The Effect of Age on Glasgow Coma Scale Score in Patients With Traumatic Brain Injury

Kristin Salottolo, MPH; A. Stewart Levy, MD; Denetta S. Slone, MD; Charles W. Mains, MD; David Bar-Or, MD

**Importance** The Glasgow Coma Scale (GCS) is used frequently to define the extent of neurologic injury in patients with a traumatic brain injury (TBI). Whether age affects the predictive ability of the GCS for severity of TBI (determined by the Abbreviated Injury Scale [AIS] score) remains unknown.

**Objective** To investigate the effect of age on the association between the GCS and anatomic TBI severity.

**Design, Setting, and Participants** We examined all patients with a TBI, defined by diagnostic codes 850 to 854 from the *International Classification of Diseases, Ninth Revision, Clinical Modification*, who were admitted to 2 level I trauma centers from January 1, 2008, through December 31, 2012.

**Exposures** We compared elderly (≥65 years) and younger (18-64 years) adults with TBI.

**Main Outcomes and Measures** We examined differences by age in GCS category (defined by emergency department GCS as severe [3-8], moderate [9-12], or mild [13-15]) at each level of TBI severity (head AIS score, 1 [minor] to 5 [critical]). Cochran-Armitage χ² trend tests and stepwise multivariate linear and logistic regression models were used.

**Results** During the study period, 6710 patients had a TBI (aged <65 years, 73.17%). Significant differences in GCS category by age occurred at each AIS score (P ≤ .01 for all). In particular, among patients with an AIS score of 5, most of the elderly patients (56.33%) had a mild neurologic deficit (GCS score, 13-15), whereas most of the younger patients (63.28%) had a severe neurologic deficit (GCS score, 3-8). After adjustment, the younger adults had increased odds of presenting with a severe neurologic deficit (GCS score, 3-8) at each of the following AIS scores: 1, 4.2 (95% CI, 1.0-17.6; P = .05); 2, 2.0 (1.0-3.7; P = .04); 3, 2.0 (1.2-3.5; P = .01); 4, 4.6 (2.8-7.5; P < .001); and 5, 3.1 (2.1-4.6; P < .001). The interaction between age and GCS for anatomic TBI severity remained significant after adjustment (estimate, −0.11; P = .005).

**Conclusions and Relevance** Age affects the relationship between the GCS score and anatomic TBI severity. Elderly TBI patients have better GCS scores than younger TBI patients with similar TBI severity. These findings have implications for TBI outcomes research and for protocols and research selection criteria that use the GCS.

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T
raumatic brain injury (TBI) is an alteration in brain function or anatomic structure due to blunt or penetrating force to the head with associated confusion, altered level of consciousness, or focal sensory, motor, or other neurologic deficits. The incidence of TBI increases with advancing age, and individuals older than 85 years are at the greatest risk for TBI.1 Adults 75 years and older have the highest incidence of TBI-related hospitalization and death.2

The most widely used methods of describing TBI are the Glasgow Coma Scale (GCS)3 and the Abbreviated Injury Scale (AIS).4,5 The GCS has been used without modification since 1974 to assess the extent and severity of neurologic deficits and as a triage tool and prognostic indicator in patients with traumatic injuries. The GCS focuses on the importance of central nervous system function and consists of verbal, motor, and eye-opening responses. The AIS is an internationally accepted anatomy-based measure of injury severity created in 1971 to provide researchers with a simple numeric method for ranking and comparing specific individual injuries; the AIS is updated periodically to reflect changes in mortality and is the basis for other widely accepted scoring systems such as the Injury Severity Score (ISS)6 and Trauma and Injury Severity Score.7 The AIS classifies severity by the magnitude of the injury and the body region affected into scores ranging from 1 (minor injury such as concussion) to 5 (critical injury such as extensive >1 cm epidural, extradural, or subdural hemorrhage). An AIS score of 6 denotes an unsurvivable injury.

The GCS is predictive of mortality in a general TBI population.8 However, health care providers recognize that pediatric and geriatric patients respond to trauma differently than nongeriatric adult patients. The current literature has demonstrated that age affects the relationship between head injury severity and mortality.9-13 Further, older adults with better GCS scores still endure worse outcomes than younger patients with more severe or comparable injuries.9,14-18

Whether advanced age plays a role in the predictive ability of the GCS for the severity of TBI has yet to be established. An older patient’s decreased reserves may result in a greater decline in neurologic function compared with a younger patient, given the same severity of injury. Delirium, confusion, and dementia may have a negative effect on the GCS score. On the other hand, elderly patients with TBI may not present with neurologic deficit owing to the increased incidence of cerebral atrophy, which is associated with overt or unexpected findings on computed tomography (CT) of the head, despite initial findings of intact neurologic function.19 We hypothesized that neurologic deficit, defined by the GCS, differs for elderly TBI patients compared with younger patients with a similar anatomic severity of TBI.

