Quantifying consciousness

In 1974, Teasdale and Jennett’s Glasgow coma scale (GCS) was published in The Lancet. This standardised bedside tool to quantify consciousness became a medical classic. Despite its indisputable worldwide success it has also been criticised. Several investigators disagree that scoring eye opening is sufficiently indicative of activity in brainstem arousal systems and have proposed coma scales that include brainstem reflexes, such as the comprehensive level of consciousness scale, the clinical neurologic assessment tool, the Bouzarth coma scale, and the Maryland coma scale. None of these scales have known widespread use because they generally are more complex than the Glasgow coma scale. A simpler system, the Glasgow Liège scale, combined the Glasgow coma scale with five brainstem reflexes but also failed to convince the medical community outside its country of origin. Another shortcoming of the Glasgow coma scale is that the increasing use of intubation has rendered its verbal component immeasurable in many patients in coma. A Swedish team, therefore, developed the reaction level scale, which does not include a verbal response criterion but combines different responses into an ordinal eight-graded scale. Outside of Sweden, however, the use of this scale remains very limited. The Glasgow coma scale also lacks reliability when assessing patients progressively recovering from their coma and entering a vegetative or minimally conscious state. For these patients, more sensitive scales are the coma recovery scale-revised, sensory modality assessment and rehabilitation technique, or Wessex head injury matrix. These scales, however, are not adapted for use in acute settings.

Wijdicks and colleagues think it is time for a change and have proposed a new coma scale: the full outline of unresponsiveness (FOUR). This acronym reflects the number of components tested (eye, motor, brainstem, and respiratory functions) and the maximum score assigned to each of these (E4, M4, B4, and R4). The researchers tested 120 patients in intensive care and compared FOUR scores made by neurology residents, neurointensivists, and neuroscience nurses with scores using the Glasgow coma scale. Their scale explicitly tests for eye movements or blinking on command—requesting to open eyes manually if closed. This test facilitates the early detection of locked-in syndrome and is very much welcomed, given that recent studies have shown that medical carers did not recognise signs of consciousness during the first weeks in more than half of patients with locked-in syndrome. Unlike the
Glasgow coma scale, FOUR also tests for eye tracking of a moving object. Most commonly, this is the first sign heralding the transition from a vegetative to a minimally conscious state. The rest of the FOUR’s E-score is identical to that of the Glasgow coma scale.

Most innovative is the hand-position test, in which patients are asked to make thumbs-up, fist, or peace signs. This is a smart alternative to the V-score of the Glasgow coma scale and remains testable in intubated patients. The rest of the M-score is taken from the Glasgow coma scale, with the exception that no difference is made between abnormal stereotyped flexion and normal flexion to pain (similar to the early version of the Glasgow coma scale). This difference may be difficult for inexperienced observers to appreciate but might lead to lower prognostic power of the FOUR scale. Generalised myoclonic status epilepticus, which is a sign of poor prognosis in anoxic coma, is scored the same as absent motor response to pain.

Amending the Glasgow coma scale’s lack of brainstem-reflexes assessment, FOUR tests pupil, cornea, and cough reflexes and separately scores respiration. For untrained users, evaluation of the brainstem component is probably the most complex because it proposes different combinations of the presence or absence of each of its three reflexes. Unilateral fixed midriasis, alerting uncal herniation, has a separate score. To avoid corneal trauma by repeated testing, it is cleverly proposed to instil some drops of saline on the cornea. The last category of FOUR scores respiration as spontaneous regular, irregular, Cheyne-Stokes, ventilator-assessed patient-generated breaths, or absent. Whether pulmonary disease and respiratory settings will bias the assessment and how reliably inexperienced users can separate Cheyne-Stokes from irregular respiration are unknown. With all FOUR categories graded zero, the scale alerts to consider brain death or standard apnoea (oxygen-diffusion) testing.

In the past 30 years, many coma scales have been proposed as an alternative to the Glasgow coma scale, but none with success. Not all change is an improvement, but there can be no improvement without change. Do we need another coma scale? The answer depends on who uses it, where it is used, and why it is used. Is it used for clinical diagnosis, assessment of neurological change, prognosis, guiding interventional decisions, or research purposes? The validity of this new scale first needs to be corroborated when used in a general hospital setting by examiners other than neuroscience professionals. By virtue of its simplicity, and despite its drawbacks, the Glasgow coma scale became the most universally used and validated consciousness scale worldwide. More than 4500 publications make reference to its use (figure) and it is part of many other scoring systems including the acute physiology and chronic health evaluation II score. Albeit convinced of the utility of FOUR, the Glasgow coma scale will not be dethroned effortlessly.

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