SHORT REPORT

Measurement of impaired consciousness in the neurological intensive care unit: a new test

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Abstract

Neurological deterioration in alert patients with an acute CNS disorder can be subtle, but current coma scales may not clearly capture changes in level of alertness. Many coma scales include components such as eye opening and content of speech, features that are difficult to assess in intubated patients and patients with facial trauma.

Two new tools have been devised by the authors. The components are a continuous performance test (patient is asked to raise his hand every time he hears a certain letter in a standardised sentence) and the three consecutive hand position test ("thumbs up-fist-victory sign").

Variation within and between observers was assessed with three neurologists, two junior neurology residents, and two neuroscience nurses, and compared with the Glasgow coma score.

The average agreements had comparable ranges for both scores, 65% to 89% for both tests and 60% to 88% for the Glasgow coma score. On the first visit 49% of all tests with a maximum Glasgow coma score had a negative continuous performance test as opposed to 13% of tests with a less than maximum Glasgow coma score. For the consecutive hand position test, these numbers were respectively 25% and 2%.

These tests may be a reasonable alternative to the Glasgow coma score to monitor patients, in particular when the verbal and eye response cannot be reliably tested.

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Monitoring of the clinical course of acutely ill neurological patients is best performed by repeated neurological examination. Coma scales have been developed to quantify the degree of impairment of consciousness and they may predict outcome. Most neuroscience intensive care units use the Glasgow coma scale.[1] This scale, introduced in 1974 by Teasdale and Jennett, was devised to facilitate communication between nursing staff and physicians.[1] The reliability of the Glasgow coma score is good, but recent studies underscore that experience in using this scale is important as substantial errors in assessment may occur with inexperienced observers.[2] None the less, the Glasgow coma score remains one of the most important clinical monitoring tools and any new scale must be tested against it.

Neurological deterioration in patients with acute neurological or neurosurgical illness is often subtle. Previously published studies of deterioration in various acute neurological illnesses have more or less arbitrarily used changes in a summed Glasgow coma score or changes in the motor score of the Glasgow coma score.[3 4] However, clinical deterioration often involves vigilance first which may not be clearly articulated in changes of the individual components of the Glasgow coma scale. In fact, the Glasgow coma score was not devised to monitor patients but to improve communication between staff.

It is our impression that early signs of neurological deterioration are not detected by the Glasgow coma scale. Moreover, the use of the Glasgow coma score is problematic in intubated patients and patients with eyes swollen shut after trauma or major critical illness. Therefore, we tested new tools to assess the level of consciousness and validated it with a between and within observer agreement study.

Patients and methods

Table 1 shows the test scale. The components of the scale are continuous performance test (CP), three consecutive hand position tests (H3), and motor responses following commands and noxious pain stimulus.

The continuous performance test is tested as follows. The patient is asked to raise a hand or index finger every time he hears the letter "A" in a standardised sentence, read one second for each word. The standardised sentence we used was: "Schools and highways cost money, we all pay for them through taxes." (The continuous performance test was scored positive when one hand was raised five times.)

The consecutive hand position test consists of three consecutive hand positions. These are: Thumbs up-fist-victory (or peace) sign. These

Table 1 The test scale

Level	Test scale		
	CP	H3	Motor response
1	+	+	FC
2	−	+	FC
3	−	−	L
4	−	−	W
5	−	−	PW
6	−	−	E
7		−	NR

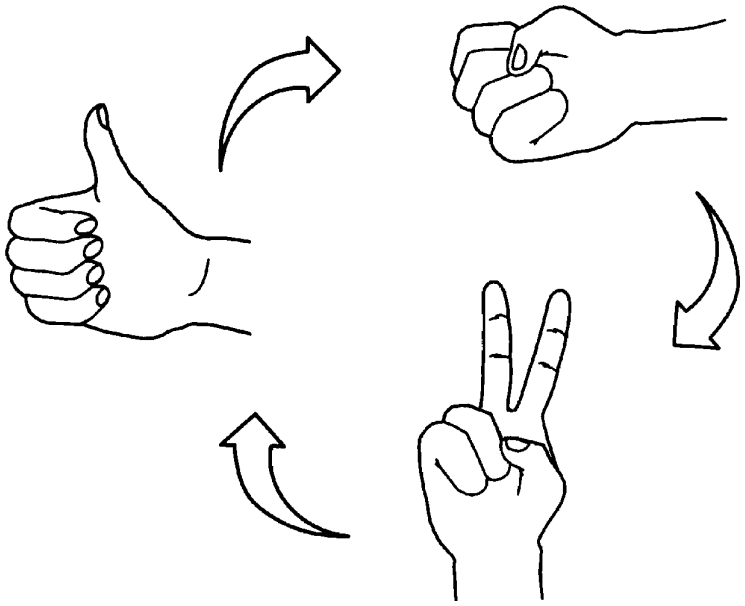
CP=continuous performance test; H3=three consecutive hand positions; FC=following commands; L=localising to pain; W=withdrawal to pain; PW=pathological withdrawal to pain (decorticate response); E=extensor response to pain (decerebrate response); NR=no response to pain.

are demonstrated to the patient who is then asked to perform the three hand positions (figure).

In patients who fail both these tests the best motor response is assessed. The possible motor responses are localisation to pain, withdrawal to pain, pathological withdrawal to pain, extensor response to pain, and no response using a standardised noxious stimulus such as nail bed compression.

