Clinical Scales for Comatose Patients: The Glasgow Coma Scale in Historical Context and the New FOUR Score

Eelco F.M. Wijdicks, MD, PhD

Department of Neurology, Mayo Clinic, Rochester, MN

The Glasgow Coma Scale (GCS) has been the gold standard for assessing the level of consciousness in patients with significant brain injury. Prior efforts to modify or replace this scale have been unsuccessful because no scale could improve on its simplicity and practical usefulness. This review provides a historical perspective on coma scales and introduces a new and simple, but more comprehensive, scale: the Full Outline of UnResponsiveness (FOUR) Score, which has been recently validated. The FOUR Score has 4 components with "4" as a maximal score for each item. The individual components are eye responses (eye opening and eye tracking), motor responses (responses to pain and following simple hand commands), brainstem reflexes (pupil, cornea, and cough reflexes), and respiration (breathing rhythm and respiratory drive in ventilated patients). The FOUR Score is a further improvement on previous scales for classifying and communicating impaired consciousness.

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The assessment of comatose patients requires a comprehensive neurologic evaluation that includes a history provided by eyewitnesses, neurologic examination, and interpretation of laboratory, neuroimaging, and electrophysiologic tests. The key findings of the neurologic examination can be entered into practical scales that allow physicians to communicate with each other and with other healthcare workers. These so-called "coma scales" can also be used to facilitate data entry for clinical studies. Ideally, a coma scale would encapsulate the most important features of the unconscious state, and grading a patient over time would indicate changes in clinical condition. This information may predict outcome.

Currently, the Glasgow Coma Scale (GCS) is the standard coma scale. Since its introduction in 1974, the GCS has been used extensively and it has been difficult to devise a scale that is much better. Prior attempts to modify the GCS or to develop entirely new scales have not been successful, primarily because the GCS is an example of admirable simplicity. The scale was rapidly adopted by physicians other than neurologists and neurosurgeons. It has been incorporated into intensive care and trauma scoring systems to assess risk of in-hospital mortality.[1] The GCS sum score also became a marker for prognosis.

In this brief review, I compare the GCS with other coma scales and discuss a recently validated new scale, the Full Outline of UnResponsiveness (FOUR) Score, which I believe has advantages over the GCS.

Historical Development of Coma Scales

Coma scales originated in neurosurgical intensive care units. Charting neurologic status and physiologic functions at the bedside was common practice, but the need for a clinical tool prompted development of a grading system. Ommaya, a neurosurgeon at the National Institute of Neurological Diseases and Blindness in Bethesda, Maryland,[2] developed one of the earliest systems in 1966—a comprehensive scoring system called a "vital sign card" (Figure 1). It later became known as the Ommaya Coma Scale (Table 1). However, no published evidence suggests that the scale was used outside that institution.

In 1974, Teasdale and Jennett[1] published "Assessment of coma and impaired consciousness: a practical scale," which was a "spin-off" of the National Institutes of Health–sponsored international studies on

