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ORIGINAL ARTICLE

Multidisciplinary assessment measure for individuals with disorders of consciousness

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Abstract

Objective: This study introduces the Comprehensive Assessment Measure for the Minimally Responsive Individual (CAMMRI) and reports on its development, inter-rater reliability, construct validity and clinical value.

Methods: A multidisciplinary team of therapists developed this measure, which comprises 12 sub-tests that examine three main areas: Response to the Environment, Motor Control and Communication and Swallowing. The sub-tests are scored using a 7-point scale; sub-tests can also be administered individually. The measure was administered during a pilot project and then 1 year later to 12 adult clients with severe acquired brain injury at a long-term rehabilitation programme. The age range of the participants was 18–65 years; individuals were 1.5–10 years post-injury.

Results: Comparison measures included the Western Neuro Sensory Stimulation Profile (WNSSP), the Coma Recovery Scale-Revised (CRS-R) and the Chedoke McMaster Impairment Inventory (CMII). Inter-rater reliability of each sub-test ranged from 0.87–1.0, with an average of 0.90 in the first year of the assessments.

Conclusion: Validity data supported the use of the CAMMRI for minimally conscious adults with ABI to measure behavioural changes and plan treatment for this population. Future research should focus on using this measure with other neurological populations.

Keywords

Minimally conscious, multidisciplinary, outcome measure, rehabilitation, brain injury

History

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Introduction

Severe acquired brain injury is a serious public health problem that leaves countless individuals with significant disability. Those with the most severe acquired brain injuries present with a disorder of consciousness (DOC) either in the form of vegetative state (VS) or minimally conscious state (MCS). 'Recent studies in Canada have estimated that the annual incidence of severe traumatic brain injury (TBI) is 11.4 per 100 000 and of mild TBI 600 per 100 000' [1, p. 88].

It is difficult to estimate the incidence and prevalence of DOC given the limitations to current surveillance practices; however, research has found that between 25 000–420 000 individuals in the US are diagnosed as being in a vegetative state (VS) and between 112 000–280 000 individuals are diagnosed as being in a minimally conscious state (MCS) [2]. The average lifetime costs of care for an individual with severe ABI can be as high as $1 875 000 [3], which represents a significant economic burden for health systems, individuals and families.

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Recovery from DOC is often protracted, but typically occurs along a continuum of stages that include coma, VS and MCS. Coma is defined as a 'failure of the arousal system' and is characterized by an absence of spontaneous eye opening and lack of response to sensory stimulation [3]. A person in a VS demonstrates some indication of a sleep–wake cycle, but there is an apparent lack of awareness of self or environment, language comprehension or purposeful response to auditory, visual or noxious stimuli. The minimally conscious state is characterized by inconsistent, but observable, behavioural indicators of some level of awareness that include the ability to follow simple commands, produce verbal or gestural yes/no responses and demonstrate purposeful movements [3].

As is the case with any other medical condition, assessment of DOC is what guides many critical treatment, placement and/or funding decisions. However, typical assessment of DOC, particularly for those progressing from VS to MCS, presents several challenges; it can be difficult to identify and/or differentiate spontaneous and inconsistent responses from purposeful and consistent responses; gradual improvement is often undetected by standard tools which assess the presence or absence of specific, discrete behaviours; several tools must be utilized for a holistic assessment; and most assessment tools use prescribed and often unfamiliar sensory stimuli that may be less effective in eliciting

behavioural responses than if familiar stimuli (i.e. response to a familiar voice, image or scent) were used. All of these challenges contribute to the possibility of misdiagnosis of DOC [3].

Responding to these concerns, this team undertook the development of an assessment tool designed to address these limitations. By using key features of existing tools and familiar stimuli and by improving the sensitivity of the assessment, the Association for the Rehabilitation of the Brain Injured (ARBI) team of therapists developed a functional measure called the Comprehensive Assessment Measure for Minimally Responsive Individuals (CAMMRI). The purpose of this paper is to briefly describe the development of the CAMMRI and to present the results of a pilot study where the measure was implemented to assess its reliability and validity.

