Glasgow Coma Scale Motor Component ("Patient Does Not Follow Commands") Performs Similarly to Total Glasgow Coma Scale in Predicting Severe Injury in Trauma Patients

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Study objective: Trauma victims are frequently triaged to a trauma center according to the patient's calculated Glasgow Coma Scale (GCS) score despite its known inconsistencies. The substitution of a simpler binary assessment of GCS-motor (GCS-m) score less than 6 (ie, "patient does not follow commands") would simplify field triage. We compare total GCS score to this binary assessment for predicting trauma outcomes.

Methods: This retrospective analysis of a statewide trauma registry includes records from 393,877 patients from 1999 to 2013. Patients with initial GCS score less than or equal to 13 were compared with those with GCS-m score less than 6 for outcomes of Injury Severity Score (ISS) greater than 15, ISS greater than 24, death, ICU admission, need for surgery, or need for craniotomy. We judged a priori that differences less than 5% lack clinical importance.

Results: The relative differences between GCS and GCS-m scores less than 6 were less than 5% and thus clinically unimportant for all outcomes tested, even when statistically significant. For the 6 outcomes, the differences in areas under receiver operating characteristic curves ranged from 0.014 to 0.048. Total GCS score less than or equal to 13 was slightly more sensitive (difference 3.3%; 95% confidence interval 3.2% to 3.4%) and slightly less specific (difference −1.5%; 95% confidence interval −1.6% to −1.5%) than GCS-m score less than 6 for predicting ISS greater than 15, with similar overall accuracy (74.1% versus 74.2%).

Conclusion: Replacement of the total GCS score with a simple binary decision point of GCS-m score less than 6, or a patient who "does not follow commands," predicts serious injury, as well as the total GCS score, and would simplify out-of-hospital trauma triage. [Ann Emerg Med. 2016;68:744-750.]

Please see page 745 for the Editor's Capsule Summary of this article.

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INTRODUCTION

Background

Rapid and accurate assessment of a patient's condition is essential for trauma triage in the field. Emergency medical services (EMS) providers of all levels must be able to quickly evaluate and classify patients for appropriate transport destination while providing medical care. Avoiding undertriage by transporting patients with potentially serious injuries to an appropriate trauma center reduces mortality, but overtriage causes a strain on resources and is inconvenient for patients.

The guidelines for field triage of injured patients were designed for use by EMS providers to identify patients with potentially serious injuries and determine the most appropriate level of care.[1,2] The 2011 version consists of 4 steps to determine the appropriate destination for patients. Step 1 includes physiologic criteria, including assessment of vital signs and the Glasgow Coma Scale (GCS) score, and recommends that a patient with a GCS score of less than or equal to 13 be transported to a trauma center, preferably to the highest level of care within the defined trauma system.

Importance

Recent research on step-specific field triage has shown the motor component of the GCS (GCS-m) to be a more specific and simpler tool for patient assessment.[3-8]

Editor's Capsule Summary

What is already known on this topic

The Glasgow Coma Scale (GCS) is widely used as a criterion for field triage of injured patients to trauma centers.

What question this study addressed

Does a single GCS element (GCS motor component score <6 or "patient does not follow commands") predict trauma outcomes, as well as the widely used threshold of total GCS score less than or equal to 13?

What this study adds to our knowledge

In this analysis of a 393,877-adult statewide trauma registry, the differences observed between the new decision point and GCS score less than or equal to 13 were all below the prespecified 5% threshold of clinical importance for 8 trauma outcomes.

How this is relevant to clinical practice

The full GCS is unnecessarily complicated for out-of-hospital field triage and can be effectively replaced by the single decision point "patient does not follow commands."

A calculated GCS score of less than or equal to 13 may be a statistically more sensitive and less specific indicator of serious injury than the GCS-m score, which may lead to overtriaging of patients and thus transporting patients to more distant resources that may not be needed for them. Small differences may not be clinically significant, and field use of GCS-m score may be more reliable than the total calculated GCS score. The GCS score is only 1 parameter of trauma triage; therefore, these relatively small differences in sensitivity have an even smaller influence on overall trauma triage sensitivity. The National Expert Panel on Field Triage considered emerging evidence for the use of GCS-m score during their literature review when developing the 2011 guidelines, but this group ultimately did not include use of the GCS-m score in the current guidelines because of "lack of confirmatory evidence, the long standing use of total GCS and its familiarity among current EMS practitioners, the inclusion of the motor score within the total GCS, and complications because of the difficulty of comparing scoring systems."[1] However, several studies have indicated a significant interobserver variability in tallying the total GCS score, with discrepancies as high as 3 points.[9] Even the assessment of the GCS-m score suffers from lack of standardization, with variations based on type of painful stimuli applied to elicit responses and variations because of provider education.[10,11] Gill et al[12] studied the interrater differences among emergency physicians in determining the GCS score and found that the agreement percentage for exact total GCS score was 32%, whereas the agreement percentage for the motor component was 72%. It is generally accepted that the motor component of the GCS is the most influential one when a patient's severity of injury is assessed.

Goals of This Investigation

We wished to compare the total GCS score less than or equal to 13 with the GCS-m score less than 6 ("patient does not follow commands") in predicting trauma-related outcomes.

MATERIALS AND METHODS

Study Design and Setting

We retrospectively analyzed the prospectively maintained Pennsylvania Trauma System Foundation's registry, which included trauma patients admitted to the state's Level I, II, III, and IV trauma centers from 1999 to 2013. The Pennsylvania Trauma System Foundation registry captures all patients with a diagnosis of trauma who are admitted to a Foundation-accredited Level I, II, III, or IV trauma center and patients presenting to the trauma center dead on arrival. This includes all trauma transfer admissions and trauma deaths. Solitary hip fractures are excluded. Patients do not need a minimum Injury Severity Score (ISS) to be included into the registry. The majority of accredited trauma centers in Pennsylvania during this study were Level I and II. Level IV trauma centers were first recognized in Pennsylvania in November 2013, and during the study (the last 2 months), there was only 1 Level IV accredited center. Pennsylvania has an exclusive trauma system, and the Pennsylvania Trauma System Foundation data exclude patients who were treated only at facilities that are not accredited trauma centers, although statewide EMS triage criteria and hospital referral patterns generally direct seriously injured trauma patients to accredited trauma centers, either initially or by interfacility transfer. Additional description of the Pennsylvania Trauma System Foundation trauma registry can be found at http://www.ptsf.org/index.php/resources.