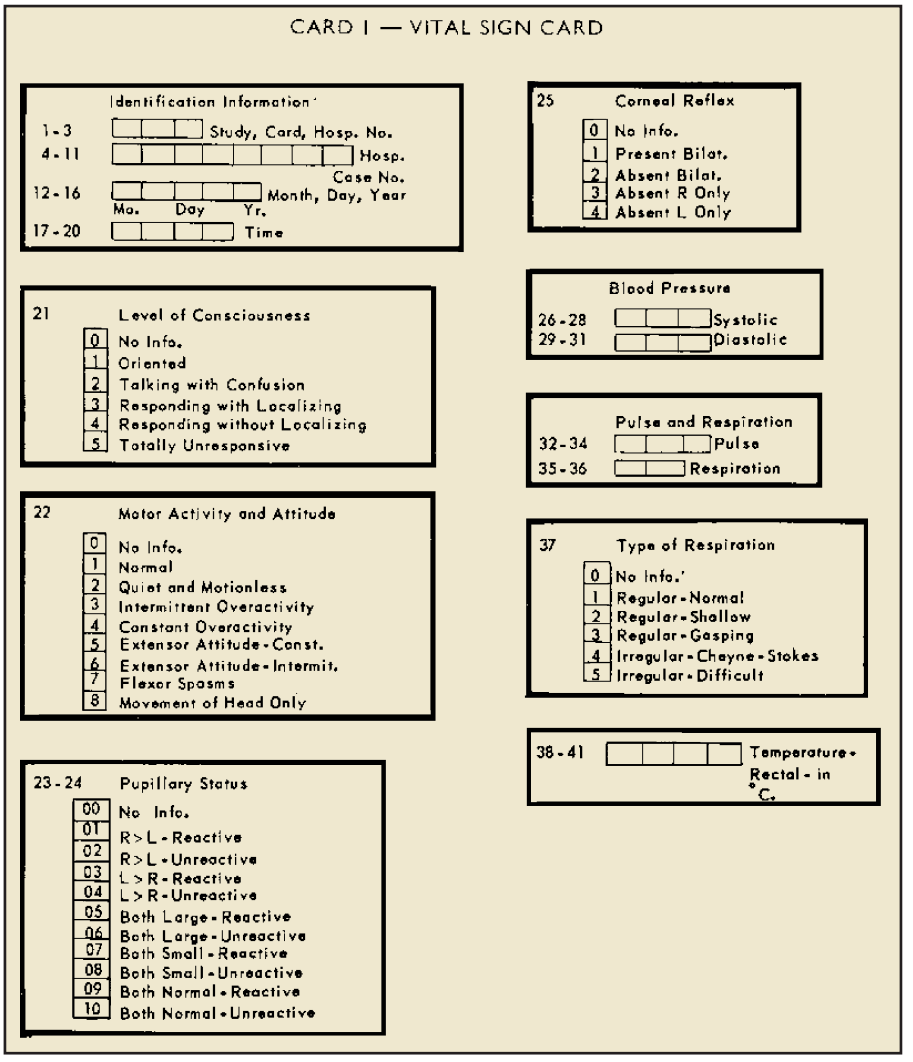

Figure 1. *Ommaya's vital sign card. Reprinted with permission from Ommaya AK.*[2]

coma and prognosis of severe head injury (Figure 2A). The first version of this scale was known initially as the Coma Index but soon became known as the Glasgow Coma Score, for the home of the authors' institution. The GCS was constructed mainly to improve communication between physicians and nurses when describing different states of impaired consciousness and to avoid ambiguous designations such as "somnolence" and "unresponsiveness."[1,3,4]

To provide a tool for repeated measurements that could be charted hourly at the bedside and to "restrict routine observations to the minimum," Teasdale and Jennett excluded certain tests from the scale (eg, brainstem reflexes) that they believed would be difficult for "inexperienced junior doctors or nurses" to perform or interpret.[1] The GCS, therefore, assessed only motor, verbal, and eye responses. Teasdale and Jennett's reasoning for the use of these 3 components was as follows:

- Motor responses: "The case with which motor responses can be

Table 1
Ommaya Coma Scale

Level	
1	Patient is oriented in time and place and is recording ongoing events, ie, the state of normal consciousness is defined operationally.
2	Patient is talking and/or obeying commands but is disoriented and not recording ongoing events.
3	Patient is responding to stimuli with correct localization ("purposeful") but not obeying commands.
4	Patient is responding to stimuli without localization, ie, "nonpurposeful," reflex, or "decerebrate" response only.
5	Patient is totally unresponsive to all stimuli.

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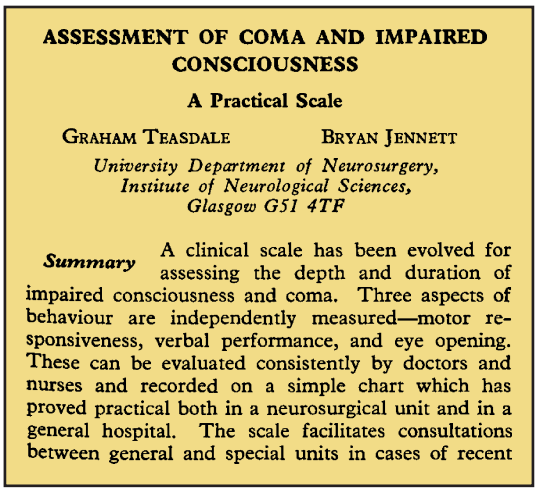

ASSESSMENT OF COMA AND IMPAIRED CONSCIOUSNESS

A Practical Scale

GRAHAM TEASDALE BRYAN JENNETT

University Department of Neurosurgery, Institute of Neurological Sciences, Glasgow G51 4TF

Summary A clinical scale has been evolved for assessing the depth and duration of impaired consciousness and coma. Three aspects of behaviour are independently measured—motor responsiveness, verbal performance, and eye opening. These can be evaluated consistently by doctors and nurses and recorded on a simple chart which has proved practical both in a neurosurgical unit and in a general hospital. The scale facilitates consultations between general and special units in cases of recent

Figure 2A. *Original paper introducing a new coma scale (later known as the Glasgow Coma Scale). Reprinted with permission from Teasdale G and Jennett B.[1] Abridged cover page, reprinted with permission.*