Determination whether age affects the association between GCS and anatomic severity of TBI is important because many guidelines for the management of TBI20 and trial selection criteria21 use the GCS. This study is, to the best of our knowledge, the first to investigate the effect of age on the predictive ability of the GCS for specific anatomic injury and TBI severity.

Methods

Design, Setting, and Participants
We conducted a retrospective cohort study of adult (aged ≥18 years) trauma patients consecutively admitted to the level I trauma centers at St Anthony Hospital and Swedish Medical Center in the Denver, Colorado, metropolitan area. This study was approved by the HealthOne Swedish Medical Center and the St Anthony Hospital institutional review boards; informed consent was waived.

We included all patients with TBI who were admitted from January 1, 2008, through December 31, 2012, and were entered into the trauma registry (TraumaBase database, Clinical Data Management). Inclusion in the trauma registry is defined according to Colorado State criteria.22 The following TBIs were defined using the presence of the corresponding diagnostic injury codes from the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM): concussion (850.0-850.99); cerebral or cerebellar contusion or laceration (851.0-851.99); subarachnoid hemorrhage (852.0-852.19); subdural hemorrhage (852.2-852.39); extradural hemorrhage (852.4-852.59); other, unspecified intracranial hemorrhage (853.0-853.19); and intracranial injury of other and unspecified nature (854.0-854.19).

Outcomes and Covariates

Data were abstracted electronically from the trauma registry. All injury data were coded according to the 2005 update of the AIS;23 the AIS is coded by dedicated trauma registrars who review medical records for written reports from radiology and physician descriptions of injury and do not rely indirectly on ICD-9-CM diagnostic codes. The maximum head AIS score was used to define the level of TBI severity. Only 7 patients presented with a head AIS score of 6 (unsurvivable); therefore, data are presented for head AIS scores ranging from 1 (minor) to 5 (critical).

Our primary end point was GCS category, defined as mild (score, 13-15), moderate (score, 9-12), or severe (score, 3-8) using the GCS score on arrival at the emergency department (ED). We examined GCS category in all patients with TBI and in patients with isolated TBI, because multiple injuries can contribute to a neurologic deficit without affecting the anatomic severity of TBI. We also examined in-hospital mortality at each GCS and head AIS stratum by age and tested for an interaction among mortality, age, and TBI severity to determine whether the prognostic ability of the AIS or the GCS differs by age.

The following covariates were collected and defined as follows: ISS (<16 vs ≥16), sex (male or female), comorbidities (median number), mechanism (blunt vs penetrating), transfer status (transfer in vs direct admission), cause of injury (fall, motor vehicular crash, and all other causes), ED systolic blood pressure (<90 vs ≥90 mm Hg), ED respiratory rate (<10 or >29 vs 10-29 breaths/min), ED heart rate (<120 vs ≥120 beats/min), and the presence of a severe concomitant extracranial injury (a nonhead injury with AIS score ≥2; chest, extremity, neck/spine, abdomen/pelvic, facial, and external injuries were included).
Statistical Analysis
Statistical analysis was performed using commercially available software (SAS, version 9.3; SAS Institute Inc). Statistical significance was set at \( P < .05 \) for each analysis. Missing data were not imputed. Nineteen patients (0.28%) were missing AIS scores. Three hundred thirty-one patients (4.93%) had missing GCS scores; missing GCS scores occurred more often at low AIS scores \( (P < .001) \) and in the elderly \( (6.44\% \text{ vs } 4.38\%; \ P < .001) \).

We examined differences in GCS category by age at each head AIS score using Cochran-Armitage \( \chi^2 \) trend tests. A multivariate general linear regression model (GLMSELECT; SAS Institute Inc) was used to identify an interaction between age and GCS category for anatomic severity, adjusting for covariates meeting entry and exit criteria of \( P < .05 \).

Predictors of severe neurologic deficit (GCS score, 3-8) were determined using stepwise logistic regression, stratified by head AIS score, to determine whether age increased the odds of a severe neurologic deficit while controlling for anatomic TBI severity. Adjustment in the model was performed for covariates meeting the entry and exit criteria of \( P < .05 \).

