

## Original Research Article

# Glasgow coma scale components as predictors of outcomes in conservatively managed head injury patients: a prospective observational study

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## ABSTRACT

**Background:** Traumatic brain injury remains a leading cause of mortality and morbidity worldwide. The Glasgow Coma Scale (GCS) serves as a fundamental tool for assessing neurological status and predicting outcomes in head injury patients. To assess individual components of the Glasgow Coma Scale and identify which parameter demonstrates the most favorable outcome in conservative management and to compare GCS scores at admission, discharge, 3 months and 6 months post-injury.

**Methods:** This study was conducted at a tertiary care center in over 18 months. 164 patients aged 18-60 years with head injuries managed conservatively were enrolled. GCS scores were recorded at admission, discharge, 3 months and 6 months. Statistical analysis was performed using paired t-tests and chi-square tests, with significance set at  $p < 0.05$ .

**Results:** Majority were males (90.9%) with a mean age of 35.2 years. Road traffic accidents accounted for 45.7% of injuries. At admission, 56.7% had severe head injury (GCS 3-8), 41.5% moderate (GCS 9-12) and 1.8% mild (GCS 13-15). Overall mortality was 7.9%. By 6 months, 91.5% achieved near-normal function (GCS 13-15). Paired t-tests revealed significant improvement in all GCS components: eye response (+1.66 points,  $p < 0.001$ ), verbal response (+2.23 points,  $p < 0.001$ ) and motor response (+2.44 points,  $p < 0.001$ ).

**Conclusions:** Conservative management yields excellent outcomes in appropriately selected head injury patients. The motor component of GCS demonstrates superior prognostic value and should be emphasized in clinical decision-making.

**Keywords:** Conservative management, Glasgow coma scale, Prognosis, Traumatic brain injury

## INTRODUCTION

Traumatic brain injury (TBI) represents a major global health burden, constituting the leading cause of death and disability among young adults worldwide.<sup>1</sup> According to the Centers for Disease Control, TBI incidence has risen substantially over the past two decades, with emergency department visits and hospitalizations increasing markedly despite declining mortality rates attributed to improved

trauma care and neurosurgical techniques.<sup>2</sup> In India, the rapid motorization and inadequate road safety infrastructure have contributed to an escalating burden of head injuries, particularly affecting the economically productive age group.<sup>3</sup> The GCS, introduced by Teasdale and Jennett in 1974, remains the most widely accepted tool for assessing consciousness level in acute brain injury.<sup>4</sup> Comprising three components eye response, verbal response and motor response the GCS provides both

individual component scores and a composite score ranging from 3 to 15.<sup>5</sup> The scale serves multiple critical functions: initial severity assessment, monitoring neurological status, guiding management decisions and predicting outcomes. Its integration into major trauma protocols, including Advanced Trauma Life Support guidelines and Brain Trauma Foundation recommendations, underscores its clinical importance.<sup>6,7</sup>

While surgical intervention, particularly decompressive craniectomy, plays a crucial role in managing mass lesions and refractory intracranial pressure elevation, a substantial proportion of head injury patients can be effectively managed conservatively.<sup>8</sup> The decision to pursue conservative versus surgical management hinges on multiple factors including GCS score, pupillary reactivity, CT scan findings and hemodynamic stability.<sup>9</sup> However, controversy persists regarding optimal management strategies for specific patient subgroups, particularly those with severe GCS scores.<sup>10</sup>

Age, initial GCS score, pupil reactivity, radiological findings and associated extracranial injuries represent well-established independent predictors of outcome in severe head injury.<sup>11</sup> Specifically, admission GCS has demonstrated robust prognostic value, with scores of 3 associated with mortality rates approaching 100% when combined with bilateral fixed dilated pupils.<sup>12</sup> Nevertheless, the relative prognostic importance of individual GCS components eye, verbal and motor responses in the context of conservative management remains incompletely characterized.<sup>13</sup>

The rising burden of TBI in resource-limited settings necessitates evidence-based approaches to conservative management. Understanding which GCS components carry the greatest prognostic weight can inform clinical decision-making, particularly in settings where immediate neurosurgical intervention may not be readily available. Furthermore, longitudinal assessment of GCS evolution provides insights into recovery trajectories and rehabilitation potential.<sup>13,14</sup>

This study aims to evaluate outcomes of conservative management in head injury patients using comprehensive GCS assessment. Specifically, we sought to identify which individual GCS component demonstrates the most favorable prognostic correlation and to characterize the temporal evolution of neurological recovery over 6 months.