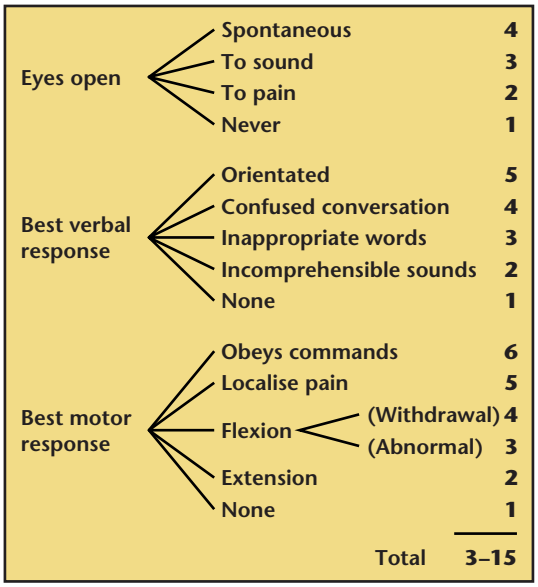

Figure 2B. *Modification of the Glasgow Coma Scale showing assignment of numbers to responses and expansion of motor responses. Reprinted with permission from Teasdale G and Jennett B.[5]*

elicited in the limbs, together with the wide range of different patterns which can occur, makes motor activity a suitable guide to the functioning state of the central nervous system."

- Verbal responses: "Probably the commonest definition of the end of coma, or the recovery of consciousness, is the patient's first understandable utterance."
- Eye responses: "Spontaneous eye opening, with sleep/wake rhythms, is most highly scored on this part of the scale, and it indicates that the arousal mechanisms in the brainstem are active."

The GCS was initially an unnumbered system. The practice of assigning a number to the responses (using "1" for the lowest score rather than "0") was introduced in a later article that also expanded the motor responses, adding abnormal flexion (Figure 2B).[5] Although users of the GCS began creating sum scores for the 3 components (giving a total range of 3 to 15 points), this method was never the intention of the originators of the scale: ". . . while we do not favour its use in day-to-day clinical practice, we find no reason to doubt that it will continue to be used widely in the analysis and reporting of a series of patients with head injury or other forms of acute brain damage."[6] Specific GCS sum scores such as 3, 8, and 15 now have immediate familiarity; use of the sum scores even led to the commonly used slogan, "Glasgow 8, intubate." The GCS became adopted by most European countries, and, through the ambassadorial work of neurosurgeon Langfitt, an accepted scale in the United States.

Critique of the GCS

Despite its broad acceptance, however, the GCS did not escape criticism.

First, the score is skewed toward the motor part of the scale (6 items versus 4 for eyes and 5 for verbal). Second, the verbal component of the GCS is unusable in intubated patients. Several techniques and mathematical models have been investigated to circumvent this problem. One technique is pseudoscoring, adding the average value of the motor and eye score to the sum in place of the missing verbal score.[7] Another study using a linear regression model found that the predicted verbal response correlated well with the actual verbal score, but its use in practice remains questionable and the model is limited to patients with high GCS sum scores[8] and nonintubated patients.[9] Making up values in a scale appears contrived and sidesteps the problem with the verbal component; it also may result in triage with inaccurate GCS scores. In clinical practice, most institutions substitute T (for "tube"), but it is not clear how sum scores can be calculated using this substitution. More recently, the same group that suggested a linear regression model for the verbal score proposed using only the motor component of the GCS in trauma patients.[10] These attempts over the years to modify or simplify the GCS are indicative of dissatisfaction with its use in patients with severe brain injury.

In addition, when tested, physicians' knowledge of the GCS is marginal. On average, when asked to name the individual scale components, physicians could identify 3 of the 4 possible eye responses, 3 of the 6 motor responses, and 2 of the 5 verbal responses. Approximately half of the neurologists and internists did not accurately name the verbal response.[11] In a critical review, 2 neuroscience nurses stated, "correcting the deficiencies of the Glasgow Coma Score will enhance its discriminatory power, internal consistency, and logically should result in more speedy diagnosis and treatment and ultimately better outcome."[3]

Table 2
Edinburgh-2 Coma Scale (E2 CS)

Stimulation (Maximum)	Response (Best)	Score
Two sets of questions:	Answers correctly to both	0
1. Month?	Answers correctly to either	1
2. Age?	Incorrect	2
Two sets of commands:	Obeys correctly to both	3
1. Close and open hand.	Obeys correctly to either	4
2. Close and open eyes.	Incorrect	5
Motor Response: Strong pain	Localizing	6
	Flexion	7
	Extension	8
	No response	9

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Alternative Coma Scales

Other groups believed that remedying the GCS could only succeed by replacing it with a new scale. Interestingly, a group at Edinburgh University devised a separate scale. After the scale had been used by the Department of Surgical Neurology, it was further developed by a Japanese team into the Edinburgh-2 Coma Scale (E2 CS) (Table 2).[12] The E2 CS scale combined sets of commands and orientation to month and age, and used a pain stimulus grading 4 possible motor responses. This scale

