International Journal of Medicine Research
www.medicinesjournal.com
ISSN: 2455-7404
Received: 07-04-2025, Accepted: 08-05-2025, Published: 23-05-2025
Volume 10, Issue 1, 2025, Page No. 46-52

Comparison of two simplified conscious assessment scale with Glasgow coma scale in traumatic brain injury for prognostic validity and need for intubation. – A cross-sectional study

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Abstract

Background

Traumatic brain injury (TBI) necessitates prompt assessment of consciousness to guide critical interventions like intubation. While the Glasgow Coma Scale (GCS) is the standard tool, its complexity limits rapid use. Simplified scales like the Simplified Motor Scale (SMS) and Modified GCS Motor Response (mGCS-motor) offer practical alternatives. This study evaluates their effectiveness in predicting intubation and clinical outcomes.

Methodology

A cross-sectional observational study was conducted over 12 months at KVG Medical College, Sullia, involving 100 adult TBI patients. GCS, mGCS-motor, and SMS scores were recorded at admission. ROC analysis assessed predictive accuracy for intubation needs. Outcomes included morbidity, mortality, and hospital stay, with data analyzed using SPSS v27.

Results

Out of 100 TBI patients studied, 61% required intubation. The Total Glasgow Coma Scale (TGCS) demonstrated the highest predictive accuracy for intubation (AUC = 1.000), mortality (AUC = 0.991), morbidity (AUC = 0.766), and hospitalization duration (AUC = 0.915). The Modified GCS Motor Response (MGCS) also showed excellent prediction for intubation (AUC = 0.908) and mortality (AUC = 0.980), with fair performance for hospitalization duration (AUC = 0.837). The Simplified Motor Scale (SMS), though statistically significant in most outcomes, showed relatively lower predictive validity. Overall, TGCS remains the most reliable tool, with MGCS offering a practical alternative in emergency settings.

Conclusion

This study demonstrates that while the Total Glasgow Coma Scale (TGCS) remains the most accurate tool for predicting intubation needs, morbidity, mortality, and hospitalization duration in traumatic brain injury (TBI) patients, simplified scales like the Modified GCS motor (MGCS) and Simplified Motor Scale (SMS) also offer practical utility. MGCS showed strong predictive performance, closely approaching TGCS, while SMS, despite lower accuracy, provides ease of use and rapid assessment. These findings support the integration of simplified consciousness scales into emergency care, particularly in resource-limited or prehospital settings, and highlight the need for further multicenter studies for broader validation.

Keywords: Traumatic Brain Injury (TBI); Glasgow Coma Scale (GCS); Modified GCS Motor Response (mGCS); Simplified Motor Scale (SMS); Intubation; Consciousness Assessment; Neurological Evaluation; Predictive Validity; Receiver Operating Characteristic (ROC) Curve; Area Under the Curve (AUC); Emergency Medicine; Prognostic Tools; Airway Management; Clinical Outcomes; Hospitalization Duration

Introduction

Traumatic brain injury (TBI) is a major cause of mortality and long-term disability worldwide, necessitating rapid and accurate assessment of consciousness to guide critical interventions such as airway management and intubation [1,2]. The Glasgow Coma Scale (GCS), developed in 1974, remains the gold standard for assessing consciousness in TBI patients, but its complexity and inter-rater variability have led to the development of simplified alternatives [3,4]. Among these, the Simplified Motor Scale (SMS) and Modified GCS Motor Response (mGCS-motor) have emerged as practical tools, particularly in emergency and prehospital settings where quick decision-making is crucial [5,6]. However, their prognostic validity in predicting the need for intubation remains inadequately explored, necessitating further investigation.

While GCS is widely used, it requires the assessment of three components—eye, verbal, and motor responses—which can be challenging in critically ill or intubated patients [7,8]. Several studies indicate that the motor response component alone is the strongest predictor of neurological deterioration and airway compromise, suggesting that simplified scales focusing on motor response may be just as effective [9,10]. Additionally, inter-rater variability among healthcare providers and the difficulty of applying GCS in non-verbal or intubated patients further complicate its utility [11,12].

