

The Interplay of Glasgow Coma Scale, Vital Signs And Emergency Department Disposition in Road Traffic Injuries

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Abstract

Background: Understanding the combined effect of vital signs, Glasgow Coma Scale (GCS) scores and collision, can strengthen the risk assessment and improve the clinical outcomes in Emergency Departments (ED). The study aimed to identify the association of GCS scores with vital signs, collision type and ED disposition among RTI patients

Methodology: This Observational cross-sectional study included 821 RTI patients. Data were recorded on demographics, vitals and injury details in a structured questionnaire. Neurological status was assessed using GCS. Systolic blood pressure (SBP), heart rate (HR), respiratory rate (RR) and oxygen saturation (SPO₂) were recorded. Descriptive statistics represented as percentage or as mean±SD with 95% CI. Student's t-test and Chi-square test were used to compare two groups and ANOVA for more than two groups.

Results: GCS scores were not associated with age and gender. GCS motor scores were associated with HR and eye scores were associated with RR. GCS scores were associated with SPO₂ levels in eye, verbal and motor categories. GCS scores not associated with SBP. GCS scores were associated with collision type and ED outcome.

Conclusions: The study identifies GCS as a robust prognostic tool, indicating that neurological impairment is independent of age and gender among RTI patients and significantly associated with SPO₂, mechanism of injury and ED outcome. These findings suggest that GCS may serve as a valuable clinical indicator when integrated with physiological markers for predicting ED disposition. It will assist in guiding resource allocation and clinical management strategies for RTI patients.

Key-words: Glasgow Coma Scale, Heart Rate, Respiratory Rate, Oxygen Saturation, Blood Pressure.

Introduction

Road traffic accidents (RTAs) are indeed an escalating public health issue in India, causing mortality, morbidity with considerable socio- economic burden.(1) India accounts for 1,40,000 deaths per year; with frequent injuries.(2) Road traffic injuries (RTIs) are ranked as the 7th leading reason of the disease burden.(3) The rising trend of fatalities due to RTA would be a critical health concern in India.(4,5) In the opinion of experts, a massive 63% of the global population could be injured following RTAs by 2030. This alarming situation of increasing RTA events is driven by a combination of factors including urbanization, advancements in automobile industry, growth in market economy, compromised road conditions, over- speeding, driving under the influence of alcohol, insufficient knowledge of traffic rules and training.(2)

There is a dynamic interplay of numerous factors at the time of injury which decide the fate of healing. Patient outcomes depend on type and severity of injury, pre- hospital care, co- morbidities, level of neurological impairment, vital signs and individual factors.(6-11)

In spite of the advancements in the early management and recovery, there is still a higher rate of mortality among severely injured patients.(12-16) Vital signs serve as a key indicator of patient's baseline health status and the impact of pre- hospital emergency care.(17-19) The complications, requirement of surgery, life- saving interventions, mortality rate can be predicted with monitoring the vital signs during hospital emergencies.(20) The important vital signs include Systolic blood pressure (SBP), Heart rate (HR), Respiratory rate (RR) and Oxygen saturation (SPO₂). Deranged vital signs have been shown to be associated with the severity of injury and increased requirement of fluids.(21,22)

These vital signs along with the level of consciousness remain significant measures of patient assessment.(18) The level of consciousness and neurological impairment in patients is assessed by Glasgow Coma Scale (GCS).(23) Investigating the association of GCS with collision type can provide insights into the degree of impaired neurological function due to different types of accident. GCS scores in association with ED disposition may help to predict the level of care required by the patients leading to the timely interventions and improved outcomes.

Exploring these associations can help in deciding the resource allocation and treatment modalities in road traffic accident patients.

Objective

To identify the association of Glasgow Coma Scale (GCS) with vital signs, types of collision and Emergency department disposition in road traffic injury patients admitted to the Trauma Unit.

Methodology:

The study has been approved by the Institutional Ethics Committee. All the patients admitted to the Trauma Unit of the hospital following road traffic accidents (RTA) between 2019 and 2020 were ruled out from the nominal register maintained at casualty. The patients were visited at their respective wards within 24 to 48 hours of admission. The patients were explained the purpose of the study and importance of their participation. The patients willing to participate in the study, were recruited for data collection. A total of 821 patients provided the written informed consent to participate in the study and were subsequently enrolled. A pre-designed and pre-tested questionnaire was used to collect data using interview method. Interview was conducted in the local language (Hindi) of the participants. The questionnaire included information on demographics, vitals, status of consciousness and injury related details such as type of vehicle, type of collision, dominant type followed by the admission related details. Patients' responsiveness was assessed by Glasgow coma scale (GCS). Vital signs were recorded in terms of systolic blood pressure (SBP), heart rate (HR), respiratory rate (RR) and oxygen saturation (SPO2). The collected data were entered in Microsoft Excel sheet. The analyses were performed using Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics for nominal or categorical variables were represented as percentages and continuous variables as means with standard deviations (SD) with 95% confidence interval (CI). Two independent groups were compared by the Student's t-test. Categorical variables were compared using the Chi-square test. Data in more than two groups were compared by One- way Analysis of Variance (ANOVA) and the significance of mean difference within the groups was done by Bonferroni post-hoc analysis.