CAMMRI

ARBI has been offering long-term rehabilitation for individuals with severe acquired brain injury in a community setting for over 35 years. Clients are assessed by a multidisciplinary team of therapists that develop an intensive rehabilitation programme, which includes sensory stimulation. However, it has been difficult to quantify the subtle changes noted in the clients' responsiveness. The ARBI therapy team utilized an array of assessment measures, including discipline-specific tools, but continued to identify the need for a more comprehensive measure to aid in the assessment and treatment planning process.

Using a consensus approach and guided by clinical judgement, the team identified the features of an ideal assessment tool that would enable clinicians to efficiently and objectively identify and track the incremental changes in adults with VS and MCS. The team determined that the ideal tool would be comprehensive enough to assess the three primary domains involved in recovery from DOC (i.e. comprehension/communication, response to the environment and motor control). It would use graduated cues and familiar stimuli to stimulate an individual's best response, thereby providing a starting point for rehabilitation. Finally, it would use a 7-point scale to assess subtle changes in behavioural functioning in all domains.

The team next identified and analysed tools that are commonly used to assess DOC to best capture these subtle changes. The following scales were examined: Glasgow Coma Scale (GCS) [4], The Coma Recovery Scale-Revised (CRS-R) [5], Sensory Modality Assessment Rehabilitation Technique (SMART) [6], Western Neuro Sensory Stimulation Profile (WNSSP) [7], Chedoke McMaster Impairment Inventory (CMII) [8], Rancho Los Amigos Levels of Cognitive Functioning Scale (LOCF) [9], the Wessex Head Injury Matrix (WHIM) [10], Functional Status Examination (FSE) [11], Functional Independence Measure (FIM) [12], Disability Rating Scale (DRS) [13], Sensory Stimulation Assessment Measure (SSAM) [14] and Neurobehavioral Cognitive Status Examination (Cognistat) [15].

Using agreed upon criteria, tools were excluded if their primary purpose was for assessment in the acute stage of brain injury and coma (e.g. GCS); if they assessed global level of cognitive functioning (e.g. LOCF, WHIM); if they were designed to assess functional outcome (e.g. FSE, FIM, DRS-R, SSAM); or if they were designed to assess higher levels of cognitive functioning, and, therefore, were not appropriate for this population (e.g. Cognistat).

Three tools were identified as having strong potential for supporting the development of CAMMRI, including WNSSP, CRS-R and CMII. These are described in Table I. CRS-R seemed to be the most sensitive tool for assessing communication and response to the environment following DOC. However, the steps between levels were too great to detect the small changes attained by this slow-to-recover population, and it did not assess motor function in detail. Similarly, the WNSSP, while considered a useful clinical scale developed to assess communication and response to environment in adults with severe brain injuries, does not assess motor skills and lacks sensitivity. Finally, the CMII was determined to be a scale that assesses motor function but not communication or response to sensory stimulation. Furthermore, it was designed specifically for stroke patients. A fourth tool, the SMART, was also considered as it is one of the only tools that include items in all domains of interest. While comprehensive, its strict guidelines for administration make it impractical for regular clinical use.

Item selection

One of the objectives for developing CAMMRI was to have a tool that included more aspects of sensory stimulation, means of communication and motor control abilities than typically found in other assessment measures. These three major areas were identified as important domains for evaluating an individual's ability to perceive and interact with the environment. These domains were then operationalized as: (a) Response to the Environment, which includes arousal, and responses to auditory, olfactory and visual stimuli; (b) Motor Control, which includes independent and/or purposeful movement of head, face and limbs; and (c) Communication and Swallowing, which include facial/gestural communication, auditory comprehension, vocalization, yes/no response and dysphagia. The Dysphagia scale is a supplementary subtest of the CAMMRI that identifies the presence of an enteral feeding tube. Twenty sub-tests were identified from among the four assessments listed in Table I and adapted for use in the CAMMRI. An additional sub-test examining augmentative/alternative communication was included to describe individuals who communicate using alternate methods (e.g. speech generating device). Table II lists the domains used in the CAMMRI and compares the sub-tests with the most related measures.

Test administration

In order to ensure consistency of use, a detailed manual was created to accompany the CAMMRI. The manual contains a detailed description of each sub-test, the scoring procedure, recording form, scale and a scoring sample. Experienced clinicians may be trained to use this measure in a short period of time. The CAMMRI is intended to be used over two 1-hour sessions using minimal equipment. Subtests may be administered individually in order to track response changes in a particular domain. When administering

Table I. Tools selected to support the development of the CAMMRI.