Table 3
Glasgow-Liege Scale (GLS)

GLS Score and the Presence of the Following Brainstem Reflexes:	Points
Fronto-orbicular*	5
Vertical oculovestibular†	4
Pupillary light	3
Horizontal oculovestibular†	2
Oculocardiac‡	1
No response	0

*The reflex is considered present when percussion of the glabella produces contraction of the orbicularis oculi muscle.
†Deviation of at least 1 eye is induced by repeated flexion and extension (vertical) or horizontal neck movement (horizontal). If the cervical spine is immobilized, an attempt is made to elicit ocular motion by simultaneous external auditory canal irrigation using iced water.
‡Pressure on the eyeball causes the heart rate to slow.
Reprinted with permission from Born JD.[13]

Table 4
Pittsburgh Brain Stem Score (PBSS)

Brain Stem Reflex	Finding	Points
Lash reflex	Present either side	2
	Absent both sides	1
Corneal reflex	Present either side	2
	Absent both sides	1
Doll's eye and/or ice water calorics	Present either side	2
	Absent both sides	1
Right pupil reaction to light	Present	2
	Absent	1
Left pupil reaction to light	Present	2
	Absent	1
Gag and/or cough reflex	Present	2
	Absent	1

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rapidly became obsolete but claimed more sensitivity than the GCS regarding the patient's ability to follow commands.

In Belgium, the GCS was modified into the Glasgow-Liege Scale (Table 3).[13] It added a set of tests of brainstem responses that may disappear when the brainstem loses its function in a rostrocaudal direction. This scale's usefulness in the clinical study of herniation syndromes has not been systematically studied. In the United States, another derivative scale incorporating brainstem reflexes was introduced and became known as the Pittsburgh Brain Stem Score (PBSS) (Table 4).[14]

The most comprehensive coma scale, the Comprehensive Level of Consciousness Scale (CLOCS), was developed by the Department of Neurosurgery of the University of Tennessee Health Sciences Center.[15] CLOCS included posture (5 options), eye positioning at rest (67 options), spontaneous eye opening (5 options), general motor functioning (27 options), abnormal ocular movements (76 options), pupillary light reflexes (8 options), general responsiveness (1 option), and best communicative effort (8 options). This instrument was more sensitive than the GCS but too comprehensive to be useful in a clinical practice.

In Europe, other serious challenges to the GCS failed, except in Sweden, which adopted the Reaction Level Scale (RLS85) (Table 5).[16] The RLS85 categorized patients as alert, drowsy or confused, very drowsy or confused, or unconscious, with all categories followed by specific motor responses. The RLS85 demonstrated greater accuracy than the GCS; however, a strong correlation was found between the RLS85 and the GCS. The Innsbruck Coma Scale included brainstem reflexes and eliminated the verbal response (Table 6).[17] This retrospective study showed that the scale had greater predictive power for mortality than did the GCS. However, all of these alternative scales rarely emerged in publications outside the institution or country where they originated.

An Ideal Coma Scale

An instrument that measures different depths of coma should fulfill certain criteria. An ideal coma scale should be reliable, valid, easy to use, easy to remember, and an indicator of patient outcome. Raters who personally examine patients can test the accuracy (measuring what the test is supposed to measure) of a scale. Rating patients by watching videotapes or by having a rater perform the test

Table 5
Reaction Level Scale (RLS85)

Level	
1	Alert; no delay in response
2	Drowsy or confused; responsive to strong stimulation
3	Very drowsy or confused; responsive to strong stimulation
4	Unconscious; localizes but does not ward off pain
5	Unconscious; withdrawing movements on pain stimulation
6	Unconscious; stereotype flexion movement on pain stimulation
7	Unconscious; stereotype extension movements on pain stimulation
8	Unconscious; no response to pain stimulation

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Table 6
Innsbruck Coma Scale

Neurological Assessment	Score	Neurological Assessment	Score
Reaction to acoustic stimuli		*Pupil size*	
Turning towards stimuli	3	Normal	3
Better-than-extension movements	2	Narrow	2
Extension movements	1	Dilated	1
None	0	Completely dilated	0
Reaction to pain		*Pupil responses to light*	
Defensive movements	3	Sufficient	3
Better-than-extension movements	2	Reduced	2
Extension movements	1	Minimum	1
None	0	No response	0
Body posture		*Position and movements of eyeballs*	
Normal	3	Fixing with eyes	3
Better-than-extension movements	2	Sway of eyeballs	2
Extension movements	1	Divergent	1
Flaccid	0	Divergent fixed	0
Eye opening		*Oral automatisms*	
Spontaneous	3	Spontaneous	2
To acoustic stimuli	2	To external stimuli	1
To pain stimuli	1	None	0
None	0		

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while bystanders grade the test will not mimic daily practice. The raters must be healthcare personnel who are expected to manage or care for coma patients and communicate their findings with each other.

