

# FINAL PROJECT REPORT

## **Title: Validation of the Simplified Motor Score in a State Trauma Registry**

### **Introduction:**

Accurate evaluation of the extent and severity of neurologic injury is a key component in the care of the trauma patient as traumatic brain injury (TBI) is one of the leading causes of morbidity and mortality in trauma victims. EMS assessment of the severity of such injury affects such decisions as need for transfer to a trauma center. Currently, the Glasgow Coma Scale (GCS) is the most widely used method of assessing severity of TBI. The GCS is a 15-point scale which measures 3 components of neurologic functioning to arrive at a composite score: eye opening, verbal response, and motor response. In Ohio, patients with a  $GCS \leq 13$  in the field meet criteria for transfer to a trauma center. Despite its widespread use, some authors have questioned the usefulness of the GCS due to its complexity. We determined to study another potential measure of neurologic injury, the **Simplified Motor Score**, as potential measure of severe neurologic injury in trauma patients.

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### **Executive summary:**

Our results indicate that the Simplified Motor Score (SMS) may be an adequate substitute for the Glasgow Coma Scale for use in triage decisions by EMS providers. These results using a statewide trauma registry are consistent with those found by other researchers in single institutions. Each decline in SMS significantly increases the odds of having a poor outcome. A normal SMS identifies a large subset of patients who have very low risk of adverse neurologic outcome or death. Consideration should be given to changing from GCS to SMS for triage use by EMS providers.

### **Information/Qualifications:**

Dr. Jeffrey Caterino is an Assistant Professor of Emergency Medicine and Internal Medicine at The Ohio State University. His research interests encompass the emergency conditions of older adults, including infectious and traumatic emergencies.

He has previous experience in use and analysis of data found in the Ohio Trauma Registry.

Amy Raubenolt is a medical student at The Ohio State University College of Medicine where she is enrolled in the MD/MPH program.

### **Review of the Literature pertaining to the current topic:**

The appropriateness of the decision by emergency medical services (EMS) providers to transport an injured patient to a trauma center significantly affects outcome. Several studies have documented that trauma center care improves mortality for injured patients (6-9).

Accurate evaluation of the extent and severity of neurologic injury is a key component in the care of the trauma patient as traumatic brain injury (TBI) is one of the leading causes of morbidity and mortality in trauma victims. Assessing the severity of such injury early in the course provides important information to care providers and affects such decisions as need for transfer to a trauma center, need for intubation, and expected outcome. Currently, the Glasgow Coma Scale (GCS) is the most widely used method of assessing severity of TBI. The GCS is a 15-point scale which measures 3 components of neurologic functioning to arrive at a composite score: eye opening, verbal response, and motor response. The GCS is now widely used in the pre-hospital and emergency department (ED) setting for neurologic assessment of trauma victims (1;3). In Ohio, patients with a GCS  $\leq 13$  in the field meet criteria for transfer to a trauma center.

Despite its widespread use, some authors have questioned the usefulness of the GCS due to its complexity and concerns over poor inter-rater reliability. In an ED setting, the GCS has been found to have only moderate inter-rater reliability (10). In one small study, GCS measured by EMS providers averaged 2 points lower than that of the ED (11).

As a result, several authors have considered whether a simpler measure of neurologic function might be substituted for GCS. In multiple investigations it appears that concentrating on the motor component of GCS provides equivalent information to the entire score (3;4;12). Recently, an even simpler method of assessing neurologic severity of TBI has been proposed, the Simplified Motor Score (SMS) (1;5). The SMS is a 3-point measure which is based upon GCS motor response component (1). In separate investigations in two Level I trauma centers, the SMS was found to have similar test performance to the GCS for prediction of mortality (1;5). In the same trauma center, the SMS has also been studied when obtained by pre-hospital providers and found to have equal accuracy to the GCS (10). Finally, the interrater reliability of the SMS has been shown to be better than that for the GCS score (2).

The SMS thus seems to be a potentially useful marker of severe TBI and one which could potentially replace the GCS as a simple field and ED measure of neurologic injury. However, studies of the SMS were based upon results obtained solely from the EDs of two trauma centers and paramedic transports to a single trauma center.

To further describe the characteristics of the SMS, we conducted a cohort study of the Ohio Trauma Registry. **The overall objective of the study was to validate the EMS-obtained SMS as an accurate predictor of neurologic outcomes and mortality in a diverse population of trauma victims.** To do this we identified the predictive

ability of SMS as compared to GCS for several outcomes including mortality, field or ED intubation, neurosurgical intervention, and significant intracranial injury.

**Future trends, regionally and nationally:**

Results of this study will guide future endeavors in improving care of trauma victims throughout Ohio. It has identified the usefulness of the SMS in a broad spectrum of patients throughout the state. The SMS could potentially replace the GCS as a more rapid, more reproducible assessment of neurologic injury to be used by Ohio EMS providers.

**Data issues and considerations:**

Information was obtained from the Ohio Acute Care Trauma Registry (OTR). The OTR is maintained by the Ohio Department of Public Safety, Division of Emergency Medical Services. Data collection began 1/1/1999 and is ongoing. To be included in the database, patients must have an ICD-9 diagnosis code consistent with injury and be admitted to the hospital for 48 hours. Each year, approximately 87% of Ohio hospitals participate in the database. For 2002 over 22,000 patients were entered into the database. The registry will be queried and de-identified information obtained to complete the required data analysis. The Ohio State University Medical Center's Institutional Review Board determined that studies using de-identified data from the OTR do not require review as the use of de-identified registry data did not constitute human subjects research as defined in 45 CFR 46:102 (f).