Quality assurance and improvement measures for the Pennsylvania Trauma Outcome Study include internal data validation of the data entry system at each trauma center. Each trauma center's data are abstracted locally and collected in the Pennsylvania Trauma Outcome Study by trained trauma registrars. Additional reviews are performed at the central site, including a random sampling program, which generates case reviews. Data are also validated against objective coding software, and foundation staff randomly select several cases from an institution and review the medical records at sites for consistency, accuracy, and completeness.

Table 1. Sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio of total GCS versus GCS-m only scores in predicting outcomes.

Outcome	GCS Score ≤13 (95% CI)	GCS-m Score <6 (95% CI)	Relative Difference (95% CI)
ISS >15, %			
Sensitivity	31.3 (31.0 to 31.6)	28.0 (27.7 to 28.3)	3.3 (3.2 to 3.4)
Specificity	91.3 (91.2 to 91.4)	92.8 (92.7 to 92.9)	−1.5 (−1.6 to −1.5)
LR+	2.54 (2.52 to 2.56)	2.56 (2.54 to 2.59)	
LR−	0.53 (0.53 to 0.54)	0.51 (0.51 to 0.52)	
ISS >24, %			
Sensitivity	47.2 (46.7 to 47.6)	43.7 (43.3 to 44.2)	3.5 (3.3 to 3.6)
Specificity	89.3 (89.2 to 89.4)	91.1 (91.0 to 91.2)	−1.8 (−1.9 to −1.8)
LR+	4.97 (4.89 to 5.05)	5.11 (5.03 to 5.19)	
LR−	0.67 (0.66 to 0.67)	0.64 (0.64 to 0.65)	
Died, %			
Sensitivity	69.8 (69.2 to 70.4)	67.3 (66.7 to 67.9)	2.5 (2.2 to 2.7)
Specificity	88.1 (88.0 to 88.2)	90.1 (90.0 to 90.2)	−2.0 (−2.1 to −1.9)
LR+	12.88 (12.52 to 13.25)	13.551 (13.183 to 13.920)	
LR−	0.76 (0.75 to 0.76)	0.726 (0.722 to 0.730)	
ICU admission, %			
Sensitivity	27.3 (27.1 to 27.5)	23.9 (23.7 to 24.1)	3.39 (3.29 to 3.50)
Specificity	91.6 (91.4 to 91.8)	92.7 (92.6 to 92.9)	−1.15 (−1.24 to −1.06)
LR+	1.52 (1.52 to 1.53)	1.51 (1.50 to 1.51)	
LR−	0.37 (0.37 to 0.38)	0.37 (0.37 to 0.38)	
Intubation, %			
Sensitivity	83.7 (83.3 to 84.2)	81.3 (80.9 to 81.8)	2.4 (2.1 to 2.6)
Specificity	90.0 (89.9 to 90.1)	92.0 (91.9 to 92.1)	−2.0 (−2.1 to −1.9)
LR+	28.62 (27.72 to 29.53)	28.70 (27.85 to 29.55)	
LR−	0.62 (0.62 to 0.62)	0.57 (0.57 to 0.58)	
Trauma care need, %			
Sensitivity	28.2 (27.9 to 28.4)	25.1 (24.9 to 25.3)	3.0 (2.9 to 3.1)
Specificity	93.7 (93.6 to 93.8)	95.0 (94.9 to 95.1)	−1.3 (−1.4 to −1.3)
LR+	2.19 (2.17 to 2.20)	2.21 (2.19 to 2.22)	
LR−	0.38 (0.37 to 0.38)	0.35 (0.34 to 0.35)	
Surgery, %			
Sensitivity	33.5 (33.0 to 34.0)	30.5 (30.0 to 31.0)	3.0 (2.8 to 3.2)
Specificity	86.5 (86.4 to 86.6)	88.4 (88.3 to 88.5)	−1.9 (−2.0 to −1.9)
LR+	2.81 (2.75 to 2.87)	2.89 (2.83 to 2.96)	
LR−	0.87 (0.87 to 0.88)	0.86 (0.86 to 0.87)	
Craniotomy, %			
Sensitivity	51.4 (50.2 to 52.5)	46.5 (45.4 to 47.7)	4.9 (4.3 to 5.4)
Specificity	85.9 (85.8 to 86.0)	87.8 (87.7 to 87.9)	−2.0 (−2.0 to −1.9)
LR+	6.03 (5.76 to 6.30)	5.88 (5.61 to 6.12)	
LR−	0.94 (0.94 to 0.94)	0.94 (0.94 to 0.94)	

CI, Confidence interval; *LR+*, positive likelihood ratio; *LR−*, negative likelihood ratio.

This study was approved by the Geisinger Health System institutional review board, with the specific determination that this study met exempt criteria for full institutional review board review. Data obtained from the Pennsylvania Trauma Systems Foundation State Registry were approved by Pennsylvania Trauma System Foundation.