We examined each patient neurologicalally and determined firstly whether the patients were not aphasic, not unwilling to cooperative with the study, and they had at least one upper limb strong enough to perform the necessary tasks. We performed a within and between observer study. Three neurologists, two junior neurology residents, and two neuroscience nurses participated. We studied 18 patients admitted to the neuroscience intensive care unit, comprising patients with postoperative craniotomies (n=13), subarachnoid haemorrhage (n=2), and head trauma (n=3). Because previous studies have extensively tested the reliability of abnormal motor responses, we tested six patients in each of the first three levels of the test scale.

After a brief instruction to the observers, the principal investigator (EFMW) performed the tests of the coma scales and repeated the tests



Drawing of the three hand position test (the cycle starts with thumbs up).

Table 2 Within rater agreement between first and second assessment

Rater	Percentage agreement	
	Test scale	Glasgow coma scale
Neurologist 1	75	81
Neurologist 2	81	88
Neurologist 3	81	88
Resident 1	75	88
Resident 2	96	81
Nurse 1	96	94
Nurse 2	87	80

three times in every patient. All six observers scored immediately after this assessment and the score of the principal investigator was included in the final evaluation. A second evaluation of the patient was done no sooner than one hour later. No mistake in the continuous performance test or consecutive hand position test in any of the three trials was scored as a positive response.

Using analysis of variance (ANOVA), the variability attributable to differences among subjects, among raters, and within raters was estimated. We computed the % agreement in replicate readings by the same rater and compared the means among types of raters. We compared agreement among raters, separately for first and second evaluations. The means of tabled entries (averaged over first and second evaluations) were computed. Reliability of the Glasgow coma score was evaluated in a similar fashion.

Results

The within rater agreement disclosed no major differences between the observers in the test scale. When compared to the Glasgow coma scale, the raters had slightly less consistency (table 2).

Tables 3 and 4 show the between rater agreement for both assessments for the test scale and Glasgow coma scale. The average agreements have comparable ranges for both scores, 65% to 89% for the test scale and 60% to 88% for the Glasgow coma scale. Of the overall variance, 89% was due to variability among subjects, 3% of the overall variance was due to variability among raters, and 8% was due to within rater variability. None of the patients had a negative hand position test and positive continuous performance test. On the first visit, 49% of all tests with a maximum Glasgow coma score had a negative continuous performance test as opposed to 13% of tests with a less than maximum Glasgow coma score, which were accompanied by a normal continuous performance test. For the consecutive hand position test, these numbers were respectively 25% and 2%.

Discussion

The Glasgow coma scale has become a routine monitoring scale in patients with neurological emergencies that impair consciousness. Other coma scales have been devised but only have complicated assessment by introducing more variables that may not influence diagnostic evaluation or management.[5 6] We introduce

Table 3 Test scale: between rater agreement

	Rater					
Rater	*Neurologist 1*	*Neurologist 2*	*Neurologist 3*	*Resident 1*	*Resident 2*	*Nurse 1*
Neurologist 2	82	—	—	—	—	—
Neurologist 3	85	85	—	—	—	—
Resident 1	83	76	85	—	—	—
resident 2	85	79	88	94	—	—
Nurse 1	83	74	80	89	86	—
Nurse 2	71	74	77	71	76	65

Table 4 Glasgow coma scale: between rater agreement

	Rater					
Rater	*Neurologist 1*	*Neurologist 2*	*Neurologist 3*	*Resident 1*	*Resident 2*	*Nurse 1*
Neurologist 2	71	—	—	—	—	—
Neurologist 3	82	71	—	—	—	—
Resident 1	68	68	68	—	—	—
resident 2	82	74	88	77	—	—
Nurse 1	80	71	71	85	83	—
Nurse 2	74	77	74	77	80	83

two new tools that monitor alertness (continuous performance test) and praxis (hand position test). Inability to perform these tests may indicate progressive impairment of consciousness or the development of a localised hemispheric lesion. The between and within rater agreement is good to excellent. The raters were slightly less consistent in the use of the test scale then in the use of the Glasgow coma scale. This difference may reflect previous experience with the Glasgow coma scale and first ever performance after a brief introduction of the test scale. The between rater agreement for both scales was similar.

Monitoring attentiveness in patients with a possible evolving acute neurological illness is of crucial importance. It is not likely that any technological device will be able to circumvent clinical neurological examination.

We found that within maximal Glasgow coma scores variations in wakefulness existed that can be detected by using a continuous performance test or the consecutive hand position test. This finding is important but not unexpected as in clinical practice the designation "following commands" is often superficially tested by asking a patient to squeeze a hand.

Our scale can be easily performed in intubated patients and patients with facial trauma, clinical situations that usually make the Glasgow coma scale less useful.

Our scale has inevitable limitations. Patients need to be literate and have reasonably good spelling skills. Alternatively, a series of random letters or numbers can be tried but the reliability of this simplification is not known. Not only does a standardised sentence improve consistency of testing but also it asks for more attention of the patient. Obviously, the scale, similar to the Glasgow coma scale, is of no value in patients with aphasia.

This is a preliminary study to determine the feasibility of using a continuous performance and a consecutive three hand position test in critically ill neurological patients. The relevance of the patient's performance in terms of prognosticating outcome within the same day of observation such as hour to hour fluctuation or a long term outcome in terms of neurologicalal recovery must be determined by a more detailed prospective study.

Our test may be a reasonable alternative to the Glasgow coma scale in patients with considerable facial trauma or on a mechanical ventilator, situations in which testing of alertness is very difficult using the Glasgow coma scale. Also it may prove useful in patients with fluctuating levels of consciousness and in alert patients at significant risk of deterioration.

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