Patient records in the database were eligible for inclusion in the study if they are  $\geq 16$  years old, arrived from the scene (Field 28 #1), and arrived by EMS transport (Field 16, #1 or 2). Exclusion criteria included failure to have a complete GCS documented by EMS. The OTR may include  $>1$  entry for a single traumatic event in cases where a patient was transferred between institutions. Entries were matched using a statistical package currently possessed by the Data Center for the Division of Emergency Medical Services and a single entry was created for each traumatic event. Field and ED GCS scores were those recorded at the initial presenting hospital. To capture all relevant outcomes, patients were considered to meet an outcome component if they have the appropriate diagnoses or procedure coded at any institution.

Adverse neurologic outcome was defined as in previous studies. Outcome measures included:

1. In-hospital mortality defined as death in the ED or inpatient setting prior to discharge home or discharge to a rehabilitation facility or nursing home.
2. ED/EMS intubation defined as intubation in the ED or any intubation recorded by EMS in the registry.
3. Neurosurgical intervention defined based on ICD-9 codes including those identifying any operations on the brain, skull, or meninges including diagnostic and therapeutic services such as shunts, craniotomies, ventriculostomies, etc.
4. Traumatic brain injury identified by ICD-9 diagnosis codes. Eligible codes will include those identifying skull fractures with underlying brain injury, intracranial hemorrhage, cerebral contusion, or nonspecific intracranial injury.

Data analysis included descriptive statistics as appropriate for both the population characteristics and the outcome measures. All data analyses were conducted with Stata, version 10 (StataCorp, College Station, TX).

We derived the Simplified Motor Score (SMS) from the motor component of the GCS as per Gill et al (10). An SMS of 0 is equivalent to a GCS motor of 1-4, an SMS of 1 is equivalent to a GCS motor of 5, and an SMS of 2 is equivalent to a GCS motor of 6.

The primary analysis was comparison of the SMS to the overall GCS score and to the GCS dichotomized at the current cutoff of 13 for each of the neurologic outcomes. To do so, we used a univariate logistic regression analysis to construct receiver-operator-characteristic (ROC) curves and to identify the area under each curve (AUC). ROC curves provide an overall identification of the accuracy of a diagnostic test with greater AUC equivalent to more accurate tests.

To further describe the predictive ability of the SMS, the results of the univariate analysis of SMS for each outcome are also presented as odds ratios as compared to the normal SMS value of 2.

### **Analysis of researcher findings:**

After matching of patients who were transported between institutions to prevent counting the same patient twice, a total of 125,672 Ohio Trauma Registry records of patients  $\geq 16$  years of age who arrived from the scene via Emergency Medical Services (EMS) transport were reviewed for potential inclusion in the study. Those without a complete EMS documentation of GCS were excluded, leaving 60,498 patients available for analysis.

Mean age was 52 years (standard deviation 23 years) and 56% were male. Ninety percent of patients had blunt mechanisms of injury. An injury severity score  $< 15$  was present in 64%. Outcomes studied included in-hospital mortality, presence of traumatic brain injury, neurosurgical intervention.

Table 1 presents the area under the ROC curve for each outcome. AUCs are presented for the SMS, the GCS when analyzed on a continuous scale (3-15), and the GCS when analyzed at the current Ohio triage cutoff of 13. Table 1 demonstrates that the AUC for quite similar to that of either GCS methodology. There are no substantial differences in the curves for any outcome. As a result, SMS has similar discriminatory ability to GCS for the detection of neurologic injury, need for emergent intubation, and mortality in trauma patients.

Table 2 presents the results of the univariate regression analyses for SMS and each of the outcomes. An SMS of 2 is considered normal as it corresponds to a normal GCS motor score. When compared to the normal SMS of 2, each decline in SMS significantly increased the odds of the outcome occurring. Most patients had an SMS of 2 (54,945 patients) and these had low rates of occurrence of each outcome ( $< 3\%$  for all outcomes except the most general, traumatic brain injury).

<b>Table 1: Comparison of predictive ability of SMS and GCS using receiver-operator-characteristic curves</b>				
Area under the receiver-operator-characteristic curve				
	Mortality	EMS or ED intubation	Traumatic brain injury	Neurosurgical intervention
Simplified motor score	0.81	0.82	0.66	0.69
GCS on a continuous scale 3-15	0.84	0.86	0.72	0.75
GCS at a cutoff of <=13	0.79	0.81	0.71	0.66

<b>Table 2: Patient outcomes stratified by EMS simplified motor score (SMS) presented as odds ratios and percentage of patients with each outcome*</b>								
Simplified motor score	Mortality		EMS or ED intubation		Traumatic brain injury		Neurosurgical intervention	
	Odds ratio	%	Odds ratio	%	Odds ratio	%	Odds ratio	%
SMS=0 (n=5,808)	31.4	39.8%	37.2	49.0%	8.1	48.8%	8.2	6.53%
SMS=1 (n=2,745)	3.4	6.6%	6.7	14.7%	3.9	31.5%	4.1	3.35%
SMS=2 (n=54,945)	Referent	2.1%	Referent	2.5%	Referent	10.5%	Referent	0.84%

\*All p values for odds ratios in comparison to referent are <0.05

### **Conclusions:**

Our results indicate that the Simplified Motor Score (SMS) may be an adequate substitute for the Glasgow Coma Scale for use in triage decisions by EMS providers. These results using a statewide trauma registry are consistent with those found by other researchers in single institutions. Each decline in SMS significantly increases the odds of having a poor outcome. A normal SMS identifies a large subset of patients who have very low risk of the outcomes studied. Consideration should be given to changing from GCS to SMS for triage use by EMS providers.

### **Recommendations:**

Consideration should be given to transitioning from the current use of GCS to use of the Simplified Motor Score for triage by Ohio EMS providers.