Assessment tool	Reference	Description and scoring	Strengths (+) and Limitations (−)
SMART	Gill Thwaites [6]	Based on the Glasgow Coma Scale (GCS) it comprises categories of behavioural responses to sensory stimulation. Domains assessed include response to sensory stimulation, motor function, functional communication and wakefulness and arousalResponses are assessed on five levels ranging from no response to obeying command/consistent/purposeful or number of prompts	+ Demonstrated reliability and validity + Comprehensive: assesses function in three primary domains + Assesses functions using a 5-point Likert-like scale. − Restricted to trained staff − Not designed to identify goals for rehabilitation − Many of the stimuli are meaningless − Testing is highly prescriptive and may be prolonged and tiring
WNSSP	Ansell and Keenan [7]	Designed to assess cognitive function in individuals with DOCConsists of 32 items that assess arousal/attention, expressive communication and response to sensory stimulationItems scores range from 0–1 to 0–5	+ Demonstrated reliability and validity − Does not assess motor function − Scores based on the presence or absence of a specific behaviour − Steps between behaviour are not evenly spaced out and may miss some levels of function
CRS-R	Giacino et al. [5];	Developed in the 1990s, and revised in 2004, CRS-R is used for the diagnosis, prognosis and treatment planning of individuals with VS and MCS Items assess auditory, visual, motor, oral motor, communication and arousal functions Items scores range from 0-2 to 0-6	+ Demonstrated reliability and validity − Does not assess motor function − Limited assessment of communication − Scores based on the presence or absence of a specific behaviour
CMII	Gowland et al. [8]	A two-part measure that assesses physical impairment and disability *Impairment inventory assesses shoulder pain, postural control, arm, hand, foot and leg function Activity inventory measures the individuals' functional ability including gross motor function and walking Items are scored based on stage 1–7	+ Demonstrated reliability and validity − Does not assess response to environment or communication − Scores based on the presence or absence of a specific behaviour − Designed to assess disability in individuals with stroke and acquired brain injury

*only the Impairment inventory is used for the CAMMRI.

Table II. CAMMRI domains comparison with other measures with similar sub-tests.

Domain	Behaviour	SMART	WNSSP	CRS-R	CMII
Communication and swallowing	Facial/gestural communication		X		X
	Auditory comprehension		X		
	Vocalization		X	X	
	Yes/No Response		X	X	
	Augmentative communication[a]				
	Dysphagia[a]		X		
Response to the environment	Arousal	X	X	X	
	Auditory response	X	X	X	
	Olfactory response[b]	X	X	X	
	Visual response	X	X	X	
	Tactile response		X		
Motor control	Head	X			
	Face	X			
	Right arm	X			X
	Right hand	X			X
	Right leg	X			X
	Right foot	X			X
	Left arm	X			X
	Left hand	X			X
	Left leg	X			X
	Left foot	X			X

[a]The Dysphagia scale and Augmentative/Alternative Communication sub-test are available as supplementary sub-tests.
[b]The Olfactory sub-test identifies the presence of a traqueostomy.

the entire measure, administering the sub-tests in a particular sequence is recommended in order to limit participant fatigue.

The CAMMRI was designed to assess the best response to a stimuli using a continuum of behaviours. In order to quantify the responses, a system of graduate cues beginning with a verbal command and ending with a physical cue was required (e.g. physical touching a limb to identify the correct limb in the command). The purpose was to differentiate between a spontaneous response and the ability to respond to a command indicating a level of consciousness and comprehension. For sensory stimuli, the research team recommends working with family and other care staff, wherever possible, to identify familiar and/or meaningful visual, auditory and olfactory sensory stimuli that should be included on the test. While using prescribed stimuli as directed in other tests helps with the standardization of a tool, recent research supports the use of familiar and meaningful stimuli. In more recent studies, individuals with DOC who may be otherwise unresponsive show evidence of awareness on functional MRI when presented with familiar, emotionally salient stimuli [16]. These findings suggest that familiar stimuli may produce a behavioural response sooner in individuals recovering from DOC than unfamiliar stimuli. Also, other studies advise that emotional stimulation provided by a familiar person during the administration of DOC evaluation scales may improve the assessment of responsiveness [17]. Therefore, the Auditory, Visual and Olfactory sub-test considerations in the CAMMRI manual provide a detailed description and advise the clinicians to choose stimuli that are familiar and/or meaningful to the client.