Simplified assessment tools such as SMS and mGCS-motor aim to improve ease of use and predictive accuracy while maintaining the clinical utility of GCS. The SMS simplifies motor response evaluation into three levels: obeys commands, localizes pain, and withdrawal or worse [13,14]. The mGCS-motor, on the other hand, modifies the traditional GCS motor scale to enhance reliability while retaining its predictive power [15,16]. Both scales are designed for rapid assessment, particularly in prehospital settings, emergency departments, and intensive care units [17].

Intubation is a life-saving intervention for Traumatic brain injury [TBI] patients at risk of airway compromise, aspiration, or respiratory failure [18]. The decision to intubate is often based on GCS scores, with a GCS ≤8 traditionally considered an indication for definitive airway management

[19]. However, given the complexities of verbal and eye responses, a simplified motor-based scale may offer a more practical, reliable, and faster alternative. While previous studies have shown that SMS and mGCS-motor correlate well with GCS in predicting mortality, there is limited research directly comparing their ability to predict intubation needs [20].

Given the global burden of TBI and the need for timely airway management, this study will provide crucial insights into the clinical applicability, reliability, and predictive validity of SMS and mGCS-motor in comparison to GCS. If proven effective, these simplified scales could enhance triage efficiency, improve early intervention, and optimize resource utilization, particularly in prehospital and resource-limited settings.

Aim

To Compare two simplified conscious assessment scale with Glasgow coma scale in prognostic validity and need for intubation.

Objectives

1. To record Glasgow Coma Scale (GCS), Modified GCS Motor Response (mGCS-motor), and Simplified Motor Scale (SMS) scores for patients with traumatic brain injury (TBI) at the time of initial assessment.
2. To document the need for intubation in TBI patients based on clinical indications and correlate it with their GCS, mGCS-motor, and SMS scores.
3. To record morbidity, mortality, and duration of hospitalization among TBI patients and evaluate their association with GCS, mGCS-motor, and SMS scores.
4. To compare the predictive accuracy of GCS, mGCS-motor, and SMS in determining intubation needs, patient outcomes, and hospital stay duration in TBI management.

Methodology

Study Design

A cross-sectional observational study was conducted at KVG Medical College, Sullia, to compare the prognostic validity and need for intubation using the Glasgow Coma Scale (GCS), Modified GCS Motor Response (mGCS-motor), and Simplified Motor Scale (SMS) in patients with traumatic brain injury (TBI).

Study Setting

The study was conducted in the Emergency Department, Trauma Care Unit, and Intensive Care Unit (ICU) of KVG Medical College, Sullia over a period of 12 months.

Study Population

Patients presenting with TBI of varying severity was included.

Ethical Considerations

1. The study was approved by the Institutional Ethics Committee (IEC) of KVG Medical College and hospital, Sullia.
2. Written informed consent were obtained from patients or their legally authorized representatives.
3. Patient confidentiality were maintained, and all data will be de-identified before analysis.

Inclusion Criteria

1. Patients aged with informed consent ≥18 years diagnosed with TBI.
2. Patients presenting to the emergency department within 24 hours of injury.
3. Patients with a documented GCS, mGCS-motor, and SMS assessment at admission.

Exclusion Criteria

1. Patients with pre-existing neurological disorders affecting motor response assessment.
2. Patients with spinal cord injuries leading to impaired motor function.
3. Patients with severe intoxication (alcohol or drugs) affecting consciousness assessment.
4. Patients with incomplete clinical documentation or prior intubation before arrival.

Sample Size

Using the formula,

$$\text{Sample size } (n) = \frac{(Z_{1-\alpha/2})^2 * (\sigma)^2}{(d)^2}$$

Where,

n = Desired number of samples

$Z_{1-\alpha/2}$ = Standardized value for the corresponding level of confidence. At 95% CI, it is 1.96.

d = Margin of error or rate of precision-0.5

σ = SD which is based on previous study or pilot study

Substituting the values, we get

n= 90.5

Therefore, the final sample size is 100.

Statistical analysis

Software: All analyses was conducted using SPSS version 27, Normality of data was checked with the Kolmogorov–Smirnov test.

Demographic and clinical characteristics (age, sex, mechanism of injury, severity of TBI) was summarized using mean, standard deviation, and frequency distributions.

