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COMPARISON OF GCS VS MOTOR COMPONENT ALONE AS AN EFFECTIVE PREDICTOR IN SEVERE HEAD TRAUMA TRIAGE.

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ABSTRACT

BACKGROUND: Severe head trauma is a leading cause of disability and mortality worldwide, particularly among young adults, and imposes a substantial burden on healthcare systems. **OBJECTIVES:** This study aims to compare the accuracy of the total GCS (GCSt) versus the GCS motor component (GCSm) alone in triaging patients with head trauma. **METHODS:** This six-month longitudinal study was conducted in the Emergency Department of Ziauddin University Hospital, Karachi, enrolling 127 head trauma patients (aged 18–60) via consecutive sampling. Those with ischemic stroke, GCS score of 3, polytrauma, spinal trauma, and prior neurologic conditions were excluded. Background information, vitals and trauma details were recorded, and each patient was assessed using both GCSt and GCSm. Diagnostic accuracy measures sensitivity, specificity, PPV, NPV, and ROC curves were calculated. **RESULTS:** The mean patient age was 43.0 ± 13.0 years; 65.35% were male. Road traffic accidents were the leading cause of head injury, followed by falls. For severe cases; the GCSm demonstrated perfect diagnostic performance with 100% sensitivity, specificity, PPV, NPV, and overall accuracy. In moderate cases, GCSm showed 91.38% sensitivity, 100% specificity, and 96.88% accuracy, with only two false negatives. For mild cases, GCSm achieved 100% sensitivity, 96.55% specificity, and 98.35% accuracy. ROC analysis showed excellent discriminative ability for both GCSt (AUC 0.916; 95% CI: 0.866–0.966) and GCSm (AUC 0.914; 95% CI: 0.862–0.965), both p<0.001. GCSm consistently demonstrated high diagnostic accuracy across all injury severities and mechanisms, including RTAs and falls **CONCLUSION:** The GCS motor component showed high diagnostic accuracy across head trauma severities, closely aligning with total GCS performance, and demonstrated near-perfect sensitivity and specificity in mild and severe cases. Its simplicity and reliability make GCSm a strong, efficient alternative for routine triage in emergency care.

KEYWORDS: Traumatic brain injury; Glasgow coma scale; Predictive Utility, Emergency

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INTRODUCTION

Severe head trauma is a leading cause of disability and mortality worldwide, particularly among young adults, and imposes a substantial burden on healthcare systems. Accurate triage is crucial for prognosis, treatment decisions, and resource allocation[1].

The Glasgow Coma Scale (GCS), comprising eye, verbal, and motor responses (total score 3-15), is widely used to assess traumatic brain injury (TBI) severity[2-7]. Despite its utility, the full GCS is criticized for complexity, inter-rater variability, and limited applicability in unconscious or intubated patients[8,9]. Recent studies suggest the motor component alone (GCSm; score 1–6) may match or surpass the total GCS in predictive accuracy due to its simplicity and reliability[9,10].

In contrast, the Motor Component alone has been proposed as a simpler and potentially more reliable alternative for head trauma triage. However, there is a lack of consensus and definitive evidence to support its standalone use in clinical decision-making. A comparative study assessing the predictive accuracy of GCSt versus GCSm is necessary to address this gap and enhance the efficiency of trauma triage protocols[11].

This study compares the predictive accuracy of GCSt versus GCSm for triaging severe head trauma, evaluating each method's reliability, usability, and implications for emergency care. Findings may inform more efficient triage protocols, especially in resource-limited settings, potentially improving outcomes and reducing healthcare costs.

MATERIAL AND METHODS

This longitudinal study was conducted over six months in the Emergency Department of Ziauddin University Hospital, Karachi, targeting patients aged 18-60 years presenting with head trauma were recruited via consecutive sampling. A sample size of 127 was calculated using an online tool, based on a reported GCSm sensitivity of 26.7%, specificity of 95.1%, and a prevalence of 66.1%[12]. Ethical approval was obtained from the hospital's Clinical Research and Ethical Review Committees.

Inclusion criteria comprised adults with head trauma, while patients with ischemic stroke confirmed on CT, a GCS score of 3, polytrauma, spinal trauma, or prior neurologic disorders were included. Upon presentation, patients' vital signs (heart rate, respiratory rate, blood pressure, and oxygen saturation) were recorded. Presenting symptoms, injury mechanism, and trauma type were also documented. Each patient underwent both GCSt and GCSm assessments to determine trauma severity, recorded in a structured proforma.