We examined the association between age and mortality at each AIS and GCS stratum using \( \chi^2 \) tests. Stepwise multivariate logistic regression models were used to identify an interaction among age, AIS score, and GCS score for mortality, adjusting for covariates meeting the entry and exit criteria of \( P < .05 \).

Results
Population Demographics
We identified 6710 patients with a TBI. The mean (SD) age was 48 (23) years, and 63.70% were male, with slightly more falls as causes of injury (38.76%) than motor vehicle crashes (30.52%) and other causes (30.72%). Other causes with greater than 5% incidence included biking and skiing/snowboarding. Most patients presented with a single TBI diagnosis (78.41%); the most common TBI diagnoses were concussion (51.21%), subarachnoid hemorrhage (26.54%), and subdural hematoma (23.62%).

Nearly three-fourths of the population was younger than 65 years \( (n = 4910 \ (73.17\%)) \), with the remaining patients 65 years or older \( (n = 1800 \ (26.83\%)) \). All TBI injury characteristics that we examined differed significantly for younger vs older TBI patients (Table 1), except the incidence of laceration/contusion. In addition, significant differences were found in nearly all of the study’s demographic and clinical covariates by age, as seen in Table 1.

GCS Category
We found significant differences in GCS category for younger vs elderly TBI patients at each head AIS score \( (Table 2, P < .01 \text{ for all AIS strata}) \). In particular, in patients with the most critical injuries (AIS score, 5), most of the elderly patients (56.33%) had a mild neurologic deficit (GCS, 13-15), whereas most of the younger patients (63.28%) had a severe neurologic deficit (GCS, 3-8). The interaction between the GCS and age for anatomic TBI severity remained significant after adjustment for ISS, transfers, cause of injury, hypotension, and extracranial injuries to the neck, abdomen/pelvis, chest, and limbs (estimate, \(-0.11; \ P = .005\)).

Among the 5261 patients with an isolated TBI, a significant difference remained for GCS category for younger vs elderly TBI patients with head AIS scores of 2, 3, 4, and 5, with findings of borderline significance for those with a head AIS score of 1 \( (P = .05; \text{ data not shown}) \). In this subset we also demonstrated that most of the elderly patients \( (59.72\%) \) with critical TBI had a mild neurologic deficit, whereas most of the younger patients \( (54.00\%) \) with critical TBI had a severe neurologic deficit.

Before adjustment, younger patients presented with severe neurologic deficit from 2- to 6-fold more frequently than elderly patients at each stratum of TBI severity (Figure 1 and Table 3). After adjustment for ISS, sex, mechanism of injury, transfers, and abnormal vital signs in the ED, being younger than 65 years increased the odds of presenting with severe neurologic deficit at each level of anatomic severity (Table 3).

Outcomes
The overall mortality was 5.11\% \( (n = 342) \) and was greater in elderly patients \( (8.50\% \text{ vs } 3.87\%; \ P < .001) \). Mortality was greater in elderly patients at each GCS stratum, whereas mortality was similar, by age group, in patients with AIS scores of 3, 4, and 5 \( (Figure 2) \). However, after adjustment, we found no interaction between age and GCS score for mortality \( (estimate, \ -0.03; \ P = .89) \), adjusted for ISS, comorbidities, mechanism of injury, transfers, abnormal respiratory rate, hypotension, and injuries to the torso) and no interaction between age and head AIS score for mortality \( (estimate, \ -0.24; \ P = .09) \), adjusted for comorbidities, mechanism, transfers, abnormal vital signs, and injuries to the torso or neck).

Discussion
The incidence of TBI in the elderly is expected to continue rising owing to the aging of the Baby Boomer generation, medical and technological advancements, and key public health initiatives that contribute to active lifestyles and increasing life expectancy. From 2002 to 2006, the Centers for Disease Control and Prevention estimated that hospitalizations increased by 34% and TBI-related deaths by 27% in the population 65 years or older.\(^{2}\) As such, the elderly TBI population is of increasing interest in TBI outcomes research. This study demonstrates that age affects the relationship between anatomic severity of TBI as measured by the AIS and the neurologic condition at presentation as measured by the GCS, such that elderly patients have better GCS scores than younger patients with similar TBI severity. Even after adjustment for demographic characteristics, vital signs, and extracranial injuries, age significantly modified the relationship between the GCS and anatomic severity of TBI.