Predictive Validity Analysis

- Receiver Operating Characteristic (ROC) curve analysis was performed to evaluate the predictive accuracy of GCS, mGCS-motor, and SMS in determining the need for intubation.
- Area Under the Curve (AUC) values was compared among the three scales. AUC values will be interpreted as follows:0.90–1.00: Excellent prediction, 0.80–0.89: Good prediction, 0.70–0.79: Fair prediction,0.60–0.69: Poor prediction, <0.60: Fail to predict.

Statistical Significance: A p-value < 0.05 was considered significant.

Procedure

Standardized Data Collection

All assessments was performed by trained emergency physicians, minimizing variability in scoring. Intra examiner Reliability was assessed using Cohen's kappa was found to be $\kappa \geq 0.81$ was considered excellent agreement for GCS, mGCS-motor, and SMS.

Initial Neurological Assessment

- On arrival, emergency physician evaluated each patient's level of consciousness using:

1. Glasgow Coma Scale (GCS)
2. Modified GCS Motor Response (mGCS-motor)
3. Simplified Motor Scale (SMS)

- These assessments were recorded immediately at admission before any interventions are performed.

Intubation Decision & Airway Management

- The decision for endotracheal intubation will be made based on standard clinical criteria, including:

1. GCS score ≤8, indicating a need for airway protection.
2. Signs of airway compromise (e.g., respiratory distress, hypoxia).
3. Loss of protective reflexes (e.g., absent gag or cough reflex).
4. Deteriorating neurological status, as determined by repeat assessments.

- The time of intubation and clinical indication was documented.

Follow-up & Outcome Assessment

- Patients will be monitored throughout hospitalization, and the following outcomes was recorded:

1. Morbidity (neurological complications, infections, or secondary brain injury).
2. Mortality (in-hospital death and cause of mortality).
3. Duration of Hospitalization (total length of hospital stay in days).

Results

Table 1: Clinical profile of the studied population

Variable	n	%	p-value
Gender			
Male	56	56.0	0.230
Female	44	44.0	
Mean Age (years)	42.5 ± 17.8		<0.001
Cause of Hospitalization			
Blunt Trauma	22	22.0	0.81
Penetrating Trauma	23	23.0	
Fall	10	10.0	
Road Traffic Accident	27	27.0	
Assault	18	18.0	
Intubation			
Intubation Not Done	39	39.0	0.028
Intubation Done	61	61.0	
Morbidity			
No Morbidity (0)	81	81.0	<0.001
Morbidity Present (1)	19	19.0	
Mortality			
Survived (0)	74	74.0	<0.001
Death (1)	26	26.0	
Hospitalization Days			
1 Day	41	41.0	<0.001
2 Days	2	2.0	
3+ Days	57	57.0	

A total of 150 were approached to participate in study of which 120 agreed, 20 people were excluded for incomplete data, total of 100 participants were included in the study. The study included 100 patients, with a male predominance (56% male, 44% female; p = 0.230). The mean age was 42.5 ± 17.8 years (p < 0.001). Regarding the cause of hospitalization, the most common reasons were road traffic accidents (27%), followed by penetrating trauma (23%), blunt trauma (22%), assault (18%), and falls (10%) (p = 0.81). Intubation was required in 61% of cases, while 39% did not require intubation (p = 0.028). Morbidity was present in 19% of patients, whereas 81% had no morbidity (p < 0.001). In terms of mortality, 74% survived, while 26% succumbed to their injuries (p < 0.001). The duration of hospitalization varied, with 41% staying for one day, 2% for two days, and 57% requiring three or more days (p < 0.001).