The primary objective was to evaluate and compare the diagnostic accuracy of GCSt and GCSm and this was a single time evaluation with no follow-up.

Data were analyzed using SPSS version 25. Quantitative variables were expressed as mean ± SD or median with IQR, based on normality assessed via the Shapiro-Wilk test. Categorical variables were reported as frequencies and percentages. Sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy were calculated. Stratification was performed for potential effect modifiers, and associations were tested using the chi-square test ($p \leq 0.05$). ROC curves were generated for both GCSt and GCSm to assess their predictive accuracy for the worst outcome.

RESULTS

The mean age was 43.00 ± 13.00 years, with males comprising 65.35% of the cohort. Road traffic accidents were the leading cause of head trauma, followed by falls. The mean total GCS score was 11.72, and the motor component averaged 4.35. Severe head injury was observed in

25.98% of cases (Figure 1). The majority of patients (61.42%) required hospital admission table 1.

Table 1: Demographic and clinical characteristics of patients with head trauma

Characteristics		n (%)	Mean±SD	Median (IQR)
Gender	Female	44(34.65)		
	Male	83(65.35)		
Age (years)			43.00±13.00	44.00(24.00)
Age groups	≤45 years	64(50.41)		
	>45 years	63(49.61)		
Injury mechanism	Fall	43(33.86)		
	RTA	76(59.84)		
	Trauma	8(6.30)		
Systolic blood pressure (SBP) mmHg			131.44±21.00	130.0(25.00)
Diastolic blood pressure (DBP) mmHg			78.34±16.06	79.00(22.00)
Heart rate (HR)/min			89.79±16.86	88.00(24.00)
Respiratory rate (RR)/min			20.79±3.06	20.00(2.00)
Oxygen saturation (O_2) (%)			93.82±6.10	96.00(7.00)
Total GCS score (GCSt)			11.72±3.38	13.00(7.00)
GCS motor score (GCSm)			4.35±1.65	5.00(4.00)
Outcome	Admitted	78(61.42)		
	Discharged	37(29.13)		
	DOR	8(6.30)		
	LAMA	4(3.15)		

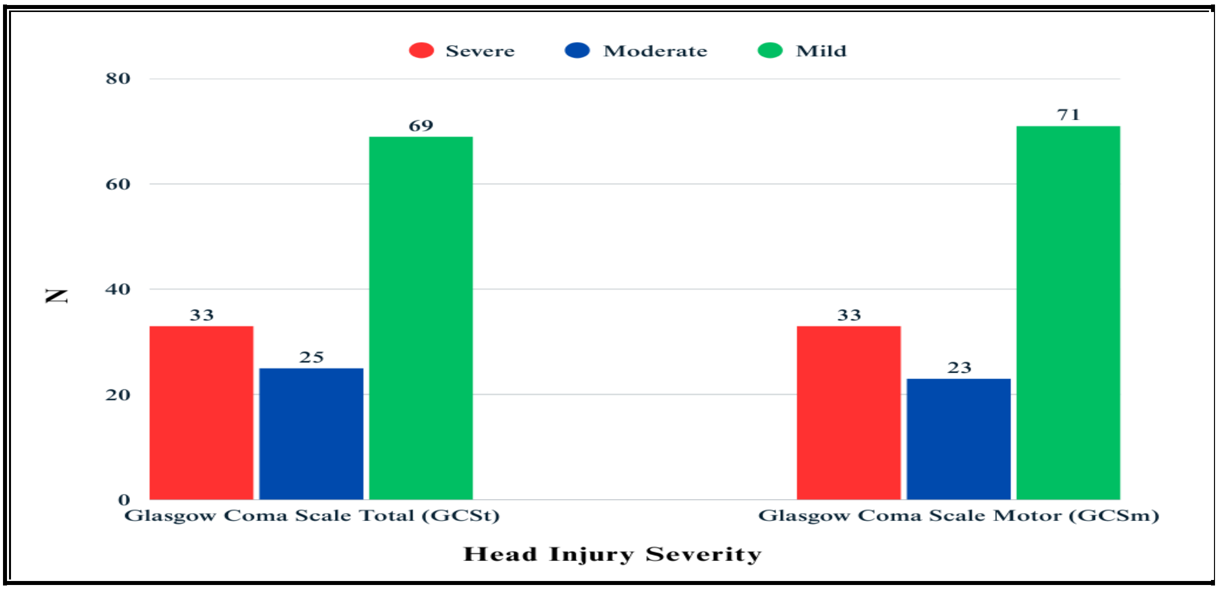

Figure: 1 Head injury severity cutoffs based in GCS total and motor component

Table 2 compares admitted and non-admitted patients, showing that those admitted had significantly lower GCS scores and oxygen saturation, and were more likely to have sustained RTAs, whereas non-admitted patients were more likely to have experienced falls and had higher GCS scores.