Scoring

One of the most important factors in developing the CAMMRI was the recognition that most assessments lack the sensitivity to detect the subtle changes that are characteristic of individuals recovering from DOC. While the CRS-R and the WNSSP provide a detailed measure of the client's ability to respond to stimulation, the team felt that they were not sufficiently sensitive to reflect the subtle changes because they examine the presence of specific behaviours or there are large gaps between the assessed behaviours. The SMART, on the other hand, uses a 5-point Likert-like scale to assess function, where 1 represents the absence of a response or behaviour and 5 represents a complete response. However, the team determined that the steps between each level are still too great to identify small improvements.

To better identify small changes in behaviour, a 7-point Likert-like scale was used. In the CAMMRI, a score of 7 represents prompt, consistent, differentiated responses to command/stimuli. A score of 5–6 represents less consistent or slower differentiated responses. Scores of 4 and under represent inconsistent, more generalized or reflexive responses to the stimuli presented. A score of 1 represents no response. CAMMRI also allows for re-testing if the clinician feels the client has not been able to demonstrate his 'best response'. Separate administration of the sub-tests offers an opportunity to look at the clients' fluctuations in function across the day.

Summary

The resulting tool is a 21-item holistic assessment designed to track subtle changes in the areas of communication/swallowing, response to the environment and motor control in adults with DOC. The primary purpose of CAMMRI is to assist clinicians in the development of comprehensive rehabilitation programmes for individuals with severe brain injury or individual sub-tests that may be used to track changes or fluctuations in a particular domain Other motor assessments such as spasticity and articular range of motion are considered in addition to CAMMRI to provide a better understanding of the client's status. The CAMMRI may be administered in two 1-hour sessions on different days or it may be repeated in its entirety or in parts over several sessions (or even in the same day) to monitor progress and track performance over time.

The study

After the completion of the development of CAMMRI, the research team undertook a pilot study to assess its reliability and validity using the methodological design for the development of a new measure. The intent was to test inter-rater reliability of CAMMRI at two time periods; assess criterion validity by comparing elements of CAMMRI with corresponding elements found in other gold standard measures of DOC; and test the sensitivity of the test by assessing participants at one time and then 12 months later. Prior to commencing the pilot, the study proposal was submitted to and ultimately approved by the Community Research Ethics Board of Alberta (CREBA).

Method

Participants

The pilot study used an availability sample of individuals who had sustained severe acquired brain injuries that resulted in DOC. A two-pronged approach was used to identify participants for the study. First, individuals who were current or past participants in the study centre's rehabilitation programme were selected to participate if they met the inclusion criteria. Inclusion criteria included: being between the ages of 18–65 years; having a history of severe brain injury secondary to trauma, anoxia or cerebral vascular accident; currently functioning at LOCF Level II or III; not presenting a safety risk to self and others; and being medical stable. Given that individuals with DOC are unable to provide informed consent, information on the pilot study and invitations to participate were provided to their legal guardians. Information letters describing the study were also sent to healthcare professionals throughout the province who worked with the population of interest. These letters requested that invitations be shared with caregivers and legal guardians of potential participants.

Guardians of 12 current and past participants of the programme provided informed consent for participation. No interest was expressed by individuals outside of the study centre. Three females and nine males, all between 1.5–10 years post-injury at the beginning of the study, were included. The average age (SD) was 41.92 (14.44) years, with an age range of 20–65. Five participants were assessed at

LOCF level II and seven were at LOCF level III. The type of injury included anoxic brain injury (58%), traumatic brain injury (34%) and stroke (8%). All 12 individuals participated in the first round of assessments (time one). Only nine individuals participated at time two. Of the three that dropped out of the study, two were deceased and a third presented a safety risk and was, therefore, withdrawn. There was no significant difference on LOCF among the three individuals who only participated in time one compared to those who participated both times. However, the one time individuals were on average younger in age, $\bar{x} = 28$ (7.55) than the rest of the group, $\bar{x} = 16.6$ (13.25).