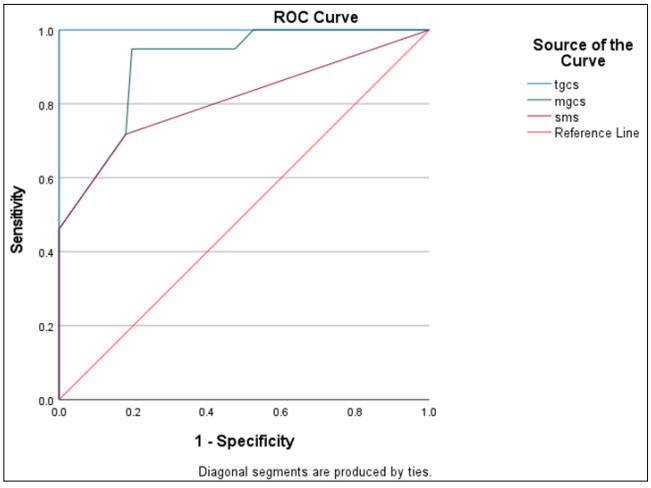

Fig 1: ROC Curve for Predicting the Need for Intubation

Table 2: Area Under the Curve (AUC) for Predicting the Need for Intubation

Test Result Variable(s)	Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
TGCS	1.000	.000	.000	1.000	1.000
MGCS	.908	.028	.000	.852	.963
SMS	.810	.049	.000	.715	.906

The Receiver Operating Characteristic (ROC) curve (Fig. 1) illustrates the diagnostic performance of the Total Glasgow Coma Scale (TGCS), Modified GCS Motor Response (MGCS-motor), and Simplified Motor Scale (SMS) in predicting the need for intubation in traumatic brain injury patients.

The Total Glasgow Coma Scale (TGCS) achieved an AUC of 1.000 (95% CI: 1.000–1.000, p = 0.000), which falls in the range of 0.90–1.00, indicating excellent prediction. This demonstrates perfect sensitivity and specificity, making TGCS the most reliable tool for predicting the need for intubation. [Threshold point -8]

The Modified GCS Motor Response (MGCS-motor) recorded an AUC of 0.908 (95% CI: 0.852–0.963, p = 0.000), also within the excellent prediction range. This reflects a highly reliable ability to distinguish between patients requiring intubation and those who do not. [Threshold point -3]

The Simplified Motor Scale (SMS) showed an AUC of 0.810 (95% CI: 0.715–0.906, p = 0.000), which falls in the good prediction range (0.80–0.89). While not as strong as TGCS or MGCS-motor, SMS still provides a reliable measure for predicting intubation needs as shown in Table.2 [Threshold point -0]

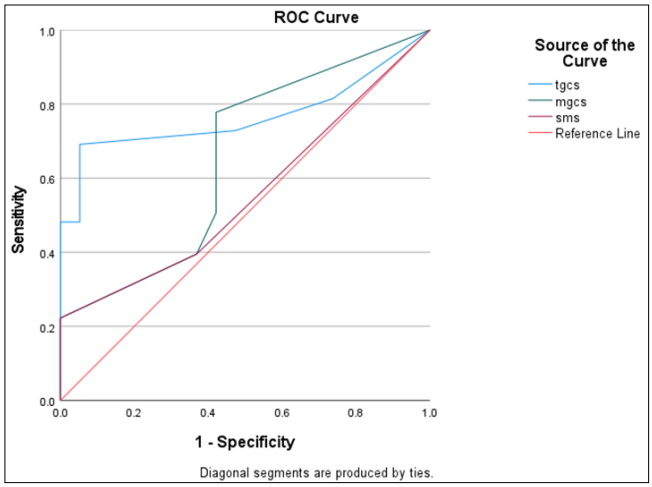

Fig.2: ROC Curve for Predicting the Morbidity

Table 3: Area Under the Curve (AUC) for Predicting the Morbidity

Test Result Variable(s)	Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
TGCS	.766	.046	.000	.675	.857
MGCS	.652	.072	.040	.511	.793
SMS	.554	.066	.463	.425	.684

The ROC curve in Fig. 2 illustrates the diagnostic performance of TGCS, MGCS, and SMS in predicting morbidity based on sensitivity and specificity

The Total Glasgow Coma Scale (TGCS) achieved an AUC of 0.766 (95% CI: 0.675–0.857, p = 0.000), which falls within the fair prediction range (0.70–0.79). This indicates that TGCS has a moderate ability to predict morbidity with a statistically significant result. [Threshold point -5]

The Modified GCS Motor Response (MGCS-motor) recorded an AUC of 0.652 (95% CI: 0.511–0.793, p = 0.040), which is within the poor prediction range (0.60–0.69). While MGCS-motor shows statistical significance, its predictive accuracy for morbidity is limited. [Threshold point -3]