Table 2: Comparison of demographic, clinical, and outcome variables between clinical outcome groups

Variables		Clinical Outcome		p-value
		Discharged	Admitted	
Age(years)		40.32±12.91	43.68±13.44	0.208
Age groups	≤45	21(56.76)	39(50.00)	
	>45	16(43.24)	39(50.00)	
Gender	Female	11(29.73)	29(37.18)	
	Male	26(70.27)	49(62.82)	
Injury mechanism	Fall	18(48.65)	17(21.79)	
	RTA	17(45.95)	56(71.79)	
	Trauma	2(5.41)	5(6.41)	
SBP		126.81±14.32	133.47±23.37	0.113
DBP		76.32±15.13	78.85±17.18	0.447
HR		87.27±16.11	91.05±17.12	0.262
RR		20.32±1.92	20.82±3.12	0.375
O_2		97.49±1.3	91.54±6.78	0.000
GCSt		14.92±0.28	10.00±3.15	0.000
GCSm		5.97±0.16	3.49±1.48	0.000
GCSt	Severe	0(0)	33(42.31)	0.000
	Moderate	0(0)	20(25.64)	
	Mild	37(100)	25(32.05)	
GCSm	Severe	0(0)	33(42.31)	0.000
	Moderate	0(0)	19(24.36)	
	Mild	37(100)	26(33.33)	

Table 3: Diagnostic performance of the GCS Motor Component in Predicting GCS Total Severity Categories

Category	TP	FP	FN	TN	Sn (95%Cl)	Sp (95%Cl)	PPV (95%Cl)	NPV (95%Cl)	DA (95%Cl)	P-value
Severe	33	0	0	94	100(96.11–100.00)	100(89.85–100.00)	100(96.11–100)	100(89.85–100.00)	100(97.11–100.00)	< 0.001
Moderate	23	0	2	102	91.38(81.36–96.26)	100(96.37–100.00)	100(93.24–100)	95.33(89.52–97.99)	96.88(92.89–98.66)	< 0.001
Mild	69	2	0	56	100(94.25–100.00)	96.55(88.27–99.05)	96.92(89.46–99.15)	100(93.58–100.00)	98.35(94.17–99.55)	< 0.001

TP, FP, FN, TN, Sn, Sp, PPV, NPV, DA

The diagnostic analysis revealed that in the severe category, GCSm achieved perfect diagnostic metrics, 100% sensitivity, specificity, PPV, NPV, and overall accuracy table 3.

For moderate injuries, GCSm retained high diagnostic precision, with 91.38% sensitivity, 100% specificity, PPV of 100%, NPV of 95.33%, and an overall accuracy of 96.88%. Only two false negatives were identified. In mild cases, sensitivity remained at 100%, specificity was 96.55%, PPV reached 96.92%, NPV was 100%, and overall accuracy stood at 98.35%. These findings affirm the high reliability of GCSm in triaging head trauma severity across all categories table 3.

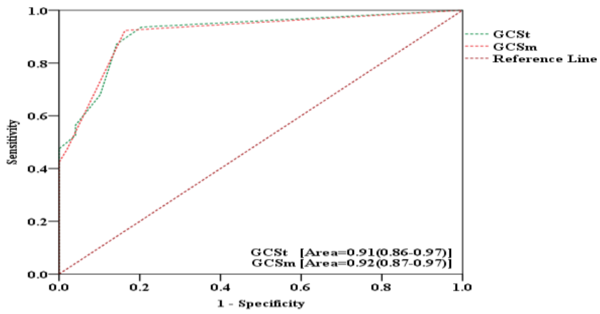

Figure 2: Area under the ROC curve of GCSt and GCSm for predicting of clinical outcomes (admitted)

