

# Cheerio, Laddie! Bidding Farewell to the Glasgow Coma Scale

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## INTRODUCTION

It is time to abandon the Glasgow Coma Scale (GCS). As discussed below, this ubiquitous neurologic scoring system is confusing, unreliable, and unnecessarily complex, and its manner of common clinical use is statistically unsound.

Teasdale and Jennett devised the GCS in 1974 not for acute care, but rather for the “repeated bedside assessment” in a neurosurgical unit to detect “changing states” of consciousness and to measure the “duration of coma.”<sup>1</sup> They never intended for its elements to be assigned numeric scores or for its 3 subscales to be merged or totaled. Yet, despite their objections<sup>2</sup> both such dubious modifications subsequently proved irresistible to the medical community.

The quantitative GCS subsequently has become the undisputed universal criterion standard for mental status assessment and is thus a fundamental part of the culture of emergency medicine, out-of-hospital care, trauma surgery, and neurosurgery.<sup>3-7</sup> This scale is a core component of prominent trauma and life support courses,<sup>4-7</sup> and in most of the developed world out-of-hospital care providers routinely assess the GCS for each patient with trauma or altered mental status.<sup>3-5</sup> The original GCS article has been cited almost 6,000 times.

This editorial outlines the potent limitations of the GCS and why it should now be considered obsolete within acute care medicine. This scale might be useful, however, for detecting subtle neurologic changes over time in an ICU (as originally envisaged). Curiously, though, it has never been validated for this separate role.

## PROBLEMS WITH THE GCS

The advantages of the GCS are that it has face validity, wide acceptance, and established statistical associations with adverse neurologic outcomes, including brain injury, neurosurgical intervention, and mortality.<sup>3,8,9</sup> However, these are offset by several important limitations.

The GCS isn't reliable. To be accurate and useful, a clinical scale must be reproducible. Unfortunately, the GCS contains

multiple subjective elements (Figure) and has repeatedly demonstrated surprisingly low interrater reliability in a variety of settings.<sup>3,10-18</sup> In a study of independent paired assessments by attending emergency physicians, for example, GCS scores were the same in just 38% and were 2 or more points apart in 33%.<sup>10</sup> Thus, the underlying precision of this tool is overstated by its 13 possible gradations, and any reported value should be considered as having an error margin of multiple adjacent points. The reliability of the GCS is further compromised in tracheally intubated patients because verbal response can no longer be evaluated.

The GCS is not consistently remembered. To be accurately and consistently applied, a clinical scale must be easy to use and remember. The GCS is widely perceived as complicated<sup>14,19-25</sup> and takes more than just a few seconds to evaluate. In one study, only 15% of military physicians could correctly calculate the GCS, despite all of them being familiar with the scale and most having completed the advanced trauma life support course.<sup>21</sup> A second report observed that less than half (48%) of clinicians correctly scored the GCS in a written clinical scenario; with neurosurgeons correct just 56% of the time.<sup>14</sup>

A remarkable insight into the scale's complexity was the embarrassing 2003 realization that one fourth of British hospitals were actually using the original 12-point form of the GCS rather than the current 13-point version, perhaps for decades without anyone noticing and correcting the error.<sup>26</sup> If many or most clinicians cannot reliably retain knowledge of the GCS scoring sequence, then how can they be expected to correctly apply the tool?

The GCS is only grossly predictive. When we calculate the GCS in clinical practice, what are we expecting it to do? In acute care settings, we are hoping that the scale will help us predict clinically important outcomes such as the presence of brain injury, the need for neurosurgical intervention, and ultimate mortality. Although statistically associated with each of these events, the prognostic value of the GCS is weak enough that it cannot accurately predict outcomes for individual patients.<sup>8,9,22,23,25,27</sup> For perspective, the GCS sensitivity and specificity combinations are similar to the ability of weather forecasters to predict rain and the ability of the WBC count to predict appendicitis.<sup>8,9</sup> Indeed, it remains unstudied whether the GCS yields any independent contribution above and beyond unstructured clinical judgment alone.

<p><b>Glasgow Coma Score</b></p> <p>Eye Opening                  4-Spontaneous                  3-To speech                  2-To pain                  1-None</p> <p>Verbal Response                  5-Oriented                  4-Confused conversation                  3-Inappropriate words                  2-Incomprehensible sounds                  1-None</p> <p>Motor Response                  6-Obeys commands                  5-Localizes pain                  4-Normal flexion (withdrawal)                  3-Abnormal flexion (decorticate)                  2-Extension (decerebrate)                  1-None</p> <p><b>Simplified Motor Scale*</b>                  Obeys commands                  Localizes pain                  Withdrawal to pain or less response</p> <p>*Alternative name: TROLL                  (Test Responsiveness: Obeys, Localizes, or Less)</p> <p><b>AVPU</b>                  A-Alert                  V-Responds to verbal stimuli                  P-Responds to painful stimuli                  U-Unresponsive to all stimuli</p> <p><b>ACDU</b>                  A-Alert                  C-Confused                  D-Drowsy                  U-Unresponsive</p>
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**Figure.** The GCS and selected simpler neurologic assessment scales.