The Simplified Motor Scale (SMS) showed an AUC of 0.554 (95% CI: 0.425–0.684, p = 0.463), which falls in the fail to predict range (<0.60). The result is not statistically significant, indicating that SMS is not a reliable tool for predicting morbidity as shown in Table.3 [Threshold point -1]

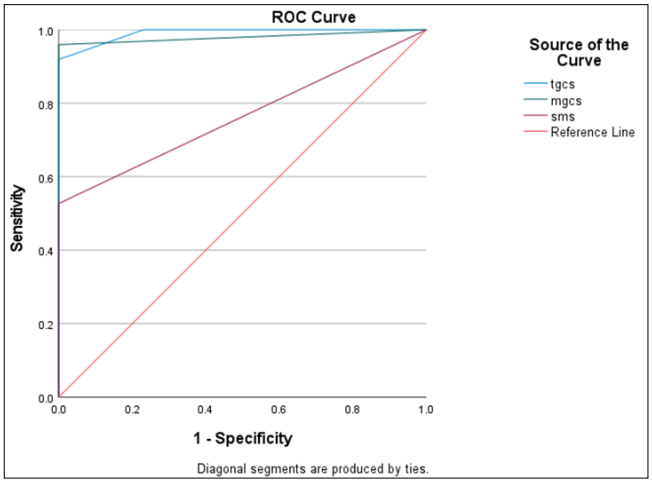

Fig 3: ROC Curve for Predicting the Mortality

Table 4: Area Under the Curve (AUC) for Predicting the Mortality

Test Result Variable(s)	Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
TGCS	.991	.006	.000	.979	1.000
MGCS	.980	.014	.000	.953	1.000
SMS	.764	.046	.000	.673	.854

The Receiver Operating Characteristic (ROC) curve (Fig. 3) illustrates the diagnostic performance of the Total Glasgow Coma Scale (TGCS), Modified Glasgow Coma Scale (MGCS), and Simplified Motor Scale (SMS) in predicting mortality.

The Total Glasgow Coma Scale (TGCS) achieved an AUC of 0.991 (95% CI: 0.979–1.000, p = 0.000), which falls in the excellent prediction range (0.90–1.00). This indicates a near-perfect ability to differentiate between survivors and non-survivors, making TGCS one of the most reliable tools for mortality prediction. [Threshold point -3]

The Modified Glasgow Coma Scale (MGCS) recorded an AUC of 0.980 (95% CI: 0.953–1.000, p = 0.000), also within the excellent prediction range. This suggests a highly accurate ability to classify patients based on their risk of mortality, closely matching TGCS in performance. [Threshold point -2]

The Simplified Motor Scale (SMS) showed an AUC of 0.764 (95% CI: 0.673–0.854, p = 0.000), which falls in the fair prediction range (0.70–0.79). While not as strong as TGCS or MGCS, SMS still provides a moderate yet statistically significant measure for mortality prediction, as shown in Table 4. [Threshold point -0]

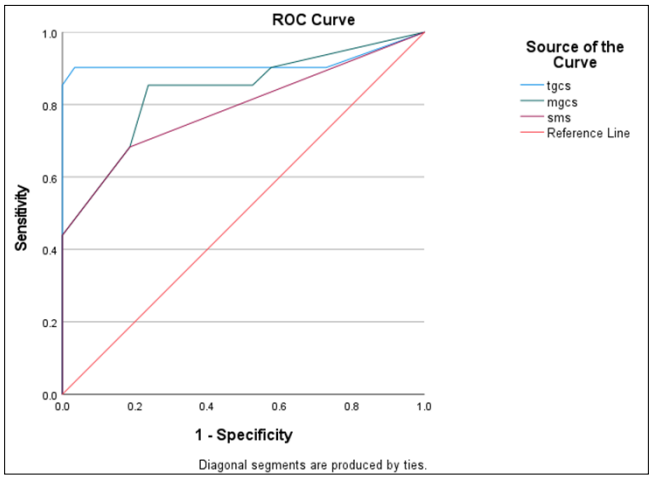

Fig 4: ROC Curve for Predicting the duration of Hospitalization

Table 5: Area Under the Curve (AUC) for Predicting the duration of hospitalization

Test Result Variable(s)	Area	Std. Error[a]	Asymptotic Sibu	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
TGCS	.915	.040	.000	.836	.994
MGCS	.837	.043	.000	.752	.922
SMS	.789	.050	.000	.691	.887

The Receiver Operating Characteristic (ROC) curve (Fig. 4) illustrates the diagnostic performance of the Total Glasgow Coma Scale (TGCS), Modified Glasgow Coma Scale (MGCS), and Simplified Motor Scale (SMS) in predicting the duration of hospitalization.