Selection of Participants

The database contained 393,877 adults aged 18 years and older. The out-of-hospital total GCS score, out-of-hospital GCS-m score, and ISS were obtained from each patient record. The primary outcome by which we compared total GCS scores with GCS-m scores was ISS greater than 15. Secondary outcomes were also collected from each patient, which included ISS greater than 24, death, ICU admission, need for craniotomy, any surgery (defined as intrathoracic, abdominal, vascular, or cranial surgery), intubation (at the scene or in the trauma care center), and a composite variable, trauma care need. Trauma care need was defined as ISS greater than 15, ICU admission 24 hours or greater, need for surgery, or death before discharge. Values of GCS and GCS-m scores, systolic blood pressure, and respiratory rate were captured at first report (at either the scene or trauma center). If these physiologic criteria were available in an out-of-hospital patient care report, then this was used. Otherwise, the first physiologic criteria obtained by the hospital providers on arrival to the trauma center were captured. In this study, the first reported physiologic data were available from out-of-hospital records

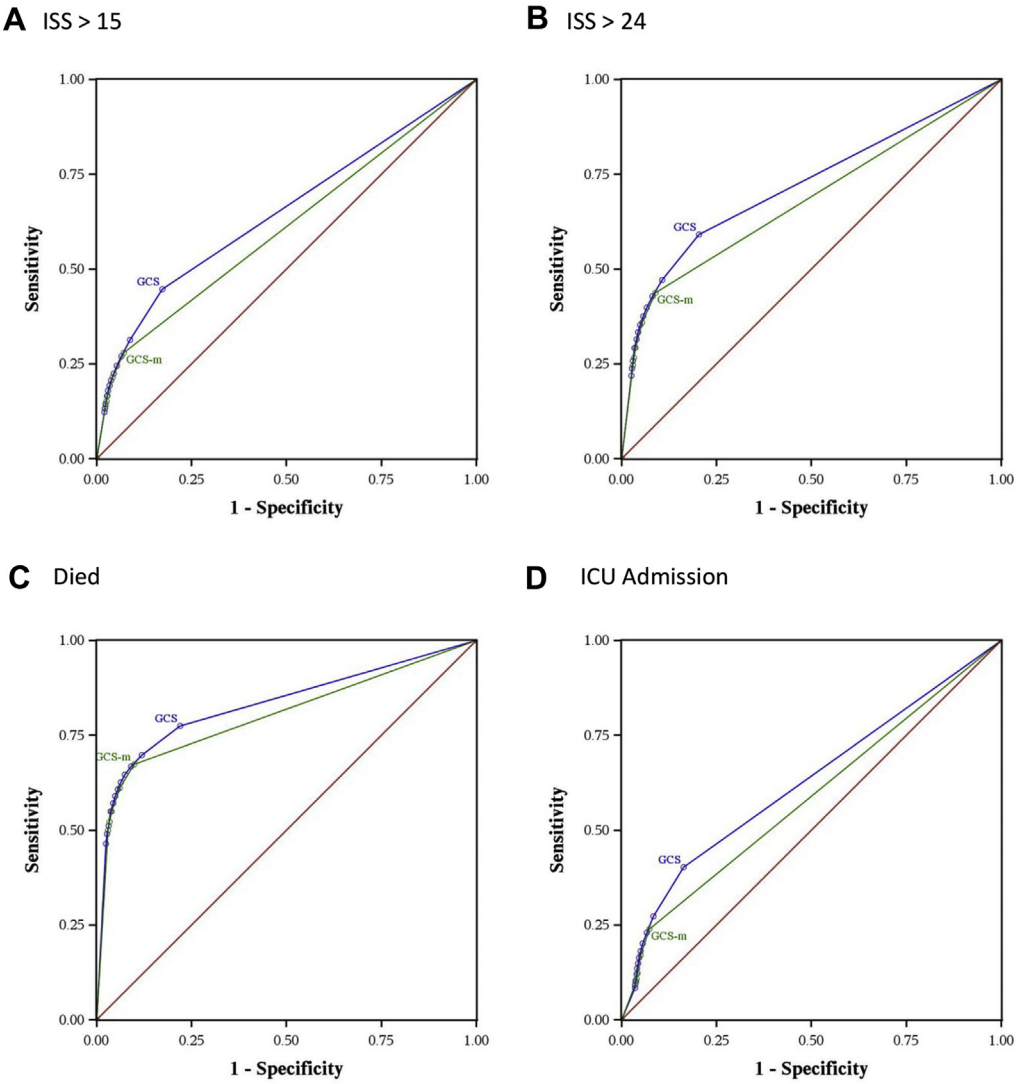

Figure. AUC for GCS-m and GCS scores.

48% of the time, and the data from initial hospital assessment were used for the remainder. After exclusion of patients with missing GCS score, GCS-m score, respiratory rates, and systolic blood pressure; with trauma year out of range; who do not fit into the trauma registry inclusion and exclusion criteria according to the Pennsylvania Trauma Outcome Study documentation; and who were missing ISS, the analysis data set included 370,392.

Methods of Measurement

We used descriptive analyses for our data (Tables E1 and E2, available online at http://www.annemergmed.com) and contrasted the GCS-m score with the total GCS score with the threshold less than or equal to 13 and with receiver operating characteristic curves. Recognizing that our large sample would likely identify some small differences as statistically significant, we defined a priori differences of less than 5% (ie, <0.05 for the area under a receiver operating characteristic curve) as clinically unimportant regardless of statistical probability.

We performed sensitivity analyses excluding patients who meet criteria for transport directly to a trauma center because of other trauma triage criteria within the guidelines (including those with systolic blood pressure less than 90 mm Hg and respiratory rate less than 10 or greater than 29 breaths/min, as well as for anatomic reasons including flail chest, skull fracture, paralysis, amputation, pelvic fractures, bone fractures, and penetrating injuries), generating a sample of 315,034. In a second sensitivity analysis, we restricted the sampling to only patients with out-of-hospital reported total GCS score versus GCS-m score.

Primary Data Analysis

We used the SAS (version 9.4; SAS Institute, Inc., Cary, NC) for data analysis.