Diagnostic evaluation of the GCSt demonstrated strong discriminative ability between admitted and discharged patients. ROC analysis yielded an AUC of 0.916 (SE: 0.026, 95% CI: 0.866–0.966, p<0.001), indicating excellent predictive accuracy. At a cutoff of 13.5, sensitivity was 87.2% with a 14.3% false positive rate, suggesting this threshold as a potential optimal point. Similarly, GCSm showed robust predictive performance, with lower scores correlating with higher admission likelihood. Its AUC was 0.914 (SE: 0.026, 95% CI: 0.862–0.965, p<0.001), nearly matching the GCSt in discriminative capacity. Although minor bias from tied outcomes may exist, its effect appears negligible. ROC coordinate analysis for GCSm revealed that a cutoff of 4.5 provided 66.7% sensitivity with an 8.2% false positive rate, while 5.5 improved sensitivity to 92.3% at a 16.3% false positive rate, indicating strong diagnostic performance figure 2.

Subgroup analyses stratified by age, gender, and mechanism of injury confirmed consistently high diagnostic validity of GCSm across categories. Remarkably, for RTAs, trauma, and falls, GCSm maintained excellent sensitivity and specificity, particularly in identifying both severe and mild injuries, often reaching 100% accuracy table 4.

Table 4: Diagnostic performance metrics (Sensitivity, Specificity, PPV, NPV and DA) across demographic and clinical subgroups for severity stratification

Characteristics	Diagnostic values	Sn (95% CI)	Sp (95% CI)	PPV (95% CI)	NPV (95% CI)	P-value
Age group ≤45	Severe	100(83.16-100)	100(91.96-100)	100(83.16-100)	100(91.96-100)	< 0.0001
	Moderate	100(71.51-100)	96.23(86.8-99.5)	84.62(54.55-98.08)	100(93.02-100)	< 0.0001
	Mild	100(88.78-100)	93.94(79.77-99.26)	93.94(79.77-99.26)	100(88.78-100)	< 0.0001
Age group >45	Severe	100(75.29-100)	100(92.89-100)	100(75.29-100)	100(92.89-100)	< 0.0001
	Moderate	100(73.54-100)	100(93.02-100)	100(73.54-100)	100(93.02-100)	< 0.0001
	Mild	100(90.75-100)	100(86.28-100)	100(90.75-100)	100(86.28-100)	< 0.0001
Male	Severe	100(83.16-100)	100(94.31-100)	100(83.16-100)	100(94.31-100)	< 0.0001

	Moderate	100(76.84-100)	98.55(92.24-99.96)	93.33(68.05-99.83)	100(94.72-100)	< 0.0001
	Mild	100(92.6-100)	97.14(85.08-99.93)	97.96(89.15-99.95)	100(89.72-100)	< 0.0001
Female	Severe	100(75.29-100)	100(88.78-100)	100(75.29-100)	100(88.78-100)	< 0.0001
	Moderate	100(66.37-100)	97.14(85.08-99.93)	90(55.5-99.75)	100(89.72-100)	< 0.0001
	Mild	100(83.89-100)	95.65(78.05-99.89)	95.45(77.16-99.88)	100(84.56-100)	< 0.0001
RTA	Severe	100(88.43-100)	100(92.29-100)	100(88.43-100)	100(92.29-100)	< 0.0001
	Moderate	100(76.84-100)	96.77(88.83-99.61)	87.5(61.65-98.45)	100(94.04-100)	< 0.0001
	Mild	100(88.43-100)	95.65(84.95-99.53)	93.75(79.19-99.23)	100(91.96-100)	< 0.0001
Trauma	Severe	100(2.50-100)	100(59.04-100)	100(2.50-100)	100(59.04-100)	0.005
	Moderate	N/A	100(63.06-100)	N/A	100(63.06-100)	NC
	Mild	100(59.04-100)	100(2.50-100)	100(59.04-100)	100(2.50-100)	0.005
Fall	Severe	100(15.81-100)	100(91.4-100)	100(15.81-100)	100(91.4-100)	< 0.0001
	Moderate	100(66.37-100)	100(89.72-100)	100(66.37-100)	100(89.72-100)	< 0.0001
	Mild	100(89.11-100)	100(71.51-100)	100(89.11-100)	100(71.51-100)	< 0.0001

NC = Not calculable due to zero values

DISCUSSION

The predictive utility, reliability, and practicality of GCS scoring, particularly the motor components are critical for outcome stratification and triage in head trauma, especially in emergency care. The cohort comprised predominantly males (65.35%) with a mean age of ~43 years, evenly distributed across age groups. Road traffic accidents (RTAs) were the leading cause of severe injuries. Although most patients presented with stable vitals, GCS scores varied widely, reflecting diverse injury severities. These findings are consistent with global TBI data, where male predominance and RTAs are recurrent patterns due to greater exposure to high-risk environments[1,13,14]. Comparable age and injury profiles in cohort studies and reviews further support the external validity of this dataset[1,14,15].