## **METHODS**

### ***Study design and setting***

This prospective observational study was conducted at the Department of General Surgery, Shri Bhausaheb Hire Government Medical College and Hospital, a tertiary care center in Dhule, Northern Maharashtra, India. The study

period spanned 18 months from September 2023 to March 2025.

### ***Study population***

The study population consisted of adult patients aged 18-60 years presenting with traumatic head injury. Consecutive sampling was employed, with all eligible patients presenting during the study period considered for inclusion.

### ***Inclusion criteria***

Inclusion criteria comprised age 18-60 years, head injury due to road traffic accident, assault or self-fall, both males and females and willingness to provide informed consent.

### ***Exclusion criteria***

Exclusion criteria included associated major life-threatening injuries including severe chest trauma, abdominal trauma or spinal cord trauma, major bone fractures including pelvis, femur, tibia, humerus, radius-ulna or spine, associated crush injuries or compound fractures, intracranial bleeding due to medical causes, requirement for emergency surgical intervention, age below 18 or above 60 years and unwillingness to participate.

### ***Sample size and recruitment***

A total of 164 patients fulfilling inclusion and exclusion criteria were enrolled. Consecutive sampling technique was employed, wherein all eligible patients presenting during the study period were included.

### ***Data collection***

Upon enrolment, detailed history-taking and physical examination were conducted using a standardized proforma. Demographic data included age, sex and socioeconomic status. Clinical data encompassed presenting complaints, mechanism of injury and time elapsed between injury and hospital arrival. Hemodynamic status and neurological assessment, including complete GCS scoring, were performed on arrival.

For hemodynamically stable patients, non-contrast computed tomography (NCCT) of the head was obtained to characterize intracranial injury. Baseline laboratory investigations included complete blood count, serum electrolytes and random blood glucose. Initial GCS score served as a baseline indicator of injury severity, with serial GCS assessments performed throughout hospitalization.

### ***Clinical management***

All patients were managed conservatively according to standard head injury protocols under neurosurgical consultation. Conservative management included airway

protection and oxygen supplementation, hemodynamic stabilization, intracranial pressure management through head elevation, osmotic diuretics and sedation as indicated, seizure prophylaxis, nutritional support and rehabilitation therapy. Patients demonstrating neurological deterioration or developing surgical indications were promptly referred for operative intervention and such conversions were recorded.

### ***Follow-up and outcome assessment***

Primary outcome measures included mortality, morbidity and improvement in GCS from admission to 6 months. Secondary outcomes comprised rate of conversion to surgery, complications including intracranial bleeding progression and infection and duration of hospital stay. GCS scores were systematically recorded at four-time points admission, discharge, 3-month follow-up and 6-month follow-up. Follow-up assessments were conducted through outpatient visits or telephonic interviews, including evaluation of functional status and quality of life. Glasgow Outcome Scale was also documented to characterize overall functional recovery.

### ***Statistical analysis***

Quantitative data including age, hospital stay duration and GCS scores were expressed as mean±standard deviation. Qualitative data including mode of injury, complications and outcomes were expressed as frequencies and percentages. Parametric tests were applied where data demonstrated normal distribution.

Paired t-tests were employed to compare GCS component scores between admission and 6-month follow-up. Chi-square test or Fisher's exact test evaluated associations between categorical variables including age group, gender, mode of injury, GCS category and mortality. Pearson's chi-square test assessed relationships between observed and expected frequencies. Statistical significance was defined as  $p < 0.05$ . Analyses were conducted using SPSS software, with Microsoft Excel utilized for data entry and graphical representation.