Experience with the use of a scale matters; however, in order for a new scale to be adopted, it should be easy to use (ie, no additional cards or tools). The scale should be useful in a wide variety of patients with acute neurologic disease, not exclusively those with traumatic brain injury. The scale should have few limitations (eg, medical interventions that would make assessment of certain components unreliable). The scale should discourage the common practice of "pseudoscoring" or making an "educated guess" (to expect a certain response in a certain patient). It also should be easy to memorize all components of the scale. The scale should have internal consistency (eg, when a component changes, parallel changes should be seen in other components). Finally, the scale should have sufficient value in predicting outcome. Lower scores on the scale may indicate higher chance of in-hospital mortality or future disability.

The degree to which a clinical neurologic examination should be abstracted into a coma scale remains arbitrary. A complicated scale with multiple testable components would certainly provide great detail, but it is not practical and would most likely be abandoned quickly. Conversely, a scale that is too simple and offers too little information would not provide enough accuracy to monitor change. A new coma scale will have to trade off sensitivity against a false-positive rate and will require testing in a prospective study with sufficient statistical power. However, any coma scale becomes less effective when major confounders are present. Confounders may occur in verbal responses (aphasia, dementia or developmental disorder, tracheostomy, inability to comprehend language), eye responses (ocular trauma, periorbital edema), brainstem reflexes (sedatives, neuromuscular junction blockers), motor response (spinal cord injury, limb injury), or respiration (pulmonary edema, aspiration, ventilator settings).

Proposal for a New Coma Scale

Examination of the comatose patient requires a comprehensive clinical assessment, which includes observation of responses to stimuli, interpretation of spontaneous eye, facial, and limb movements, and determination of muscle tone and tendon reflexes. Because brainstem function is impaired with any type of brain herniation syndrome, it is important for a scale to include presence or absence of brainstem function that incorporates the mesencephalon, pons, and medulla oblongata.

In our new coma scale, my colleagues and I decided to include eye responses (not only eye opening but also the assessment of voluntary horizontal and vertical eye movements), motor responses (added myoclonus status epilepticus as the most important spontaneous movements and added a complex command to test alertness and praxis), brainstem reflexes (concentrating on 3 reflexes

that measure parts of mesencephalon, pons, and medulla function), and respiration (identifying spontaneous breathing and breathing patterns before or after intubation).

Gaze preference and spontaneous nystagmus are difficult for non-neuroscientists to judge, and their value for prognosis is unclear. The same is true for other findings such as tone, asterixis, or other spontaneous movements. Oculocephalic responses should be discouraged as a monitoring tool, particularly in patients with head injury and possible cervical spine injury. There is good reason for the elimination of the verbal response from the scale: it decreases error due to aphasia (although following commands would remain untestable) and prior studies have found considerable difficulty with the validity of the verbal response.[18] The best argument for not including the verbal response is that a large proportion of patients with stupor or coma are intubated.

The new coma scale is named the FOUR Score (Figure 3).[19] The FOUR Score has 4 testable components (E, eye responses; M, motor responses; B, brainstem reflexes; and R, respiration) in contrast to 3 components of the GCS (Figure 2B). Although 5 different scores are possible for each component (0 to 4), the maximal grade is 4 in each (E4, M4, B4, R4). The motor category includes the presence of myoclonus status epilepticus (persistent multisegmental arrhythmic, jerk-like movements), which is a poor prognostic sign after cardiac resuscitation.[20] The motor component combines decorticate and withdrawal responses because the difference between the 2 responses is often difficult to appreciate. The hand position tests (thumbs-up, fist, and peace sign) have been validated before and are reliable for assessing alertness.[19,21] Three brainstem reflexes testing mesencephalon, pons, and medulla oblongata function are used in different combinations. The clinical sign of acute third-nerve dysfunction (unilateral dilated pupil) is included. The cough reflex is usually absent when both corneal and pupillary reflexes are absent. Breathing patterns are also graded. Cheyne-Stokes respiration and irregular breathing can indicate bihemispheric or lower brainstem dysfunction of respiratory control. In intubated patients, overbreathing the mechanical ventilator represents functioning respiratory centers.