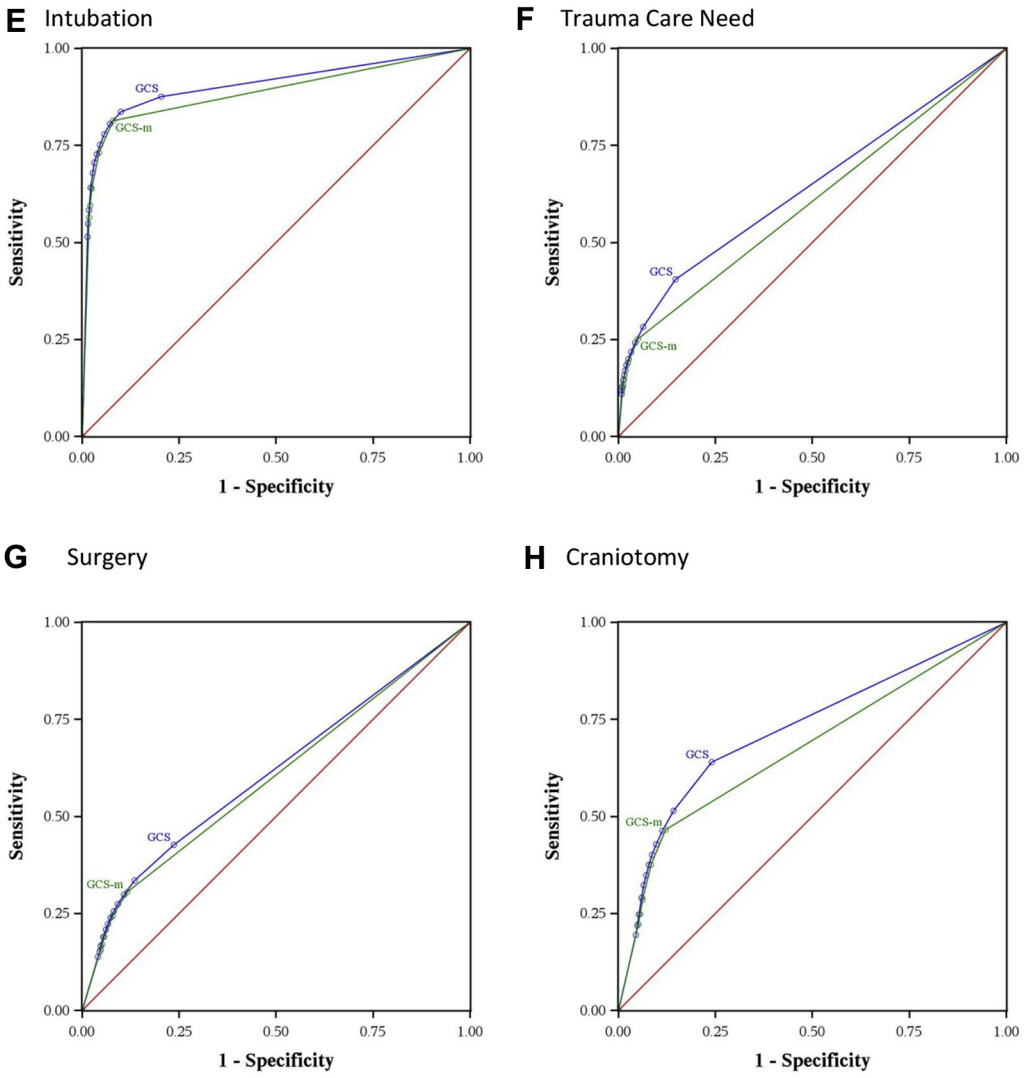

Figure. Continued.

RESULTS

We found that the differences between total GCS score less than or equal to 13 and GCS-m score less than 6 were all below our prespecified 5% threshold for clinical importance, ranging from 2.5% to 4.9% for sensitivity and –1.2% to –2.0% for specificity (Table 1). All such differences had 95% confidence intervals that did not overlap zero. We found similar results in our 2 sensitivity analyses.

Differences in areas under receiver operating characteristic curves ranged from 0.014 to 0.048 (Figure, Tables 2 and E3 [available online at http://www.annemergmed.com]), all also below our prespecified 0.05 threshold for clinical importance.

LIMITATIONS

This study is from a single state and may not be representative elsewhere, although Pennsylvania includes large urban, suburban, and rural areas. A large proportion of the patients in the registry were victims of blunt trauma. In addition, for analysis the values of total GCS and GCS-m scores, systolic blood pressure and respiratory rate were captured at first report (either in the out-of-hospital setting or at the trauma center). A further limitation is that approximately half of the first reported GCS scores were determined by hospital providers rather than in the field by EMS providers, and the outcomes might have differed if EMS providers had routinely provided GCS scores. However, our sensitivity analysis of just this subgroup showed similar results.

DISCUSSION

Total GCS score has historically been an important physiologic component of field triage used to predict trauma outcomes. This relatively complicated 13-point scale has shown inaccuracy among health care workers, however, putting its reliability in question.[9]

A simpler assessment of cerebral function is the binary clinical determination of whether a patient "follows

Table 2. Area under the receiver operating characteristic curve for each outcome.

Outcome	AUC (95% CI)		
	GCS Score ≤13	GCS-m Score <6	Relative Difference
ISS >15	0.648 (0.646–0.650)	0.606 (0.605–0.608)	0.042 (0.041–0.043)
ISS >24	0.719 (0.716–0.721)	0.680 (0.677–0.682)	0.039 (0.038–0.041)
Died	0.831 (0.828–0.834)	0.803 (0.800–0.806)	0.028 (0.026–0.030)
ICU admission	0.625 (0.623–0.626)	0.583 (0.581–0.584)	0.042 (0.041–0.043)
Intubation	0.904 (0.902–0.907)	0.884 (0.882–0.887)	0.020 (0.019–0.021)
Trauma care need	0.641 (0.639–0.642)	0.603 (0.602–0.604)	0.038 (0.037–0.039)
Surgery	0.612 (0.608–0.615)	0.597 (0.595–0.600)	0.014 (0.013–0.016)
Craniotomy	0.724 (0.718–0.730)	0.676 (0.670–0.682)	0.048 (0.044–0.052)

AUC, Area under the receiver operation characteristic curve.

commands" (GCS-m score=6) or does not. Although previous studies have shown greater agreement among emergency physicians assessing the GCS-m score compared with total GCS score, it is reasonable to posit that the straightforward assessment of "following commands" would be as accurate as or more accurate than the assessment of all parts of the GCS-m score. This simple binary assessment of whether a patient "follows commands" is practical and appealing when one considers ease of education and use by all levels of EMS providers when they make field triage determinations.