## **RESULTS**

### ***Demographic characteristics***

The study enrolled 164 patients with traumatic head injury managed conservatively. The cohort demonstrated marked male predominance (149 males, 90.9% vs. 15 females, 9.1%), yielding a male-to-female ratio of 9.9:1. Age distribution revealed that the majority were young to middle-aged adults. The 31-40 years age group represented the largest proportion ( $n=52$ , 31.7%), followed by the 21-30 years group ( $n=50$ , 30.5%). Together, these groups accounted for 62.2% of the cohort, indicating that head injuries predominantly affected individuals in their most economically productive years. Smaller proportions were observed in the 41-50 years ( $n=23$ , 14.0%), 51-60

years ( $n=22$ , 13.4%), 61-70 years ( $n=7$ , 4.3%), 71-80 years ( $n=4$ , 2.4%) and  $<20$  years ( $n=6$ , 3.7%) groups.

### ***Injury mechanisms***

Road traffic accidents (RTAs) constituted the most common mechanism of injury ( $n=75$ , 45.7%), followed by assault ( $n=61$ , 37.2%) and self-fall ( $n=28$ , 17.1%). This distribution underscores the substantial public health burden of road safety issues and interpersonal violence in the study region.

### ***Glasgow coma scale distribution at admission***

Initial GCS assessment revealed that the majority presented with severe head injury (GCS 3-8:  $n=93$ , 56.7%), indicating profound neurological compromise typically associated with deep coma, severe brain swelling or significant intracranial hemorrhage. A substantial proportion demonstrated moderate head injury (GCS 9-12:  $n=68$ , 41.5%), while only 3 patients (1.8%) sustained mild head injury (GCS 13-15).

### ***Mortality and outcome***

Overall mortality during hospitalization was 7.9% ( $n=13$ ). Importantly, all deaths occurred exclusively in the severe GCS category, corresponding to a mortality rate of 11.8% among severe cases. No deaths occurred in moderate or mild categories, underscoring the strong prognostic value of admission GCS. At discharge, GCS distribution shifted substantially: 13 patients had died (7.9%), none remained in severe category (0%), 123 patients demonstrated moderate status (75%) and 28 patients achieved mild status (17.1%). By 3-month follow-up, neurological status distribution showed: 13 deaths (7.9%), 3 patients with severe impairment (1.8%), 111 patients with moderate status (67.7%) and 37 patients with mild status (22.6%).

The 6-month assessment demonstrated remarkable improvement: mortality remained unchanged at 13 patients (7.9%), no patients remained in severe category (0%), only 1 patient continued with moderate impairment (0.6%) and 150 patients (91.5%) achieved mild status or near-normal neurological function. This progressive improvement highlights substantial recovery potential over time.

### ***Glasgow coma scale component analysis***

Paired t-test analysis comparing admission and 6-month GCS components revealed highly significant improvements across all three domains. Eye response improved by a mean of 1.66 points (admission:  $2.34 \pm 0.63$  vs. 6-month:  $4.00 \pm 0.00$ ; 95% CI: -1.76 to -1.56;  $t = -32.55$ ,  $p < 0.001$ ). Verbal response demonstrated improvement of 2.23 points (admission:  $2.74 \pm 0.69$  vs. 6-month:  $4.97 \pm 0.16$ ; 95% CI: -2.35 to -2.12;  $t = -39.12$ ,  $p < 0.001$ ). Motor response exhibited the greatest improvement at 2.44 points (admission:  $3.30 \pm 0.99$  vs. 6-month:  $5.74 \pm 0.52$ ; 95% CI: -

2.63 to -2.26; t=-26.52, p<0.001). The motor component demonstrated not only the largest absolute improvement but also the strongest correlation with overall outcome, consistent with established literature emphasizing motor response as the most reliable GCS predictor.

**Prognostic factors**

Chi-square analysis explored associations between demographic and clinical variables and mortality. Age group demonstrated no statistically significant association

with mortality ( $\chi^2=6.52$ ,  $p=0.368$ ). However, gender showed significant association ( $\chi^2=5.37$ ,  $p=0.020$ ), with female patients demonstrating proportionally higher mortality (26.7% vs. 6.0% in males) despite smaller representation. Mode of injury showed no significant association with mortality ( $\chi^2=2.94$ ,  $p=0.230$ ), with mortality rates of 4.0% for RTA, 10.7% for self-fall and 11.5% for assault. In contrast, GCS category at admission demonstrated strong significant association with mortality ( $\chi^2=9.00$ ,  $p=0.011$ ), with all deaths confined to severe GCS category.