Validation of the FOUR Score

To maximize the predictive power of the FOUR Score and to study agreement between healthcare workers who actually examine comatose patients, my colleagues and I devised an interobserver variability study of 120 patients.[16] This was the largest validation study of a coma scale. The inter-rater reliability of the FOUR Score and the GCS were of equivalent magnitude, both with a κ_w (weighted kappa statistic) of 0.82, indicating excellent agreement. However, compared with the GCS, the inter-rater agreement for the FOUR Score was higher in patients who were drowsy, stuporous, or comatose. Neuroscience nurses, neurointensivists, and neurology residents were able to master the rating of the components of the FOUR Score quickly and accurately after only a brief introduction.

Most remarkable in our study was that 25 different scores of the FOUR Score could be identified in the subset of patients with a GCS sum score of 3. These different scores were mainly provided by the brainstem and respiration components. In addition, the probability of in-hospital mortality was higher for the lower total score of the FOUR Score when compared with the GCS; the score for risk of in-hospital mortality was close to zero with a FOUR Score sum score of >12 (compared with a GCS score of >8).

The validation study, however, was performed exclusively with neuroscience practitioners and nursing staff. A study comparing non-neuroscience nurses with neuroscience nurses and differences in years of experience has recently been completed. An emergency department validation of the FOUR Score is under way.

Arguments for a New Coma Scale

Is a new coma scale needed or is it just another futile attempt to replace the GCS? Should the GCS be abandoned? Would there be a positive reception to a new scale or would most neurologists and neurosurgeons still use the GCS after the initial enthusiasm for the new test waned? The GCS has weathered substantial criticism. No challenges to the GCS have occurred in the last 15 years; it has certainly "withstood the test of time."[22]

However, studies of our new scale, the FOUR Score, have shown that inclusion of brainstem reflexes and respiration patterns is taught quickly, although interpretation may be subject to education and experience. I believe the FOUR Score could be implemented in neurosurgical intensive care units and tested further. There are good arguments for its use. The FOUR Score requires very little training, provides greater neurologic detail than the GCS, is simple to use, and recognizes possible brain death, allowing for possible organ donation. It recognizes a locked-in syndrome, uncal herniation, and the need for immediate medical or surgical intervention. Use of the FOUR Score forces the physician to do a more thorough coma examination, and it

MAYO CLINIC

FOUR Score

Eye Response

4 Eyelids open or opened, tracking or blinking to command

3 Eyelids open but not tracking

2 Eyelids closed but opens to loud voice

1 Eyelids closed but opens to pain

0 Eyelids remain closed with pain

Motor Response

4 Thumbs up, fist, or peace sign to command

3 Localizing to pain

2 Flexion response to pain

1 Extensor posturing

0 No response to pain or generalized myoclonus status epilepticus

Brainstem Reflexes

4 Pupil and corneal reflexes present

3 One pupil wide and fixed

2 Pupil or corneal reflexes absent

1 Pupil and corneal reflexes absent

0 Absent pupil, corneal, and cough reflex

Respiration

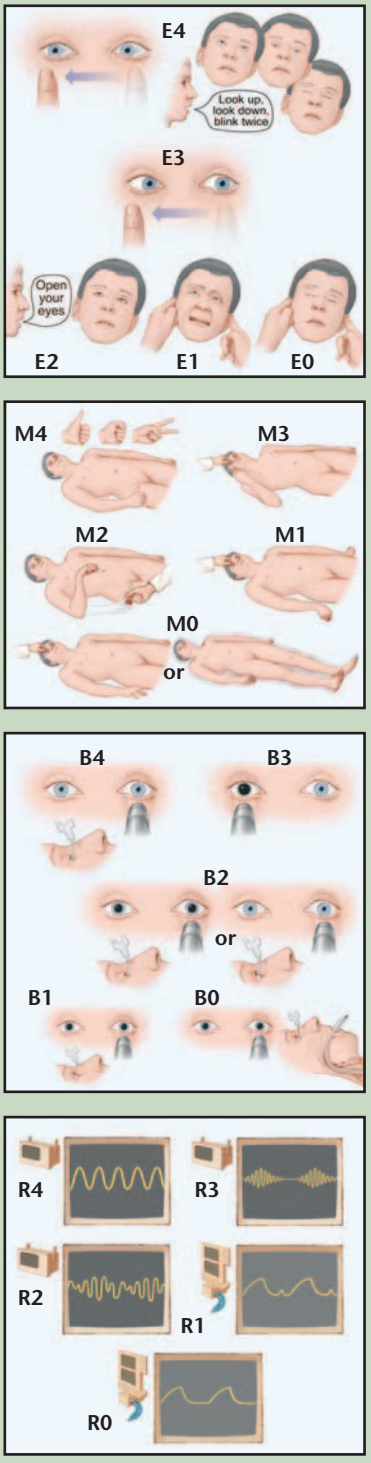
4 Not intubated, regular breathing pattern

