy in a half-day workshop on the scoring and administration of the CAHAI. The physiotherapist who administered the CAHAI was also one of the raters.

All participants were administered the CAHAI at approximately 6 weeks post-admission to capture the majority of patients before discharge. The raters independently viewed and scored the most involved UL using the videos and were blinded to the other raters' scores. The scores for each of the three shortened versions were calculated from the total CAHAI-13 score for each participant because the items in each of the shortened versions are also included in the CAHAI-13; as a result, scores for the CAHAI-7, CAHAI-8, and CAHAI-9 were calculated by adding up the first seven, eight, and nine items, respectively, on the score sheet.

Statistical analysis

Descriptive statistics were used to summarize the characteristics of the patients and raters. The mean and standard deviation were calculated for each CAHAI item and for the total score. The primary analysis was a three-way analysis of variance (ANOVA), with CAHAI scores as the dependent variable. Factors were patients (six levels), raters (six levels), and order (six levels). In the absence of an order effect, the three-way model was reduced to a two-way ANOVA containing the factors patients and raters.

Variance components were estimated and used to calculate a Shrout and Fleiss type 2,1 ICC and SEM. Data were analyzed using STATA software, version 12.1 (StataCorp LLC, College Station, TX, USA).

RESULTS

Demographics

Demographic findings are reported in Table 1. Six male participants with ABI were included in the study, with a mean age of 55.33 (SD 4.84; range 50–64) years. The mean number of months from injury to admission to the programme was 10.72 (SD 5.41; range 4.20–19.53). Two participants had had traumatic injuries, two had aneurysms, and two had anoxic injuries. CMSA scores indicated that four participants had bilateral UL impairments; of those, two were more impaired on the right side. Both participants with unilateral impairment were also more impaired on the right side. The severity of motor impairment for the more affected arm and hand varied from 2 to 6 on the CMSA.

Table 1 Demographics and Injury Characteristics of the Participants

Characteristic	Mean (SD), range*
Sex, male/female	6/0
Age, y	55.33 (4.84); 50–64
Type of injury	2 traumatic, 2 anoxic, 2 hemorrhagic
Hand dominance, right/left	4/2
More impaired side, right/left	4/2
CMSA left arm	5.83 (1.47)
CMSA right arm	4.50 (1.76)
CMSA left hand	5.50 (1.76)
CMSA right hand	4.80 (1.60)
Time post-injury, mo	10.72 (5.41), 4.20–19.53

*Unless otherwise indicated.

CMSA = Chedoke-McMaster Stroke Assessment.

Table 2 Summary Scores of the CAHAI-7, CAHAI-8, and CAHAI-9

Participant	Observations	Mean (SD)		
		CAHAI-7	CAHAI-8	CAHAI-9
A	6	30.00 (3.52)	34.67 (4.13)	37.83 (5.91)
B	6	19.00 (3.52)	21.83 (3.87)	24.00 (4.86)
C	6	10.17 (0.98)	12.00 (1.26)	13.00 (1.26)
D	6	45.33 (3.14)	51.50 (2.81)	55.00 (3.16)
E	6	22.50 (1.76)	24.33 (1.86)	26.83 (2.04)
F	6	12.67 (1.63)	14.67 (1.63)	17.17 (1.72)

CAHAI = Chedoke Arm and Hand Activity Inventory.

We analyzed 36 assessments for each version of the CAHAI (see Table 2 for the summary scores). The mean total score for the CAHAI-7 was 23.28 (SD 12.21; range 9–49); for the CAHAI-8, 26.5 (SD 13.78; range 10–56); and for the CAHAI-9, 28.97 (SD 14.60; range 11–59).

Interrater reliability

The three-way ANOVA (participant, rater, and order) revealed no significant order effect; as a result, a two-way ANOVA considering the subject and rater was reported. The interrater reliability estimates for the three versions of the measure were as follows: CAHAI-7, ICC = 0.96 (95% CL: 0.89, 0.99); CAHAI-8, ICC = 0.96 (95% CL: 0.90, 0.99); and CAHAI-9, ICC = 0.95 (95% CL: 0.85, 0.99). These results are shown in Table 3.

DISCUSSION

The aim of this study was to estimate the interrater reliability of three shortened versions of the CAHAI when used with persons with ABI. The interrater reliability of all three versions was excellent³⁵ (CAHAI-7, ICC = 0.96; CAHAI-8, ICC = 0.96; CAHAI-9, ICC = 0.95). The ICC is one of the most commonly used indicators of reliability,³⁶ and in this case, it was high, demonstrating the CAHAI's ability to differentiate UL function among people. The SEM is reported in the actual units of the CAHAI. This is

Table 3 Reliability Coefficients and Standard Errors of Measurement

Version of CAHAI	ICC (95% CL)	SEM (95% CL)
CAHAI-7	0.96 (0.89, 0.99)	2.65 (2.08, 3.66)
CAHAI-8	0.96 (0.90, 0.99)	2.72 (2.13, 3.76)
CAHAI-9	0.95 (0.85, 0.99)	3.49 (2.73, 4.81)

CAHAI = Chedoke Arm and Hand Activity Inventory; CL = confidence limit; ICC = intra-class correlation coefficient; SEM = standard error of measurement.

important so that clinicians know how much of the score can be attributed to error and how much is true change. In our study, the SEM was low, which demonstrates the consistency of the CAHAI scores.³⁷ These findings indicate excellent reliability and suggest that the shortened versions of the CAHAI may be clinically useful in the population with ABI.