We found that the differences between total GCS score less than or equal to 13 and GCS-m score less than 6 were below our prespecified 5% threshold for clinical importance, despite statistically significant associations that predictably resulted from our extremely large sample size. Our data thus confirm the findings of previous studies that our simpler decision point is just as predictive of trauma outcomes as the full GCS.[13,14] A simplified field triage score for battlefield casualties, which includes the GCS-m, has shown promising results for use as a practical instrument in the combat zone.[15] Additionally, the use of motor response in children after they sustain a traumatic head injury has shown to predict long-term outcome, as well as the full GCS score, with better interobserver agreement.[16] A 2012 study identified GCS-m score as part of a prognostic model for predicting mortality at 30 days and unfavorable outcome at 6 months after traumatic brain injury.[17] A retrospective study found that if patients had a GCS-m score less than 6 and a systolic blood pressure less than 90 mm Hg, 95% of them needed a lifesaving intervention.[18] A similar study showed that GCS-m and GCS verbal scale scores, along with pulse character, predicted need of out-of-hospital lifesaving intervention.[19] The performance of GCS-m in previous studies and in this study, as well as ease of using GCS-m in the out-of-hospital setting, make a strong argument for simplifying the national Guidelines for Field Triage by changing to the use of GCS-m score less than 6 or "patient does not follow commands" when making out-of-hospital trauma triage decisions.

In conclusion, during trauma triage a simple binary decision point of GCS-m score less than 6, or a patient who "does not follow commands," predicts serious injury similarly to the more complicated calculation of total GCS score. For all outcomes, the relative differences in specificity, sensitivity, and area under the receiver operation characteristic curve between GCS-m score and total GCS score were clinically unimportant; therefore, we recommend our simpler binary assessment as a replacement for the total GCS score for field trauma triage.

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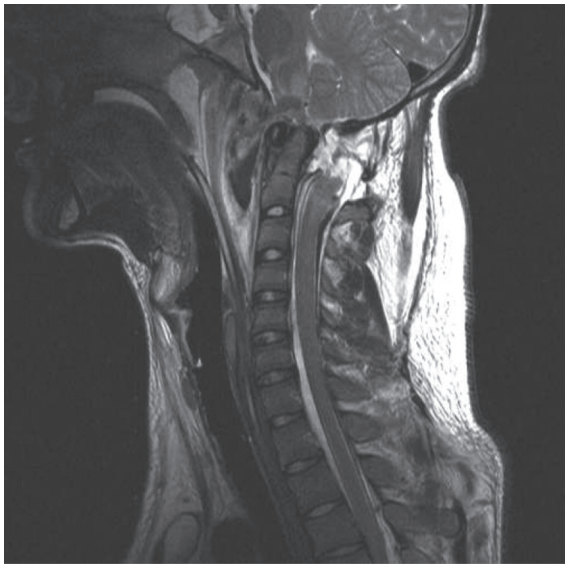

"Long-Term Survival Following Complete Medulla/Cervical Spinal Cord Transection" by Gautschi and Zellweger, April 2007, Volume 49, #1, pp. 540, 545.

Table E1. Characteristics of patients: categorical variables (N=370,392).

Variable	N	%
Sex		
Male	230,263	62.2
Female	140,036	37.8
Missing	93	<0.1
Race		
White	291,108	78.6
Black	51,287	13.9
Asian	3,156	0.9
Other	9,528	2.6
Unknown	15,313	4.1
Trauma year		
1999	16,411	4.4
2000	17,644	4.8
2001	17,986	4.9
2002	19,528	5.3
2003	19,681	5.3
2004	21,096	5.7
2005	22,595	6.1
2006	24,301	6.6
2007	25,498	6.9
2008	27,357	7.4
2009	29,049	7.8
2010	30,496	8.2
2011	31,758	8.6
2012	33,360	9.0
2013	33,632	9.1
Injury type		
Blunt	325,583	87.9
Penetrating	31,034	8.4
Burn	13,621	3.7
Skin disease*	2	0
Missing	152	0
Injury type (secondary)		
Blunt	342	0.1
Penetrating	89	0
Burn	137	0
Skin disease	3	0
Missing	369,821	99.9
Systolic blood pressure (first report), mm Hg		
<90	16,383	4.4
≥90	354,009	95.6
Respiratory rate (first report), breaths/min		
10–29	347,785	93.9
<10 or >29	22,607	6.1
Any surgery (intrathoracic, abdominal, vascular, or cranial)		
Yes	30,895	8.3
No	336,278	90.8
Missing	3,219	0.9
Craniotomy		
Yes	7,447	2.0
No	353,575	95.5
Missing	51,271	2.5
ICU admission		
Yes	147,229	39.8
No	97,713	26.4
Missing	125,450	33.9
Intubation		
Yes	26,214	7.1
No	344,138	92.9
Missing	40	<0.1
Trauma care need (ISS >15, ICU admission 24 h or greater, need for surgery, or death before discharge)		
Yes	150,635	40.7
No	219,757	59.3
Status		
Alive	349,378	94.3
Dead	21,014	5.7
ISS categorized at 15		
≤15	264,155	71.3
>15	106,237	28.7
ISS categorized at 24		
≤24	324,537	87.6
>24	45,855	12.4
GCS-m score (first report)		
1, none	21,092	5.7
2, extension	1,663	0.5
3, flexion	2,546	0.7
4, withdraws	8,816	2.4
5, localizes pain	14,734	4.0
6, obeys commands	321,541	86.8
GCS-m score categorized (first report)		
6 (obeys commands)	321,541	86.8
<6 (does not obey commands)	48,851	13.2
GCS score (first report)		
3	18,243	4.9
4	1,510	0.4
5	1,698	0.5
6	3,082	0.8
7	2,507	0.7
8	2,425	0.7
9	2,654	0.7
10	3,456	0.9
11	4,237	1.1
12	6,080	1.6
13	10,451	2.8
14	36,965	10.0
15	277,084	74.8
GCS total score categorized (first report)		
>13	321,409	84.8
≤13	56,343	15.2

*Dermatologic disorders not related to thermal injury, but often treated at burn centers. Examples include toxic epidermal necrolysis, Stevens-Johnson syndrome, acute porphyria, and psoriasis.