3 Not intubated, Cheyne-Stokes breathing pattern

2 Not intubated, irregular breathing pattern

1 Breathes above ventilator rate

0 Breathes at ventilator rate or apnea



Instructions for the Assessment of the Individual Categories of the FOUR Score

Eye Response (E)

Grade the best possible response after at least 3 trials in an attempt to elicit the best level of alertness. A score of **E4** indicates at least 3 voluntary excursions. If eyes are closed, the examiner should open them and examine tracking of a finger or object. Tracking with the opening of 1 eyelid will suffice in cases of eyelid edema or facial trauma. If tracking is absent horizontally, examine vertical tracking. Alternatively, 2 blinks on command should be documented. This will recognize a locked-in syndrome (patient is fully aware). A score of **E3** indicates the absence of voluntary tracking with open eyes. A score of **E2** indicates eyelids opening to loud voice. A score of **E1** indicates eyelids open to pain stimulus. A score of **E0** indicates no eyelids opening to pain.

Motor response (M)

Grade the best possible response of the arms. A score of **M4** indicates that the patient demonstrated at least 1 of 3 hand positions (thumbs-up, fist, or peace sign) with either hand. A score of **M3** indicates that the patient touched the examiner's hand after a painful stimulus compressing the temporomandibular joint or supraorbital nerve (localization). A score of **M2** indicates any flexion movement of the upper limbs. A score of **M1** indicates extensor posturing. A score of **M0** indicates no motor response or myoclonus status epilepticus.

Brainstem reflexes (B)

Grade the best possible response. Examine pupillary and corneal reflexes. Preferably, corneal reflexes are tested by instilling 2-3 drops of sterile saline on the cornea from a distance of 4-6 inches (this minimizes corneal trauma from repeated examinations). Cotton swabs can also be used. The cough reflex to tracheal suctioning is tested only when both of these reflexes are absent. A score of **B4** indicates pupil and cornea reflexes are present. A score of **B3** indicates one pupil wide and fixed. A score of **B2** indicates either pupil or cornea reflexes are absent, **B1** indicates both pupil and cornea reflexes are absent and a score of **B0** indicates pupil, cornea, and cough reflex (using tracheal suctioning) are absent.

Respiration (R)

Determine spontaneous breathing pattern in a nonintubated patient, and grade simply as regular **R4**, Cheyne-Stokes **R3**, or irregular **R2** breathing. In mechanically ventilated patients, assess the pressure waveform of spontaneous respiratory pattern or the patient triggering of the ventilator **R1.** The ventilator monitor displaying respiratory patterns is used to identify the patient generated breaths on the ventilator. No adjustments are made to the ventilator while the patient is graded, but grading is done preferably with PaCO2 within normal limits. A standard apnea (oxygendiffusion) test may be needed when patient breathes at ventilator rate **R0.**

Figure 3. *The FOUR Score. E4, eyelids open or opened, tracking or blinking to command; E3, eyelids open but not tracking; E2, eyelids closed but open to loud voice; E1, eyelids closed but open to pain; E0, eyelids remain closed with pain; M4, thumbs-up, fist, or peace sign; M3, localizing to pain; M2, flexion response to pain; M1, extension response; M0, no response to pain or generalized myoclonus status; B4, pupil and cornea reflexes present; B3, one pupil wide and fixed; B2, pupil or cornea reflexes absent; B1, pupil and cornea reflexes absent; B0, absent pupil, cornea, and cough reflex; R4, not intubated, regular breathing pattern; R3, not intubated, Cheyne-Stokes breathing pattern; R2, not intubated, irregular breathing; R1, breathes above ventilator rate; R0, breathes at ventilator rate or apnea. Reprinted with permission from Wijdicks EF et al.*[19]

provides information that may be of great use in prospective clinical trials that involve stuporous and comatose patients. The sum scores of the FOUR Score would be 0 (brain death is possible) and 16 (fully alert, intact brainstem reflexes, and normal respiration), although I would not encourage using sum scores. A 1-point decrease in any of the components has significant clinical relevance.

Anyone challenging established methods must confront the more important question of whether the new scale will change practice. The FOUR Score improves communication. Decisions on the care of comatose patients can only be made after the physician amasses the most pertinent neurologic details. I believe the FOUR Score will provide those details. ■

[FOUR Score pocket cards can be obtained by contacting the author at: Wijde@mayo.edu]