The Total Glasgow Coma Scale (TGCS) achieved an AUC of 0.915 (95% CI: 0.836–0.994, p = 0.000), which falls in the excellent prediction range (0.90–1.00). This indicates a strong ability to predict the length of hospital stay, making TGCS the most reliable tool among the three. [Threshold point -4]

The Modified Glasgow Coma Scale (MGCS) recorded an AUC of 0.837 (95% CI: 0.752–0.922, p = 0.000), which falls within the good prediction range (0.80–0.89). MGCS demonstrates a reliable predictive capability, though slightly lower than TGCS. [Threshold point -3]

The Simplified Motor Scale (SMS) showed an AUC of 0.789 (95% CI: 0.691–0.887, p = 0.000), which falls in the fair prediction range (0.70–0.79). While SMS provides a moderate ability to predict hospitalization duration, it is less accurate compared to TGCS and MGCS, as shown in Table 5. [Threshold point -0]

This analysis suggests that TGCS is the most effective predictor of hospitalization duration, followed by MGCS and SMS.

Discussion

This study comprehensively evaluates the predictive accuracy of the Total Glasgow Coma Scale (TGCS), Modified Glasgow Coma Scale (MGCS), and Simplified Motor Scale (SMS) in assessing key clinical outcomes in traumatic brain injury (TBI) patients, including intubation needs, morbidity, mortality, and hospitalization duration. Among the three scales, TGCS consistently demonstrated the highest predictive accuracy, achieving an AUC of 1.000 for intubation prediction, 0.766 for morbidity, 0.991 for mortality, and 0.915 for hospitalization duration, indicating excellent predictive reliability. MGCS performed slightly lower than TGCS but still provided statistically significant and reliable predictive values, with AUCs of 0.908 for intubation, 0.652 for morbidity, 0.980 for mortality, and 0.837 for hospitalization duration, demonstrating its strong utility in clinical decision-making. SMS, while the least predictive among the three scales, still showed moderate effectiveness in intubation prediction (AUC = 0.810) and hospitalization duration (AUC = 0.789), but was significantly weaker in morbidity prediction (AUC = 0.554), making it an unreliable predictor for that outcome. These findings suggest that TGCS remains the most robust and comprehensive tool for assessing critical clinical outcomes in TBI patients, particularly for intubation, mortality risk, and prolonged hospitalization. MGCS provides a simplified but still effective alternative, while SMS, despite being easier to use, lacks strong predictive power, especially for morbidity assessment. This reinforces the importance of TGCS and MGCS in guiding emergency and intensive care interventions for TBI patients, ensuring timely and accurate clinical decisions that could significantly impact patient outcomes.

In a systematic review and meta-analysis by Chou *et al*., the total Glasgow Coma Scale (tGCS) demonstrated slightly better discrimination than the motor component of the GCS (mGCS) or the Simplified Motor Score (SMS) in predicting in-hospital mortality, neurosurgical interventions, severe brain injury, and emergency intubation. The differences in the area under the receiver operating characteristic curve (AUROC) were small, ranging from 0.01 to 0.05, suggesting that for every 100 trauma patients, the tGCS could correctly discriminate 1 to 5 more patients than the mGCS or SMS [21].

Similarly, a meta-analysis by Singh *et al*. found that the SMS is comparable to the GCS in predicting outcomes such as emergency tracheal intubation, clinically significant brain injuries, neurosurgical intervention, and mortality in patients with traumatic brain injury (TBI). The study concluded that the SMS, due to its simplicity, could be a practical alternative to the GCS in emergency settings [22].

A study by Gill *et al*. compared five simplified scales to the out-of-hospital GCS for predicting TBI outcomes. The results indicated that the simplified scales, including the SMS, performed as well as the GCS but were easier to calculate, suggesting potential advantages in prehospital care [23].