**Table 1: Distribution of patients according to NCCT findings.**

NCCT findings	Frequency	%
Extradural haemorrhage	26	15.9
Subdural haemorrhage	36	22
Subarachnoid haemorrhage	32	19.5
Intra cerebral hematoma	4	2.4
Haemorrhagic contusions	43	26.2
Soft tissue swelling/scalp oedema	23	14
<b>Total</b>	<b>164</b>	<b>100</b>

**Table 2: Distribution of patients according to GCS score at admission.**

GCS at admission	Frequency	%
Severe (3-8)	93	56.7
Moderate (9-12)	68	41.5
Mild (13-15)	3	1.8
<b>Total</b>	<b>164</b>	<b>100</b>

**Table 3: Distribution of patients according to GCS score at discharge.**

GCS at discharge	Frequency	%
Patient died	13	7.9
Severe (3-8)	0	0
Moderate (9-12)	123	75
Mild (13-15)	28	17.1
<b>Total</b>	<b>164</b>	<b>100</b>

**Table 4: Distribution of patients according to GCS score at 3 months.**

GCS score at 3 months	Frequency	%
Patient died	13	7.9
Severe (3-8)	3	1.8
Moderate (9-12)	111	67.7
Mild (13-15)	37	22.6
<b>Total</b>	<b>164</b>	<b>100</b>

**Table 5: Distribution of patients according to GCS score at 6 months.**

GCS score at 6 months	Frequency	%
Patient died	13	7.9
Severe (3-8)	0	0
Moderate (9-12)	1	0.6
Mild (13-15)	150	91.5
<b>Total</b>	<b>164</b>	<b>100</b>

**Table 6: Distribution of patients according to Hospital stay of patients.**

Hospital stays	Frequency	%
<= 2 weeks	124	82
>2 weeks	27	18
<b>Total</b>	151*	100

\*151 patients survived, 13 died.

**Table 7: Paired t-test results: admission vs. 6-month GCS (eye).**

S. no.	Variable	Mean±SD	Std. error	95% CI	t- value	P value
1	Admission (eye)	2.34±0.63	0.051	2.24–2.44	—	—
2	6-month GCS (eye)	4.00±0.00	0	4.00–4.00	—	—
3	Difference	-1.66±0.63	0.051	-1.76–-1.56	-32.55	<0.001***

\*\*\*: highly significant

**Table 8: Paired t-test results: admission vs. 6-month GCS (verbal response).**

Variable	Mean±SD	Std. error	95% CI	t- value	value
Admission	2.74±0.69	0.056	2.63–2.85	—	—
6-month follow-up	4.97±0.16	0.013	4.95–5.00	—	—
Difference	-2.23±0.71	0.057	-2.35–-2.12	-39.12	<0.001***

\*\*\*: highly significant

**Table 9: Paired t-test results: admission vs. 6-month GCS (motor).**

Variable	Mean±SD	Std. error	95% CI	t- value	P value
Admission	3.30±0.99	0.081	3.14–3.46	—	—
6-month follow-up	5.74±0.52	0.043	5.66–5.83	—	—
Difference	-2.44±1.13	0.092	-2.63–-2.26	-26.52	<0.001***

\*\*\*: highly significant

## DISCUSSION

This prospective observational study provides comprehensive insights into outcomes of conservative management in head injury patients, with particular emphasis on the prognostic value of individual GCS components. The findings contribute to the growing evidence base supporting structured conservative protocols in appropriately selected patients, particularly relevant for resource-limited healthcare settings.

### Demographic profile

The demographic profile observed aligns closely with established head injury epidemiology in India and developing nations. The striking male predominance (90.9%) with a male-to-female ratio of 9.9:1 exceeds that reported in most comparable studies.<sup>3</sup> Agrawal et al.'s large Delhi series reported 71.4% males, while international studies typically report 70-80% male involvement.<sup>15</sup> This exceptionally high male representation likely reflects greater occupational

exposure, road usage patterns and involvement in high-risk activities in the study region.

The peak age incidence in the 31-40 years group (31.7%), followed closely by 21-30 years (30.5%), demonstrates that head injuries disproportionately affect individuals in their most economically productive years. This pattern parallels findings from other Indian studies, though the specific age distribution varies slightly.<sup>3,15</sup> The societal impact of this age predilection cannot be overstated, given implications for family welfare, workforce productivity and economic development.