No other studies have examined directly the effect of age on the relationship between GCS and TBI severity. Two studies examined the effect of age on the GCS score, while taking
into account an alternative measure of anatomic severity (radiologic findings and grade of head trauma). Kim studied 136 TBI patients with initial CT studies available and demonstrated that being 60 years or older increased the odds of a poor GCS score after adjustment for cause and radiographic findings (odds ratio, 3.14; \(P < .05\)). Renner and colleagues examined 427 rehabilitation-bound patients and demonstrated that age had a significant effect on the GCS score (\(P = .03\)) after adjustment for grade of head trauma. Unfortunately, those authors did not clarify the definition of head trauma grade or whether the association was positive or negative. Our study demonstrates that being older increased the likelihood of a better GCS while controlling for anatomic severity of TBI.

Other investigators have demonstrated an age effect on the clinical management of TBI. The Canadian CT Head Rule recommends head CT for older patients with minor neurologic deficits (GCS score, 13-15), demonstrating that being older than 65 years is a high risk factor for neurosurgical intervention. Similarly, Moore and colleagues reported that elderly patients with a high GCS score necessitate an emergency head CT owing to an increased risk for neurosurgical interventions.

Numerous studies demonstrate that age affects the relationship between head injury severity and outcomes, including the following findings:

1. Mortality is greater in elderly patients at each GCS and AIS strata.
2. The GCS is a better predictor of death in patients younger than 55 years.
3. The GCS is most accurate at predicting outcome when combined with age and pupillary response.
4. The correlation between GCS score and outcome is age dependent.
5. Greater age independently increases mortality after controlling for GCS and head AIS scores, and age independently predicts mortality across all head AIS and GCS categories.

Further, several studies have demonstrated that older adults with better GCS still endure worse outcomes than younger patients with more severe or comparable injuries. Similar to these studies, we demonstrated that mortality was significantly greater for elderly patients across each GCS strata; however, the unadjusted mortality was similar across AIS strata by age, particularly for patients with serious, severe,
the presence of a blunted or delayed clinical response may be partially responsible for better ED GCS scores in the elderly population with TBI despite similar anatomic severity.

Although several potential explanations exist for our findings, we believe the most likely reason is that elderly patients have a blunted and/or delayed clinical response to injury compared with younger patients. A blunted response could result from differences in the physiological response to injury between younger and older patients, including a decreased inflammatory response to injury, differences in vasoreactivity and brain swelling, or a decreased extent of neuroexcitatory depolarization after brain injury, among other possible differences. Often a delay occurs in the time between the trauma and the onset of an obvious mass effect on physical, neurologic, or psychosocial functioning in the elderly because the increase in space between the brain and the skull permits the expansion of intracranial content with fewer symptoms. Further, cerebral atrophy is more common in older adults and is associated with occult or unexpected findings on head CT despite an initial examination finding of intact neurologic function. The presence of a blunted or delayed clinical response may be partially responsible for better ED GCS scores in the elderly population with TBI despite similar anatomic severity.

Alternative explanations include the following:

1. The head AIS overestimates the severity of injury in elderly patients, particularly because acute-on-chronic subdural hematomas, predominantly a disease of the elderly, effectively increase the head AIS score but may not contribute to a decreased GCS score.

2. The GCS score underestimates the severity of injury in older patients owing to the clinician’s perception of lower baseline neurologic response, because normal functional decline appears to mirror GCS deficits (eg, decreased attention and visual spatial ability plus a reduced capacity for complex motor movement)

3. The GCS score overestimates the severity of TBI in younger patients owing to impairment caused by alcohol or other drugs, which are often assumed to lower the GCS score, despite a study demonstrating no association between alcohol-induced impairment and GCS score after controlling for anatomic severity of TBI (head AIS score).

4. Elderly patients truly tolerate equivalent injuries better. This theory is not supported by literature demonstrating outcomes in elderly compared with younger trauma patients, which are typically much worse at each anatomic and physiological score, and an unfavorable outcome is significantly associated with increased age at every decade.