Comparison with previous research

The CAHAI-13 has an ICC of 0.96 (95% CL: 0.87, 0.99) and an SEM of 3.35 in the ABI population, whereas in the shortened versions of the CAHAI the ICC ranges from 0.95 for the CAHAI-9 to 0.96 for both the CAHAI-7 and the CAHAI-8. This suggests that the shortened versions may be as reliable in this population as the full version. In addition, the interrater reliability of the three shortened versions in the stroke population is high (CAHAI-7, ICC = 0.96; CAHAI-8, ICC = 0.97; CAHAI-9, ICC = 0.97)²⁰ and was corroborated by our findings, described previously. These results support using the shortened versions in the stroke and ABI populations when time constraints are an issue. Completing the full version may give clinicians greater insight into their patients' abilities and challenges with those specific items; however, it does not appear to affect the measure's reliability as an assessment of UL function.

Clinical utility

These results are encouraging for the use of the shortened versions of the CAHAI in this population because they offer the clinical advantages of shortened administration time, use of easily accessible items, and functional tasks. Multiple patient, environmental, and clinician factors have been identified that affect using outcome measures, and clinicians may be more likely to use an assessment that is reliable but also time efficient for both them and their patients. When there are time constraints or patient factors, such as decreased endurance or ability to attend to a task, a shortened version of the CAHAI will be particularly useful. In addition, the CAHAI-7 may be useful as a screening tool to quickly and efficiently identify UL impairments.

It may be challenging for some clinicians to decide which version of the CAHAI is optimal. Two items that were particularly challenging for the patients, on the

basis of observing the participant videos and on previous research, were item 8, putting toothpaste on a toothbrush, and item 9, cutting medium-resistance putty.²⁷ These two items are included on the CAHAI-8 and CAHAI-9 but are omitted from the CAHAI-7. Clinicians in a previous study²⁰ stated that these were important tasks for their patients to practise. However, on the basis of our findings, unless these two tasks would be particularly meaningful for a patient, there is no benefit to patients from completing the CAHAI-8 or CAHAI-9. The CAHAI-7 is the most time efficient of the three, uses the simplest tasks, and is highly reliable. Thus, there does not appear to be an advantage to including items 8 and 9 when considering interrater reliability.

This study has some limitations in terms of generalizability. The participants were chosen from a sample of individuals with severe ABI and therefore may not be representative, and they were later post-injury than those whom a typical rehabilitation programme might accept. Although our study used multiple raters, we did not recruit participants from across the continuum of care. The literature suggests that although men are twice as likely as women to sustain an ABI, both sexes are affected,¹¹ but from our sample, we can only conclude that the CAHAI versions are reliable with in-patient men with an ABI.

There are also limitations related to the video design of the test. Participants with ABI often have a reduced tolerance for activity.³⁸ Because of the associated burden the participants would have experienced by undergoing multiple assessments by different raters, we used videotaping to gather the data. This approach allowed us to use multiple raters with no additional demand on the participants; however, in clinical practice, raters would administer the test. This adds sources of error: Different raters may administer the test slightly differently, and the participants may perform slightly differently on different occasions. All these factors may affect the raters' ability to score the items. As a result, use of the video design may have reduced some of the error variability in our sample and may have increased our ICC.

Future directions

Future studies may wish to use an alternate design to confirm these findings. Studies to establish additional psychometric properties in the ABI population are also necessary. The CAHAI versions score the more affected UL; however, there is a need to be able to score each limb in the ABI population individually; future work to modify and validate bilateral scoring would be beneficial.

CONCLUSIONS

The current study indicates that the CAHAI-7, CAHAI-8, and CAHAI-9 demonstrate high reliability in the population with ABI. There appears to be no added advantage to using the CAHAI-8 or CAHAI-9 over the CAHAI-7

unless a therapist finds that the additional tasks provide helpful information for a particular patient. This gives clinicians a choice of three highly reliable, time-efficient, and functional assessments of the UL. The CAHAI-7 is recommended as the most time-efficient measure without compromising reliability.

KEY MESSAGES

What is already known on this topic

The Chedoke Arm and Hand Activity Inventory (CAHAI) is a measure of arm and hand function. All versions of the CAHAI have established psychometric properties in the stroke population. Psychometrics of a measure are population specific. The CAHAI-13 has high reliability in the population with acquired brain injury (ABI). Reliability of the three shortened versions of the CAHAI in an ABI population has not been published.

What this study adds

In this study, three shortened versions of the CAHAI demonstrated high reliability in an ABI population. The CAHAI is a reliable measure of arm and hand function in the ABI population. Shortened versions of the measure may be useful when there are time constraints.

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