Summing 3 different scales is inherently unsound. The creators of the GCS never intended its 3 subscales to be summed and indeed argued in vain against such application.<sup>2</sup> Adding the components assumes that each gradation of each subscale exhibits a similar magnitude of clinical importance. This presumption is intuitively unlikely and indeed has been statistically refuted because the relationship between the total GCS and mortality is nonlinear.<sup>22,27</sup>

The fallacy of combining the 3 subscales is dramatically highlighted by the differential prognostic significance of permutations within single reported scores.<sup>22,23,28</sup> The 13 possible GCS values can include 120 combinations of its components. A GCS score of 4 predicts a mortality rate of 48% if calculated 1+1+2 for eye, verbal, and motor, a mortality of 27% if calculated 1+2+1, but a mortality of only 19% if calculated 2+1+1.<sup>22</sup> Despite the numeric illusion of greater precision, the summary score thus effectively communicates less prognostic information than its components.<sup>3,22,23,28</sup>

**SIMPLER SCALES PERFORM JUST AS WELL**

Do we really need a scale with 13 levels? The GCS predicts mortality well at its extremes and poorly in its midrange,<sup>27</sup> and thus most of its predictive capacity is anchored by the endpoints. Accordingly, some of the GCS elements are truly predictive, whereas others are either redundant or simply noise.

What about just using 1 of the 3 GCS subscales in place of the summary score? Indeed, several investigators have demonstrated essentially equivalent test performance for the individual subscales compared with the total,<sup>8,9,20,22-25,27</sup> whether in out-of-hospital<sup>9,20,23,25</sup> or emergency department (ED) settings<sup>8,22-24,27</sup> and whether in adults<sup>8,9,22,24,25,27</sup> or children.<sup>20,23</sup> Given this confirmation that the 3 subscales do not contribute independent information, the act of combining them is redundant at best. The 6-point motor component exhibits the best performance of the 3 subscales, and there have been calls to adopt it as a GCS replacement.<sup>20,23-25</sup>

But can we get even simpler than this? McNarry and Goldhill<sup>19</sup> describe two 4-point scores (AVPU, ACDU) as comparable to the GCS (Figure). Gill et al<sup>8,9</sup> used receiver operating characteristic curve analyses to observe that just 3 of the 6 points of the GCS motor score defined essentially its total performance, and they collapsed this scale to just these items to form the Simplified Motor Scale (Figure). An alternative name for this scale with a built-in mnemonic is “TROLL” (Test Responsiveness: Obeys, Localizes, or Less). In 2007, Haukoos et al<sup>29</sup> independently validated this simplified scale in the ED setting, and in this issue Thompson et al<sup>30</sup> similarly validate it in the out-of-hospital arena. Thus, it is now established that this 3-point scale accomplishes everything that the total GCS does.

Some traditionalists will no doubt object to the blasphemy of “dumbing down” the GCS, but why tolerate pointless complexity? The Simplified Motor Scale/TROLL provides the same information, was statistically derived,<sup>8,9</sup> is simple (3 points), has been externally validated,<sup>29,30</sup> and demonstrates

superior interrater reliability.<sup>31</sup> Some will argue that a 3-point scale is so basic that it can hardly add to clinical judgment. If true, then this suggests that all along we have been actually relying on judgment alone, with perfunctory GCS calculation a noncontributory ritual.

An alternative scale called the FOUR (Full Outline of UnResponsiveness) score has been proposed.<sup>32</sup> However, it is even more complicated than the GCS (4 component scales), requires more time to calculate,<sup>12</sup> and has similarly limited interrater reliability.<sup>12,32</sup>

## WHY HAS THE GCS PERSISTED?

The GCS never began with a sound scientific basis and, as discussed above, fails to meet the standards of modern evidence-based medicine. Why has this sacred cow thrived over the decades? Perhaps the reasons are psychological. The GCS is intellectually appealing to health care providers in that it creates apparent order out of disorder. It ambitiously tackles the enormous complexity of human neurologic response and organizes (oversimplifies) it into a tangible, appealing yardstick that cannot fail to impress with its seeming accuracy and precision. We want to believe that medicine can be this objective, and thus we tolerate the delusion.

## CONCLUSION

In 1978, the creators of the GCS said, "We have never recommended using the GCS alone, either as a means of monitoring coma, or to assess the severity of brain damage or predict outcome."<sup>33</sup> Nevertheless, clinicians worldwide persist in using the GCS for all of these things—now despite compelling contrary evidence. The GCS should be abandoned in the ED and out-of-hospital settings altogether. Simple unstructured clinical judgment alone is likely just as accurate; however, if we must satisfy our human need for some sort of tool, then it should be one that is easier to learn, use, and retain than the GCS. For now, the Simplified Motor Scale/TROLL would appear to amply fill the bill.

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## IMAGES IN EMERGENCY MEDICINE

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### DIAGNOSIS:

*Left central retinal vein occlusion.* Patients with central retinal vein occlusion typically present with sudden painless vision loss. Ophthalmoscopic findings include optic disc edema, retinal hemorrhages, cotton-wool spots, and dilated tortuous retinal veins (Figures 1 and 2). Retinal vein occlusions occur in 1% to 2% of patients older than 40 years, with branch vein occlusions being 4 times as common as central vein occlusions.<sup>1,2</sup> Risk factors include hypertension, diabetes, dyslipidemia, smoking, renal disease, and glaucoma.<sup>3,4</sup> Visual acuity at presentation is the strongest predictor of final visual outcome. One study found that 65% of central retinal vein occlusion patients presenting with visual acuity of 20/40 maintained 20/40 or better, and less than 1% presenting with worse than 20/200 ever achieved 20/40.<sup>5</sup>

The emergency physician's responsibilities include recognizing the entity and ensuring urgent ophthalmologic evaluation. Fluorescein angiography can be performed to assess the degree of macular edema and perfusion (Figures 3 and 4). Treatment options include laser photocoagulation, chorioretinal venous anastomosis, and intravitreal glucocorticoids or anti-vascular endothelial growth factor agents. Although central retinal vein occlusion is not an independent risk factor for cardiovascular mortality, it is considered end-organ damage, and patients should undergo cardiovascular disease risk management interventions.<sup>6,7</sup>

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