References

1. Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. *Lancet*. 1974;2:81-84.
2. Ommaya AK. Trauma to the nervous system. *Ann R Coll Surg Engl*. 1966;39:317-347.
3. Segatore M, Way C. The Glasgow Coma Scale: time for change. *Heart Lung*. 1992;21:548-557.
4. Sternbach GL. The Glasgow Coma Scale. *J Emerg Med*. 2000;19:67-71.
5. Teasdale G, Jennett B. Assessment and prognosis of coma after head injury. *Acta Neurochir (Wien)*. 1976;34:45-55.
6. Teasdale G, Jennett B, Murray L, Murray G. Glasgow coma scale: to sum or not to sum (correspondence). *Lancet*. 1983;2:678.
7. Grahm TW, Williams FC, Harrington T, Spetzler RF. Civilian gunshot wounds to the head: a prospective study. *Neurosurgery*. 1990;27: 696-700.
8. Rutledge R, Lentz CW, Fakhry S, Hunt J. Appropriate use of the Glasgow Coma Scale in intubated patients: a linear regression prediction of the Glasgow verbal score from the Glasgow eye and motor scores. *J Trauma*. 1996;41: 514-522.
9. Meredith JW, Rutledge R, Fakhry S, et al. The conundrum of the Glasgow Coma Scale in intubated patients: a linear regression prediction of the Glasgow verbal score from the Glasgow eye and motor scores. *J Trauma*. 1998;44: 839-845.
10. Healey C, Osler TM, Rogers FB, et al. Improving the Glasgow Coma Scale score: motor score alone is a better predictor. *J Trauma*. 2003; 54:671-678.
11. Riechers RG, Ramage A, Brown W, et al. Physician knowledge of the Glasgow Coma Scale. *J Neurotrauma*. 2005;22:1327-1334.
12. Sugiura K, Muraoka K, Chishiki T, Baba M. The Edinburgh-2 coma scale: a new scale for assessing impaired consciousness. *Neurosurgery*. 1983;12:411-415.
13. Born JD. The Glasgow-Liege Scale. Prognostic value and evolution of motor response and brain stem reflexes after severe head injury. *Acta Neurochir (Wien)*. 1988;91:1-11.
14. Brain Resuscitation Clinical Trial II Study Group. A randomized clinical study of a calcium-entry blocker (lidoflazine) in the treatment of comatose survivors of cardiac arrest. *N Engl J Med*. 1991;324:1225-1231.
15. Stanczak DE, White JG 3rd, Gouview WD, et al. Assessment of level of consciousness following severe neurological insult. A comparison of the psychometric qualities of the Glasgow Coma Scale and the Comprehensive Level of Consciousness Scale. *J Neurosurg*. 1984;60:955-960.
16. Starmark JE, Stalhammar D, Holmgren E. The Reaction Level Scale (RLS85). Manual and guidelines. *Acta Neurochir (Wien)*. 1988;91: 12-20.
17. Benzer A, Mitterschiffthaler G, Marosi M, et al. Prediction of non-survival after trauma: Innsbruck Coma Scale. *Lancet*. 1991;338:977-978.
18. Diringer MN, Edwards DF. Does modification of the Innsbruck and the Glasgow Coma Scales improve their ability to predict functional outcome? *Arch Neurol*. 1997;54:606-611.
19. Wijdicks EF, Bamlet WR, Maramattom BV, et al. Validation of a new coma scale: the FOUR score. *Ann Neurol*. 2005;58:585-593.
20. Wijdicks EF, Young GB. Myoclonus status in comatose patients after cardiac arrest. *Lancet*. 1994;343:1642-1643.
21. Wijdicks EF, Kokmen E, O'Brien PC. Measurement of impaired consciousness in the neurological intensive care unit: a new test. *J Neurol Neurosurg Psychiatry*. 1998;64:117-119.
22. Rush C. The history of the Glasgow Coma Scale: an interview with professor Bryan Jennett. Interview by Carole Rush. *Int J Trauma Nurs*. 1997;3:114-118.

Main Points

- The assessment of comatose patients includes the key findings of a neurologic examination, which can be entered into a practical scale such as the Glasgow Coma Scale (GCS), the standard coma scale for assessing the level of consciousness in patients with significant brain injury.
- The GCS assesses the motor, verbal, and eye responses of comatose patients and was constructed mainly to improve communication between physicians and nurses when describing different states of impaired consciousness and to avoid ambiguous designations.
- Despite broad acceptance for its simplicity and practical usefulness, the GCS has been criticized for being skewed toward the scale's motor response component and for the fact that the verbal component is unusable in intubated patients. Over the years, alternative scales have been developed but have rarely emerged in publications outside the institution or country where they originated.
- However, a new and simple scale that is more comprehensive than the GCS has recently been validated, the Full Outline of Unresponsiveness (FOUR) Score, which has 4 testable components (eye responses, motor responses, brainstem reflexes, and respiration) with 5 possible scores for each component.
- The FOUR Score requires very little training, provides greater neurologic detail than the GCS, is simple to use, and recognizes possible brain death, allowing for possible organ donation. It forces the physician to do a more thorough coma examination, and provides information that may be of great use in prospective clinical trials.