In a validation study by Thompson *et al*., the SMS was assessed in the out-of-hospital setting for predicting outcomes after TBI. The findings supported the use of the SMS as an accurate and simpler alternative to the GCS for prehospital assessment [24].

A study by Brown *et al*. evaluated the National Trauma Triage Protocol, comparing the GCS to its motor subscale. The research suggested that the motor component alone could perform similarly to the total GCS in predicting severe injury, potentially simplifying trauma triage protocols [25].

Beskind *et al*. compared the prehospital motor component of the GCS to the total GCS as a risk adjustment measure for trauma patients. The study concluded that the motor component is as effective as the total GCS in prehospital settings, offering a simpler assessment tool [26].

Kupas *et al*. found that the GCS motor component ("Patient Does Not Follow Commands") performs similarly to the total GCS in predicting severe injury in trauma patients, suggesting that the motor component alone may be sufficient for assessment [27].

Caterino *et al*. analyzed a statewide trauma registry and found that the prehospital SMS is as accurate as the prehospital GCS, supporting the use of the SMS as a simpler alternative in emergency medical services [28].

A study by Buitendag *et al*. validated the SMS in patients with TBI at a major trauma center in South Africa, confirming its reliability and accuracy as a simplified assessment tool [29].

Namiki *et al*. highlighted inaccuracies and misjudged factors in GCS scores when assessed by inexperienced physicians, suggesting that simpler scales like the SMS could reduce assessment errors [30].

Reith *et al*. reported a lack of standardization in the use of the GCS across international surveys, indicating a need for more consistent and straightforward assessment tools like the SMS [31].

Bledsoe *et al*. found that GCS scoring is often inaccurate, further supporting the potential benefits of adopting simpler scales such as the SMS in clinical practice [32].

Gill *et al*. reported on the interrater reliability of GCS scores in the emergency department, finding variability that could be mitigated by using simpler, more reliable scales like the SMS [33].

Haukoos *et al*. validated the SMS in the out-of-hospital setting for predicting TBI and mortality, supporting its use as a reliable and simpler alternative to the GCS [34].

Overall, these studies suggest that while the tGCS may offer slightly better predictive accuracy, the mGCS and SMS provide comparable performance with the advantage of simplicity, potentially leading to more consistent and accurate assessments in both prehospital and hospital settings.

This study strengthens the comparative evaluation of consciousness scales by objectively analyzing the Glasgow Coma Scale (GCS) alongside simplified alternatives (mGCS-motor and SMS) using robust statistical methods like ROC and AUC. It assesses clinically relevant endpoints such as intubation need, morbidity, mortality, and hospitalization duration, with standardized data collection by trained emergency physicians ensuring reliability ($\kappa \geq 0.81$). Conducted in a tertiary care hospital, the findings are highly applicable to real-world emergency settings. Ethical rigor was maintained with IEC approval and informed consent. With an adequate sample size of 100, the study highlights simplified alternatives suitable for resource-limited and prehospital settings.

This study has some limitations. Conducted in a single tertiary care hospital, its findings may not be generalizable to other settings. The sample size, though adequate, could be expanded for broader validation. While emergency physicians collected data, interobserver variability remains a possibility. The study primarily focused on short-term outcomes like intubation, morbidity, and mortality, without long-term follow-up. Additionally, the simplified consciousness scales were compared only with GCS, limiting comparisons with other established scoring systems.

This study highlights the effectiveness of simplified consciousness scales in assessing patients in emergency settings, demonstrating comparable performance to the Glasgow Coma Scale (GCS) for predicting short-term outcomes like intubation, morbidity, and mortality. Their ease of use makes them valuable tools for rapid neurological evaluation, especially in resource-limited or high-pressure environments. However, further research with larger, multi-center studies and long-term follow-up is needed to validate their broader applicability and predictive accuracy.

The findings of this study suggest that simplified consciousness scales can serve as practical alternatives to the Glasgow Coma Scale (GCS) in emergency settings, aiding rapid neurological assessment with comparable predictive value. Their ease of use may enhance efficiency in prehospital and hospital environments, especially for non-specialist healthcare providers. Implementing these scales could improve patient triage, expedite decision-making, and optimize resource allocation. Further validation through larger studies could support their widespread adoption in diverse clinical settings.

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