Our findings have implications for treatment guidelines and protocols that use the GCS, such as the Brain Trauma Foundation and the American Association of Neurological Surgeons guidelines for the management of severe TBI, Advanced Trauma Life Support triage and activation protocols, prehospital intubation protocols, clinical trial selection criteria, and guidelines for initiating support and education to families. Our findings also have implications for TBI outcomes research in which the GCS is frequently used in conjunction with ICD-9-CM diagnoses to define the TBI population, particularly when only one group of TBI patients (with mild, moderate, or severe injuries) is studied. Our study suggests that a bias exists in current TBI populations defined by the GCS, such that elderly patients in each GCS strata will have worse anatomic injuries than their younger counterparts. For instance, in our population with severe TBI (GCS, 3-8), twice

Table 2. GCS Category by Head AIS Score and Age

<table>
<thead>
<tr>
<th>Head AIS Score (Category) by GCS Categorya</th>
<th>% of Patients</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aged &lt;65 y (n = 4910)</td>
<td>Aged ≥65 y (n = 1800)</td>
</tr>
<tr>
<td>1 (Minor)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>3.54</td>
<td>0.66</td>
</tr>
<tr>
<td>Moderate</td>
<td>2.69</td>
<td>2.33</td>
</tr>
<tr>
<td>Mild</td>
<td>93.76</td>
<td>97.01</td>
</tr>
<tr>
<td>2 (Moderate)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>4.97</td>
<td>2.53</td>
</tr>
<tr>
<td>Moderate</td>
<td>2.82</td>
<td>2.14</td>
</tr>
<tr>
<td>Mild</td>
<td>92.21</td>
<td>95.33</td>
</tr>
<tr>
<td>3 (Serious)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>15.65</td>
<td>6.04</td>
</tr>
<tr>
<td>Moderate</td>
<td>4.99</td>
<td>3.85</td>
</tr>
<tr>
<td>Mild</td>
<td>79.35</td>
<td>90.11</td>
</tr>
<tr>
<td>4 (Severe)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>36.46</td>
<td>10.70</td>
</tr>
<tr>
<td>Moderate</td>
<td>8.10</td>
<td>6.27</td>
</tr>
<tr>
<td>Mild</td>
<td>55.44</td>
<td>83.03</td>
</tr>
<tr>
<td>5 (Critical)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>63.28</td>
<td>30.57</td>
</tr>
<tr>
<td>Moderate</td>
<td>8.19</td>
<td>13.10</td>
</tr>
<tr>
<td>Mild</td>
<td>28.53</td>
<td>56.33</td>
</tr>
</tbody>
</table>

Abbreviations: AIS, Abbreviated Injury Scale; GCS, Glasgow Coma Scale.

* Severe indicates a GCS score of 3 to 8; moderate, 9 to 12; and mild, 13 to 15.
as many younger adults presented with minor anatomic injury compared with elderly patients (20.79% vs 11.03%). Alternative classifications may be necessary to define the population with severe TBI rather than the GCS.

Our findings suggest that systemic changes attributable to aging may lead to differences in the neurologic or anatomic response after TBI. The elderly population may require an alternative to the widely used GCS and/or AIS to ensure appropriate decisions are made regarding severity of illness, transfer, triage, clinical assessment, and research study selection criteria. Alternatives include using new scoring systems such as the Full Outline of Unresponsiveness score, creating a modified GCS specifically for the geriatric population similar to the pediatric GCS, using additional variables to define severity of injury or for prediction models such as the AIS or the ISS, using biomarkers or CT findings, or using different thresholds to define GCS category for the geriatric population. For instance, the Ohio Emergency Medical Services system has recently adopted a lower GCS threshold for elderly patients for prompt transport to a trauma center.

This study has limitations. First, owing to the retrospective design, we do not have all potentially relevant data. We did not collect data on preinjury medications, including warfarin sodium, aspirin, and clopidogrel bisulfate. Potential bias exists because use of anticoagulants was higher in the elderly population, and use of anticoagulants has been shown to affect response to TBI and severity of TBI and to result in a greater likelihood of hematoma progression and delayed neurologic deterioration. Second, we did not correct for intubation status before arrival, and the GCS score may be artificially lower in patients who are intubated before the ED GCS score is recorded. We do not believe prehospital intubation affects our findings because we found continued differences in GCS category by age, particularly for head AIS scores of 4 and 5, when we excluded patients (12.23%) who underwent intubation before hospitalization.

Third, we chose to focus the analysis on ED total GCS scores, because others have shown that the ED GCS score is more predictive of outcome than the GCS score at the scene of the trauma. Fourth, we were unable to establish cause and effect from registry data, such that we could not determine whether a cerebral vascular accident led to a fall, or whether the fall led to a traumatic hemorrhage. Last, we assumed that the “true” assessment of severity of injury is the anatomic (AIS) rather than the neurologic (GCS) injury measure. As such, our findings demonstrate that the GCS appears to be confounded by age and that the AIS is not. However, we cannot rule out the hypothesis that the GCS is less confounded by age than the AIS, partly because we were unable to demonstrate an interaction between age and the GCS or the AIS for mortality. Future studies should determine whether systemic changes attributable to aging lead to greater differences in the initial neurologic than the anatomic response after TBI.