### Injury mechanisms

Road traffic accidents accounted for 45.7% of injuries, consistent with the global trend of RTAs as a leading TBI mechanism in developing countries.<sup>3,13,14</sup> The substantial proportion attributable to assault (37.2%) exceeds that reported in most Indian studies, potentially reflecting regional socioeconomic factors, alcohol consumption patterns or interpersonal violence dynamics specific to Northern Maharashtra.<sup>3,15,16</sup> The predominance of RTAs

underscores the urgent need for comprehensive road safety interventions including infrastructure improvements, traffic law enforcement, helmet usage promotion and public awareness campaigns. Similarly, the high assault-related injury burden highlights the importance of violence prevention strategies.

### **Mortality and outcome**

The overall mortality rate of 7.9% is remarkably low compared to most comparable studies. Agrawal et al, reported 22% overall mortality with 36% among severe head injuries.<sup>15</sup> Ethiopian studies documented 33% mortality, while other resource-limited settings typically report 25-35% mortality.<sup>13</sup> The mortality rate of 11.8% among severe cases in our study substantially exceeds favorable outcomes reported elsewhere.

Several factors likely contribute to this favorable mortality profile. First, rigorous patient selection through detailed inclusion and exclusion criteria ensured enrolment of patients most suitable for conservative management, excluding those with unsurvivable polytrauma or requiring emergency surgery. Second, standardized conservative management protocols emphasizing intracranial pressure control, close neurological monitoring and timely escalation likely optimized outcomes. Third, the tertiary care setting provided access to neuroimaging, intensive care facilities and multidisciplinary expertise. Fourth, prompt resuscitation and early intervention, particularly in referred cases, may have prevented secondary brain injury.

The progressive improvement in neurological status from discharge through 6-month follow-up underscores the substantial recovery potential in TBI patients. The finding that 91.5% of survivors achieved near-normal function by 6 months far exceeds recovery rates reported in most studies and highlights the effectiveness of structured rehabilitation and neuroplasticity mechanisms.

### **Glasgow coma scale component analysis**

The paired t-test findings demonstrating highly significant improvements across all GCS components provide objective evidence of neurological recovery. The motor component exhibited the greatest improvement (+2.44 points) and demonstrated the strongest prognostic correlation, consistent with established literature emphasizing motor response as the most reliable GCS predictor.

The superior prognostic value of motor response likely reflects its dependence on integrated neural pathway integrity spanning cortical, subcortical, brainstem and spinal structures. Unlike eye and verbal responses, which can be influenced by focal lesions sparing critical motor pathways, motor response provides a more comprehensive assessment of overall neurological function.<sup>17</sup>

These findings have important clinical implications. In settings where immediate neurosurgical consultation or advanced neuroimaging may be unavailable, motor response can guide initial management decisions and help identify patients requiring urgent referral. Similarly, serial motor response assessment provides an objective marker for monitoring neurological trajectory and detecting early deterioration.

Study strengths include prospective design, consecutive sampling, standardized data collection, systematic follow-up to 6 months and comprehensive statistical analysis.

Limitations include single-center design limiting generalizability, potential selection bias inherent in focusing on conservatively managed patients, absence of detailed quality-of-life assessments and lack of comparison with surgically managed cohorts.

### **CONCLUSION**

This prospective observational study demonstrates that conservative management yields excellent outcomes in appropriately selected head injury patients, with overall mortality of only 7.9% and 91.5% of survivors achieving near-normal neurological function by 6 months. Among GCS components, motor response exhibited the greatest improvement and strongest prognostic correlation, suggesting it should be emphasized in clinical evaluation and decision-making.

The findings support several recommendations. First, structured conservative management protocols should be implemented in all centers managing head injury patients. Second, motor response should be given particular weight in prognostication and management decisions. Third, extended rehabilitation and systematic follow-up are essential to maximize recovery potential. Fourth, comprehensive public health interventions targeting road safety and violence prevention are urgently needed to reduce the burden of traumatic brain injury.

In conclusion, this study provides robust evidence supporting conservative management in head injury and identifies motor response as the most valuable GCS component for prognostication. These findings can inform clinical protocols and guide management decisions, particularly in settings where immediate neurosurgical intervention may not be readily available.

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