Table E2. Characteristics of patients: continuous variables (N=370,392).

Variable	N	Median (IQR)	Mean (SD)
Age, y	370,392	50 (32, 72)	52.1 (22.5)
ISS	370,392	9 (5, 17)	12.0 (10.1)
Number of ICU days	244,942	1 (0, 2)	3.0 (7.1)
Number of hospital days	370,392	4 (2, 7)	6.2 (8.8)
Pulse rate (first report), beats/min	370,266	88 (76, 100)	88.5 (21.5)
Respiratory rate (first report), breaths/min	370,392	18 (16, 20)	18.7 (5.2)
Systolic blood pressure (first report), mm Hg	370,392	137 (120,154)	136.4 (32.3)

Table E3. Sensitivity, specificity, and accuracy for each point on the receiver operating characteristic curve.

	Sensitivity	Specificity	Accuracy
ISS >15			
GCS-m score			
≤5	28.0 (27.7–28.3)	92.8 (92.7–92.9)	74.2 (74.1–74.3)
≤4	21.5 (21.2–21.7)	95.7 (95.7–95.8)	74.4 (74.3–74.6)
≤3	16.7 (16.5–16.9)	97.1 (97.1–97.2)	74.1 (73.9–74.2)
≤2	15.1 (14.9–15.3)	97.4 (97.4–97.5)	73.8 (73.7–74.0)
1	13.9 (13.7–14.2)	97.6 (97.6–97.7)	73.6 (73.5–73.8)
GCS score, total			
≤14	44.7 (44.4–45.0)	82.7 (82.5–82.8)	71.8 (71.6–71.9)
≤13	31.3 (31.0–31.6)	91.3 (91.2–91.4)	74.1 (73.9–74.2)
≤12	27.0 (26.7–27.3)	93.5 (93.4–93.6)	74.4 (74.3–74.6)
≤11	24.4 (24.1–24.6)	94.7 (94.6–94.8)	74.5 (74.4–74.7)
≤10	22.4 (22.2–22.7)	95.5 (95.5–95.6)	74.6 (74.4–74.7)
≤9	20.7 (20.4–20.9)	96.2 (96.1–96.2)	74.5 (74.4–74.6)
≤8	19.3 (19.1–19.5)	96.6 (96.5–96.7)	74.4 (74.3–74.6)
≤7	18.0 (17.7–18.2)	97.0 (96.9–97.1)	74.3 (74.2–74.5)
≤6	16.4 (16.2–16.7)	97.3 (97.3–97.4)	74.1 (74.0–74.3)
≤5	14.5 (14.3–14.7)	97.7 (97.6–97.8)	73.8 (73.7–74.0)
≤4	13.3 (13.1–13.5)	97.9 (97.8–97.9)	73.6 (73.5–73.8)
3	12.2 (12.0–12.4)	98.0 (98.0–98.1)	73.4 (73.3–73.6)
ISS >24			
GCS-m score			
≤5	43.7 (43.2–44.2)	91.1 (91–91.2)	85.3 (85.1–85.4)
≤4	35.9 (35.5–36.4)	94.6 (94.5–94.6)	87.3 (87.2–87.4)
≤3	29.2 (28.8–29.7)	96.3 (96.3–96.4)	88.0 (87.9–88.1)
≤2	26.6 (26.2–27.0)	96.7 (96.7–96.8)	88.1 (87.9–88.2)
1	24.6 (24.2–25.0)	97.0 (96.9–97.0)	88.0 (87.9–88.1)
GCS score, total			
≤14	59.1 (58.7–59.6)	79.6 (79.5–79.7)	77.1 (76.9–77.2)
≤13	47.1 (46.7–47.6)	89.3 (89.2–89.4)	84.1 (84.0–84.2)
≤12	42.8 (42.3–43.2)	91.9 (91.8–92.0)	85.8 (85.7–85.9)
≤11	39.8 (39.4–40.3)	93.4 (93.3–93.4)	86.7 (86.6–86.8)
≤10	37.6 (37.1–38.0)	94.3 (94.3–94.4)	87.3 (87.2–87.4)
≤9	35.3 (34.8–35.7)	95.1 (95.0–95.2)	87.7 (87.6–87.8)
≤8	33.4 (33.0–33.8)	95.6 (95.6–95.7)	87.9 (87.8–88.0)
≤7	31.5 (31.1–31.9)	96.1 (96.1–96.2)	88.1 (88.0–88.2)
≤6	29.1 (28.7–29.5)	96.6 (96.5–96.6)	88.2 (88.1–88.3)
≤5	25.8 (25.4–26.2)	97.0 (97.0–97.1)	88.2 (88.1–88.3)
≤4	23.8 (23.4–24.2)	97.3 (97.2–97.3)	88.2 (88.1–88.3)
3	21.9 (21.5–22.2)	97.5 (97.4–97.5)	88.1 (88.0–88.2)
Died			
GCS-m score			
≤5	67.3 (66.7–67.9)	90.1 (90.0–90.2)	88.8 (88.7–88.9)
≤4	61.2 (60.5–61.8)	93.9 (93.8–94.0)	92.1 (92.0–92.1)
≤3	54.9 (54.2–55.5)	96.1 (96.0–96.1)	93.7 (93.6–93.8)
≤2	52.2 (51.6–52.9)	96.6 (96.6–96.7)	94.1 (94.0–94.2)
1	49.9 (49.2–50.6)	97.0 (96.9–97.0)	94.3 (94.2–94.4)
GCS score, total			
≤14	77.5 (76.9–78.0)	78.0 (77.8–78.1)	77.9 (77.8–78.1)
≤13	69.8 (69.2–70.4)	88.1 (88.0–88.2)	87.0 (86.9–87.1)
≤12	66.8 (66.1–67.4)	90.9 (90.8–91.0)	89.5 (89.4–89.6)
≤11	64.6 (63.9–65.2)	92.5 (92.4–92.6)	90.9 (90.8–91.0)
≤10	62.6 (62.0–63.3)	93.6 (93.5–93.7)	91.8 (91.7–91.9)
≤9	60.7 (60.0–61.4)	94.5 (94.4–94.5)	92.5 (92.5–92.6)
≤8	58.9 (58.3–59.6)	95.1 (95.0–95.2)	93.1 (93.0–93.1)
≤7	57.1 (56.5–57.8)	95.7 (95.6–95.8)	93.5 (93.4–93.6)
≤6	54.9 (54.3–55.6)	96.3 (96.2–96.3)	93.9 (93.9–94.0)
≤5	51.2 (50.5–51.9)	96.9 (96.9–97.0)	94.3 (94.3–94.4)
≤4	48.9 (48.3–49.6)	97.3 (97.2–97.3)	94.5 (94.5–94.6)
3	46.4 (45.7–47.1)	97.6 (97.5–97.6)	94.7 (94.6–94.7)