### Table 3. Odds of a Severe Neurologic Deficit for Younger vs Elderly Patients With TBI

<table>
<thead>
<tr>
<th>Head AIS Score (Category)</th>
<th>Unadjusted OR (95% CI)</th>
<th>Adjusted OR (95% CI)</th>
<th>P Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Minor)</td>
<td>5.5 (1.3-22.7)</td>
<td>4.2 (1.0-17.6)</td>
<td>.05</td>
</tr>
<tr>
<td>2 (Moderate)</td>
<td>2.0 (1.1-3.6)</td>
<td>2.0 (1.0-3.7)</td>
<td>.04</td>
</tr>
<tr>
<td>3 (Serious)</td>
<td>2.9 (1.8-4.6)</td>
<td>2.0 (1.2-3.5)</td>
<td>.01</td>
</tr>
<tr>
<td>4 (Severe)</td>
<td>4.8 (3.1-7.3)</td>
<td>4.6 (2.8-7.5)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>5 (Critical)</td>
<td>3.9 (2.7-5.6)</td>
<td>3.1 (2.1-4.6)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

### Figure 2. Mortality by Age

We stratified mortality by head Abbreviated Injury Scale (AIS) score and Glasgow Coma Scale (GCS) strata.  

*P < .05, χ² test.  
*P < .001, χ² test.
Conclusions

Age affects the relationship between anatomic severity of TBI and neurologic response to injury, resulting in elderly TBI patients having better GCS scores than younger TBI patients with similar TBI severity. Our findings underscore the importance of determining whether alternative measures for TBI severity, rather than relying on GCS alone, would benefit triage and transfer criteria, initial workup and treatment, clinical trial inclusion criteria, and TBI outcomes research. Although we propose several potential explanations for our findings, further investigation is needed to determine the potential mechanisms underlying the association between GCS and age.

ARTICLE INFORMATION

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Author Contributions: Ms Salottolo and Dr Bar-Or had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Salottolo, Levy.

Acquisition, analysis, or interpretation of data: Salottolo, Slone, Mains, Bar-Or.

Drafting of the manuscript: Salottolo, Bar-Or.

Critical revision of the manuscript for important intellectual content: Levy, Slone, Mains.

Statistical analysis: Salottolo.

Administrative, technical, or material support: Slone, Mains.

Study supervision: Levy, Bar-Or.

Conflict of Interest Disclosures: None reported.

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REFERENCES


In 1974, the Glasgow Coma Scale (GCS) was first validated in adult (mean age, 33 years) patients using repeated measurements during the course of a week.\textsuperscript{1, 2} According to the original authors, “repeated assessment of responsiveness is essential in the monitoring of the patient with a head injury.”\textsuperscript{2} Since then, this scale has not been modified, and reliance on a single value has been shown repeatedly to be poorly calibrated for outcome, especially in the elderly.\textsuperscript{3-4}

In their retrospective analysis of patients with traumatic brain injury (TBI), Salottolo et al\textsuperscript{5} report that elderly patients have a higher initial GCS score than younger patients with similar severity of TBI. They conclude that when a scale is applied to the population double the age of the validation cohort in a manner not originally intended (single measurement) without accounting for comorbid diseases, medications, advance directives, or treatment interventions, the scale is inadequate to assess injury severity, to prognosticate outcome, or to stratify for research.

As important as these conclusions are, we should start designing solutions rather than repeating the questions. Future investigators should focus on the calibration problem. One solution may be a coefficient multiplier (a “geriatric handicap”) applied to the existing GCS. Another solution may be derivation of a geriatric TBI scale using different criteria. Discharge disposition (eg, home, rehabilitation, nursing home) and long-term neurologic function, two highly relevant outcomes in this population, must also be considered. Balance between accuracy and complexity is essential. Although using multiple coma scales for different ages or performing additional calculations may be cumbersome, the time has come to correct longstanding inaccuracies. Can we perform a properly powered study, followed by a consensus conference, to examine the GCS? Teasdale and Jennett\textsuperscript{1-2} created a useful coma scale almost half a century ago using only 700 patients. Surely we can do better.