Procedure

The complete CAMMRI was administered over a period of 2 non-consecutive days following the guidelines of the manual. The initial assessment was simultaneously administered and scored by pairs of trained clinicians. On the first day, sub-tests assessing 'Response to the Environment' and 'Communication and Swallowing' were administered and, on the 2nd day, a sub-test assessing 'Motor Control' was administered. Sub-tests of WNSSP, CRS-R and CMII that correspond with items on the CAMMRI were administered concurrently. CAMMRI was re-administered 1 year later following the same procedure. All assessments were videotaped for reference purposes.

All three clinicians were involved in the development of the CAMMRI and, therefore, had the same level of understanding and training in its implementation. In addition, all followed the directions for administering and scoring the assessment as directed in the manual.

All data were coded and entered into SPSS v.13 software for statistical analysis. Analysis of demographics and sub-test items were undertaken using frequencies for categorical items and calculation of means, standard deviation and range for interval and ratio items. Inter-item correlations and Cronbach's Alpha co-efficient were calculated for sub-tests as appropriate. Correlations with standard measures of similar and differing constructs were examined for evidence of construct validity.

Because the item 'augmentative communication' was only relevant to a few participants and scores indicated perfect agreement, it was not included in this analysis.

Results

The inter-rater reliability of each sub-test ranged from 0.87–1.0, with an average of 0.9 (see Table III). Note that the inter-rater reliability calculated on items 4 and 14 (Visual Response Sub-test and the Motor Control Sub-test–right upper extremity) has a discrepancy. The range was at 0.96–1.00 in 2009 and in 2010 it was 0.76–0.70. This discrepancy may have resulted due to an inconsistency in the real-time scoring between the therapists and lack of preciseness of the video to capture the subtle behaviour for the therapists, allowing the therapists to re-evaluate their scores.

The correlations between the CAMMRI and the other standard assessment measures of similar and differing constructs were examined for evidence of construct validity. The measures used for comparison were: the WNSSP, the CRS-R and the CMII. Data analysis confirmed that the WNSSP is the measure most similar to the CAMMRI. The two measures show an average correlation of 0.5. However, it should be noted that the WNSSP does not include a motor response component. The CRS has an average correlation of 0.4 with the similar sub-tests of the CAMMRI. Again, the CAMMRI includes 12 sub-tests, whereas the CRS-R only includes six different sub-tests. The CMII demonstrates an average correlation of 0.4 with the corresponding CAMMRI sub-tests, but the limitation is it only assesses motor responses. While the sample size was too small to have the power to detect significant correlations between comparable scales on the CRS-R and CMII and WNSSP measures, there is clear

Table III. Descriptive data of Inter-rater Reliability; 2009 and 2010.

Items	Reliability (2009)	Reliability (2010)
1. Facial/Gestural communication	1.0** ($n = 10$)	0.818** ($n = 10$)
2. Auditory response scale	0.866** ($n = 10$)	0.949** ($n = 10$)
3. Olfactory response scale	0.898** ($n = 9$)	0.853** ($n = 9$)
4. Visual response scale	0.958** ($n = 9$)	0.760* ($n = 10$)
5. Auditory comprehension	0.957** ($n = 10$)	0.837** ($n = 10$)
6. Vocalization	1.00** ($n = 10$)	0.962** ($n = 10$)
7. Yes/No Response scale	0.978** ($n = 9$)	0.916** ($n = 10$)
8. Augmentative communication	1.00** ($n = 2$)	Not applicable
9. Tactile response scale	1.00** ($n = 10$)	0.985** ($n = 10$)
10. Arousal scale	1.00** ($n = 10$)	1.00** ($n = 10$)
11. Dysphagia scale	1.00** ($n = 10$)	1.00** ($n = 10$)
12. Head	0.949** ($n = 9$)	0.825** ($n = 10$)
13. Face	1.00** ($n = 9$)	0.917** ($n = 10$)
14. Right arm	1.00** ($n = 9$)	0.705* ($n = 10$)
15. Right hand	0.980** ($n = 9$)	0.949** ($n = 10$)
16. Right leg	0.946** ($n = 9$)	0.955** ($n = 10$)
17. Right foot	0.904** ($n = 9$)	0.974** ($n = 10$)
18. Left arm	1.00** ($n = 9$)	0.929** ($n = 10$)
19. Left hand	1.00** ($n = 9$)	0.782** ($n = 10$)
20. Left leg	1.00** ($n = 9$)	0.883** ($n = 10$)
21. Left foot	1.00** ($n = 9$)	0.985** ($n = 10$)

n, number of subjects tested in each year/sub-test.
$p < 0.05$, ** $p < 0.01$.

support for a moderate relationship, on average, between the CAMMRI and the above-mentioned scales.