Table E3. Continued.

	Sensitivity	Specificity	Accuracy
ICU admission			
GCS-m score			
≤5	23.9 (23.7–24.1)	92.7 (92.6–92.9)	51.4 (51.2–51.6)
≤4	17.1 (16.9–17.2)	94.9 (94.8–95.1)	48.1 (47.9–48.3)
≤3	12.3 (12.1–12.5)	95.8 (95.7–96.0)	45.6 (45.4–45.8)
≤2	10.8 (10.7–11.0)	96.1 (95.9–96.2)	44.8 (44.6–45.0)
1	9.9 (9.7–10.0)	96.2 (96.1–96.3)	44.3 (44.1–44.5)
GCS score, total			
≤14	40.2 (39.9–40.4)	83.6 (83.4–83.9)	57.5 (57.3–57.7)
≤13	27.3 (27.1–27.5)	91.6 (91.4–91.8)	52.9 (52.8–53.1)
≤12	22.9 (22.7–23.1)	93.4 (93.2–93.6)	51.0 (50.8–51.2)
≤11	20.1 (19.9–20.3)	94.4 (94.2–94.5)	49.8 (49.6–50.0)
≤10	18.1 (17.9–18.3)	95.0 (94.8–95.1)	48.8 (48.6–49.0)
≤9	16.3 (16.1–16.5)	95.4 (95.3–95.6)	47.9 (47.7–48.1)
≤8	14.9 (14.7–15.1)	95.7 (95.6–95.8)	47.1 (46.9–47.3)
≤7	13.5 (13.3–13.7)	95.9 (95.8–96.0)	46.4 (46.2–46.6)
≤6	12.0 (11.9–12.2)	96.1 (95.9–96.2)	45.6 (45.4–45.8)
≤5	10.2 (10.1–10.4)	96.3 (96.2–96.4)	44.6 (44.4–44.7)
≤4	9.2 (9.1–9.4)	96.4 (96.3–96.5)	44.0 (43.8–44.2)
3	8.3 (8.2–8.5)	96.5 (96.4–96.6)	43.5 (43.3–43.7)
Intubation			
GCS-m score			
≤5	81.3 (80.9–81.8)	92 (91.9–92.1)	91.2 (91.2–91.3)
≤4	73.2 (72.7–73.7)	95.7 (95.6–95.7)	94.1 (94.0–94.2)
≤3	63.9 (63.3–64.4)	97.5 (97.5–97.6)	95.1 (95.1–95.2)
≤2	59.6 (59.0–60.2)	97.9 (97.9–98.0)	95.2 (95.1–95.3)
1	56.4 (55.8–57.0)	98.2 (98.1–98.2)	95.2 (95.1–95.3)
GCS score, total			
≤14	87.6 (87.2–88.0)	79.6 (79.4–79.7)	80.1 (80.0–80.3)
≤13	83.7 (83.3–84.1)	90.0 (89.9–90.1)	89.6 (89.5–89.7)
≤12	80.6 (80.1–81.1)	92.8 (92.7–92.9)	91.9 (91.9–92.0)
≤11	77.9 (77.4–78.4)	94.4 (94.3–94.4)	93.2 (93.1–93.3)
≤10	75.2 (74.7–75.7)	95.4 (95.3–95.5)	94.0 (93.9–94.0)
≤9	72.8 (72.2–73.3)	96.2 (96.1–96.3)	94.6 (94.5–94.6)
≤8	70.5 (70.0–71.1)	96.8 (96.8–96.9)	94.9 (94.9–95.0)
≤7	67.8 (67.3–68.4)	97.3 (97.3–97.4)	95.2 (95.2–95.3)
≤6	64.1 (63.5–64.6)	97.8 (97.7–97.8)	95.4 (95.3–95.4)
≤5	58.3 (57.7–58.9)	98.2 (98.2–98.3)	95.4 (95.3–95.5)
≤4	54.8 (54.2–55.4)	98.4 (98.4–98.5)	95.3 (95.3–95.4)
3	51.5 (50.9–52.1)	98.6 (98.6–98.7)	95.3 (95.2–95.4)
Trauma care need			
GCS-m score			
≤5	25.1 (24.9–25.3)	95.0 (94.9–95.1)	66.6 (66.4–66.7)
≤4	19.1 (18.9–19.3)	97.6 (97.5–97.6)	65.6 (65.5–65.8)
≤3	14.8 (14.6–15.0)	98.6 (98.6–98.7)	64.5 (64.4–64.7)
≤2	13.4 (13.2–13.6)	98.8 (98.8–98.9)	64.1 (63.9–64.2)
1	12.5 (12.3–12.6)	98.9 (98.9–99.0)	63.8 (63.6–63.9)
GCS score, total			
≤14	40.5 (40.2–40.7)	85.3 (85.1–85.4)	67.1 (66.9–67.2)
≤13	28.2 (27.9–28.4)	93.7 (93.6–93.8)	67.0 (66.9–67.2)
≤12	24.2 (24.0–24.4)	95.7 (95.6–95.8)	66.6 (66.5–66.8)
≤11	21.8 (21.6–22.0)	96.8 (96.7–96.9)	66.3 (66.1–66.4)
≤10	19.9 (19.7–20.1)	97.5 (97.4–97.5)	65.9 (65.8–66.1)
≤9	18.3 (18.1–18.5)	98.0 (97.9–98.0)	65.6 (65.4–65.7)
≤8	17.1 (16.9–17.2)	98.3 (98.2–98.3)	65.3 (65.1–65.4)
≤7	15.8 (15.7–16.0)	98.6 (98.5–98.6)	64.9 (64.8–65.1)
≤6	14.5 (14.3–14.7)	98.8 (98.7–98.8)	64.5 (64.3–64.6)
≤5	12.8 (12.6–13.0)	99.0 (99.0–99.0)	63.9 (63.8–64.1)
≤4	11.8 (11.7–12.0)	99.1 (99.1–99.2)	63.6 (63.5–63.8)
3	10.9 (10.8–11.1)	99.2 (99.2–99.2)	63.3 (63.2–63.5)