The mean GCSt score (11.72) and severity distribution (26% severe, 19% moderate, 54% mild) align with prior hospital-based TBI studies[15,16]. Lower GCS scores were associated with poorer outcomes and higher admission rates, consistent with existing literature [16,17].

The GCSm demonstrated high predictive accuracy, with sensitivity and specificity reaching 100% in severe cases and exceeding 90% in moderate and mild categories. ROC analysis yielded AUCs >0.91 for both GCSt and GCSm, confirming excellent discriminative power. These results are supported by recent studies, including a large validation study reporting GCSt >9.5 and GCSm = 6 achieved 90% sensitivity and 88% specificity for consciousness detection (AUC = 0.95)[18]. Comparative analyses indicate that while the FOUR score may have advantages in intubated or aphasic patients, the GCS, especially its motor component remains a robust and reliable predictor of neurological outcomes[19, 20].

The GCS remains the standard tool for initial TBI assessment, despite limitations in intubated patients. Although the FOUR score offers additional clinical parameters, it does not significantly outperform the GCS. The motor component (GCSm) continues to demonstrate high reliability, low inter-rater variability, and strong correlation with clinical outcomes[14,20].

Kupas et al. reported that a binary GCSm cutoff (<6) effectively predicts major trauma outcomes such as severe injury, mortality, ICU admission, and surgical intervention. The difference in predictive accuracy between GCSm and GCSt is less than 5 percent, which is clinically negligible, supporting the use of GCSm for simplified triage in prehospital settings[21].

Jina et al. found similar prognostic accuracy for 30-day mortality in intracranial hemorrhage patients using GCSm (AUC 0.864) and GCSt (AUC 0.871; P = 0.552), with both scores correlating well with Glasgow Outcome Scale measures. While the Simplified Motor Score (SMS) is slightly less accurate than GCSt, it remains a practical tool in acute neurological emergencies. These findings are consistent with the present study, confirming GCSm's strong diagnostic performance across all severity levels and subgroups, and supporting its broader clinical application[22].

Pooled analyses confirm that while the GCSm is the primary predictor of GCSt and outcomes in severe TBI, the eye and verbal components contribute greater prognostic value in moderate and mild injuries. Each component displays distinct floor and ceiling effects; thus, reliance on the total or motor score alone may obscure key clinical differences among patients with similar total scores but varied subcomponent patterns. Prognostic accuracy improves when all three components are evaluated together, especially in less severe TBI[5].

A systematic review and meta-analysis by Chou et.al found that GCSt offers only marginally higher discriminatory power than GCSm or the Simplified Motor Score (AUROC differences < 0.03) in predicting severe trauma, mortality, and need for high-level intervention. These minimal differences are likely clinically negligible and are outweighed by the operational simplicity and high reliability of GCSm, especially in emergency and prehospital settings. These findings align with our results, supporting the GCSm as a robust, efficient tool for rapid triage and early decision-making in severe head trauma[10].

Strengths and Implications

The GCS Motor component emerges as a robust standalone tool for rapid neurological assessment, offering high sensitivity, specificity, and predictive validity across injury severities and demographic subgroups. Its consistent diagnostic performance affirms its utility in emergency and critical care settings, enabling efficient triage without compromising accuracy. Nonetheless, inherent limitations of observational design, namely selection and information bias may affect data integrity. The exclusive focus on in-hospital outcomes neglects long-term sequelae such as cognitive decline, psychiatric morbidity, and diminished quality of life. Moreover, the lack of detailed injury classification and neuroimaging restricts prognostic granularity.

CONCLUSION

In conclusion, the GCS and its motor component (GCSm) demonstrate high reliability, diagnostic accuracy, and clinical utility in assessing and stratifying severe head trauma. The GCSm's robust performance across demographic and clinical subgroups underscores its value in rapid decision-making. Future studies should incorporate long-term outcomes and additional prognostic indicators to optimize TBI management and resource allocation.

ETHICS APPROVAL: The ERC gave ethical review approval. **REFFERENCE CODE: 7670823AAEM DATED:21/09/2023.**

CONSENT TO PARTICIPATE: written and verbal consent was taken from subjects and next of kin.

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