Discussion

The present pilot study provides evidence for the use of CAMMRI as a comprehensive tool that is appropriate for use with individuals with DOC. The findings suggest that it is a reliable and valid measure of the behavioural functioning of individuals with DOC. There was strong agreement between the two groups of clinicians on all items of CAMMRI at both time one and time two. This consensus suggests that it produces relatively stable and consistent results when used by different clinicians. In addition, the correlations between CAMMRI and both CRS-R and WNSSP exceeded the hypothesized value of $r = 0.40$, which acknowledges that it is measuring the intended parameter in the areas of Communication and Swallowing and Response to Environment domains. Correlations between motor sub-tests on CAMMRI and the corresponding sub-tests on CMII were less conclusive. Five sub-tests had strong correlations ($r > 0.40$), but four did not. This comparison may suggest that the Motor Control sub-tests on the CAMMRI do a poorer job of assessing this domain. However, closer examination of CMII reveals that motor control is measured very differently than CAMMRI and it is more likely that it is a poor reference assessment for determining the validity of the motor control sub-test.

The findings of the study also provided evidence that CAMMRI has sufficient sensitivity to identify changes in behaviour in individuals with DOC over time. While change was not expected, particularly in those who were further from time of injury and presumed to have plateaued, small changes were in fact detected. This finding supports the value of implementing a 7-point measurement scale over others that are currently in use.

There are several limitations in this study. The first relates to sample size. While the study was planned with between 20–30 individuals with DOC from across the province, only guardians who were familiar with the programme expressed interest and provided consent for participation. While having 12 participants at time one and nine at time two enabled the pilot to be conducted, the findings can only be considered with caution. For increased confidence in the reliability of the CAMMRI, testing with a larger sample size will be required. This may be accomplished through collaborations with other facilities that provide care and/or support for this population.

A second limitation of the pilot is related to its sensitivity. While this team argues that the current 'gold standards' are not sensitive enough to identify the subtle changes that occur in individuals with DOC over time, this study did not re-assess participants using the CRS-R, WNSSP or CMII at time two. As a result, it can be said conclusively that the CAMMRI does a better job of detecting change over time compared to other assessments. Future studies should include the reference tests at both time one and time two in order to make these comparisons.

Another consideration in this study is related to the choice of using the CMII. The CMII is a measure designed to assess functional changes in the stroke population; however, the authors recommend the use of this measure for other neurological conditions including acquired brain injury. The CMII was used as a comparable measure to the CAMMRI in assessing motor function. The CMII assessed the motor function of each limb separately, which allows for greater sensitivity. This design was included in the development of the Motor Control sub-test of the CAMMRI to ensure the most precise scores were captured for each specific limb.

In spite of the limitations, it is believed that the CAMMRI has the potential to make a significant contribution to the assessment of change in the slowest-to-recover segment of the population with severe brain injuries. At this time, while it is rare for these individuals to continue to receive active therapy over the years, it is hoped that objective evidence of improvement using the CAMMRI will encourage the approval and provision of continued rehabilitation treatment over the longer term.

Additionally, the CAMMRI sub-tests can also be used as stand-alone measures to track changes or fluctuations in a particular modality. Parts of/or the entire measure can be re-administered over several sessions (or even in the same day) to monitor progress/track performance over time. Some sub-tests may need to be repeated more frequently than others, due to fluctuations in client performance often seen in this severely brain-injured population. The measure enables the therapist to determine the areas in which the client performs most competently and provides guidance for the development of therapy goals for those aspects that are weaker.

Also, it is anticipated that this measure can be used in the acute phase of recovery in order to quantify responses that the client may be developing in response to the environment and to provide information about consistency of response. This has important implications for determining a client's readiness for the next stages of rehabilitation. These findings may also aid in the diagnosis of the DOC.

It may be possible to use the CAMMRI or the individual sub-tests as part of an assessment battery for individuals with other neurological diagnosis. Further studies would be necessary to determine if CAMMRI is a reliable and valid instrument for other populations.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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