Table E3. Continued.

	Sensitivity	Specificity	Accuracy
Surgery			
GCS-m score			
≤5	30.5 (30.0–31.0)	88.4 (88.3–88.5)	83.5 (83.4–83.7)
≤4	24.3 (23.8–24.8)	92.2 (92.1–92.3)	86.5 (86.4–86.6)
≤3	19.1 (18.6–19.5)	94.3 (94.2–94.4)	88.0 (87.9–88.1)
≤2	17.0 (16.6–17.5)	94.9 (94.8–94.9)	88.3 (88.2–88.4)
1	15.7 (15.3–16.1)	95.2 (95.2–95.3)	88.5 (88.4–88.6)
GCS score, total			
≤14	42.6 (42.1–43.2)	76.4 (76.3–76.6)	73.6 (73.4–73.7)
≤13	33.5 (33.0–34.0)	86.5 (86.4–86.6)	82.0 (81.9–82.2)
≤12	29.8 (29.3–30.4)	89.2 (89.1–89.3)	84.2 (84.1–84.4)
≤11	27.4 (26.9–27.9)	90.8 (90.7–90.9)	85.5 (85.3–85.6)
≤10	25.5 (25.0–26.0)	91.9 (91.8–92.0)	86.3 (86.2–86.4)
≤9	23.8 (23.4–24.3)	92.7 (92.6–92.8)	86.9 (86.8–87.0)
≤8	22.3 (21.8–22.7)	93.4 (93.3–93.5)	87.4 (87.3–87.5)
≤7	20.7 (20.3–21.2)	93.9 (93.9–94.0)	87.8 (87.7–87.9)
≤6	18.9 (18.5–19.4)	94.5 (94.4–94.6)	88.2 (88.1–88.3)
≤5	16.6 (16.2–17.0)	95.2 (95.1–95.3)	88.6 (88.5–88.7)
≤4	15.1 (14.7–15.5)	95.6 (95.5–95.6)	88.8 (88.7–88.9)
3	13.8 (13.5–14.2)	95.9 (95.8–96.0)	89.0 (88.9–89.1)
Craniotomy			
GCS-m score			
≤5	46.5 (45.4–47.7)	87.8 (87.7–87.9)	87.0 (86.8–87.1)
≤4	37.5 (36.4–38.6)	91.6 (91.5–91.7)	90.5 (90.4–90.6)
≤3	28.5 (27.4–29.5)	93.8 (93.7–93.9)	92.5 (92.4–92.6)
≤2	24.8 (23.8–25.8)	94.4 (94.3–94.5)	93.0 (92.9–93.1)
1	22.2 (21.3–23.2)	94.8 (94.7–94.9)	93.3 (93.2–93.4)
GCS score, total			
≤14	64.0 (62.9–65.1)	75.9 (75.8–76.0)	75.7 (75.5–75.8)
≤13	51.4 (50.2–52.5)	85.9 (85.8–86.0)	85.2 (85.0–85.3)
≤12	46.2 (45.1–47.4)	88.6 (88.5–88.7)	87.8 (87.6–87.9)
≤11	42.8 (41.7–43.9)	90.2 (90.1–90.3)	89.2 (89.1–89.3)
≤10	40.1 (39.0–41.2)	91.3 (91.2–91.4)	90.3 (90.2–90.4)
≤9	37.5 (36.4–38.6)	92.2 (92.1–92.3)	91.1 (91.0–91.2)
≤8	34.9 (33.8–36.0)	92.9 (92.8–92.9)	91.7 (91.6–91.8)
≤7	32.2 (31.1–33.3)	93.5 (93.4–93.5)	92.2 (92.1–92.3)
≤6	29.1 (28.0–30.1)	94.1 (94.0–94.1)	92.7 (92.6–92.8)
≤5	24.7 (23.7–25.7)	94.8 (94.7–94.9)	93.3 (93.3–93.4)
≤4	21.8 (20.9–22.8)	95.2 (95.1–95.2)	93.7 (93.6–93.7)
3	19.4 (18.5–20.3)	95.5 (95.5–95.6)	94.0 (93.9–94.0)