Results:

The mean age of the RTI patients recruited in the study was 32.98 ± 14.41 years. 91% of total patients were male and 9% were female. RTI events occurred in different months of the year has been depicted in the Figure-1. The highest RTI events occurred in the month of December (63.3%) followed by 6% in the months of April and September each, 4.2% in August, 3.5% in October, 3.4% in July, 3.1% in May and November each. Less than 3% RTI events occurred between January to March and June months. GCS scores across three parameters: Eye, Verbal and Motor were recorded in all the patients. GCS eye response exhibited that majority of the patients (41%) responded spontaneously followed by 30% responded to sound, 23% responded to pressure and 6% did not respond. GCS scores for verbal responsiveness showed that 45% patients were well oriented, 24% responded by speaking inappropriate words, 21% were confused, 5% produced incomprehensible sound and 5% did not respond. GCS scores in motor response exhibited that 57% obeyed the commands indicating normal motor function, 21% had localized pain, 11% showed withdrawal due to pain, 7% had abnormal flexion, 1% showed abnormal extension and 3% had no motor response indicating compromised motor function. The association of GCS scores for eye, verbal and motor responsiveness was studied with age and gender. Both age and gender were not associated with GCS scale in the present study (Table-1&2).

The association of GCS scores was studied with vital signs (Table-3). GCS responses in eye, verbal and motor categories were not associated with SBP. Heart rate was not associated with eye and verbal responses. However, a significant association was observed with motor responses. Post-hoc analysis demonstrated the most significant difference in the heart rate among patients who showed abnormal flexion and those who obeyed the commands. Respiratory rate had a significant association with eye response, particularly between patients who responded to sound and those with spontaneous response. Verbal and motor scores were not associated with respiratory rate. SPO2 is the only vital sign among all the observed signs which showed significant association with all the three parameters of GCS responses; eye, verbal and motor. The total GCS scores showed an insignificant correlation with SBP, heart rate and respiratory rate. However, SPO2 had a significant correlation with total GCS scores.

The association of GCS scores with different types of collision was studied (Table-4). GCS scores for eye responsiveness were significantly different in all types of collision. The post-hoc analysis showed the strongest association among head collision, hit from back and hit pedestrian. Similarly, there was a significant difference in verbal, motor and total GCS scores among all the collision types. The post- hoc analysis for GCS verbal

responsiveness exhibited that the scores in case of Hit pedestrian were significantly different from all the other types of collision except for hit from side. The post-hoc analysis of GCS scores for motor responsiveness showed the most significant association between head collision and hit fixed object. The inter-group analysis of total GCS scores showed significant association of scores in head collision with hit from back and skid individually. The association between GCS scores and ED disposition showed a significant association for all the three parameters i.e. eye, verbal, motor and total GCS scores. The score of the patients discharged and those admitted in the ward were the most significantly associated scores with all the other disposal categories (Table-4).

Discussion:

The study exhibited that RTAs disproportionately affected more males (91%) than females. Road Safety in India Status Report (2023) corroborated similar findings.(24) This disparity of higher RTI incidence in males is multifactorial, comprising of more exposure of males to driving and hazardous road conditions, over-speeding, overtaking, drink and drive.

Two wheeled vehicles (72.6%) were the predominant type of vehicle in RTAs in our study population followed by four wheeled vehicles (8.5%). A report on Road Accidents in India (2021) has also exhibited the consistent findings.(25) Young adults experience more injuries and fatalities due to RTAs in two wheeled vehicles as they avoid using helmets, use mobile and ear phones and are involved in reckless driving.

Further evaluation of data exhibited a captivating fact that the maximum RTA incidences were recorded in the month of December (65%) followed by 6% in the months of April and September each. The lowest RTAs were reported in the month of February (0.8%). The plausible contributing factors in the rural areas could be the reduced visibility due to fog in the month of December and more people commute due to vacations leading to increased traffic volume. The weather transition in the month of April may cause dust storms and sudden/unexpected rainfall affecting the road conditions and visibility. April, being the harvest season, in some regions, may affect the traffic as there is increased movement of heavy agricultural vehicles. In the present scenario of climate shift, heavy rainfall is observed in the month of September leading to reduced visibility and poor road conditions which may cause skidding and hydroplaning. In a report on Road Accidents in India (2021), highest RTAs were indicated in January alone and May was the month with lowest reported RTAs.(25) A discordant finding has been reported by Lopez et al (2006) where the maximum accidents were observed in May because of the intense summer season.(26)

RTIs occurred in rural areas accounted for 70% of all the accidents and metropolitan areas for 30%. This pattern is in concordance with survey reports on Road Accidents in India for two subsequent years (2021 and 2022).(25,27) This disparity can be explained by for higher incidences of RTAs in rural areas. Multiple interconnected factors are responsible for this disparity including poor road infrastructure (road surface quality, street lights, safety features), mixed type of vehicles (heavy and light), awareness and weaker enforcement of traffic rules etc.

The neurological assessment was done using Glasgow Coma Scale. The mean total GCS score of the surviving patients in our study population was 12.22±3.04 suggesting mild neurological impairment. Whereas, the deceased patients had a mean GCS score of 9.34±3.12. In a study by Cassagnol et al., the mean GCS score of 14 have been reported in surviving trauma patients and score of 6 in those who died.(28) Younger age of the patients and non-existence of the co-morbidities might explain the near to normal neurological function. Also, the injury might have affected other body parts than having a significant effect on head. However, age was not found to be associated with GCS for eye, verbal and motor responses in the study which again could be because the majority of patients were young adults. Gender wise distribution of patients revealed that GCS scores were not significantly different between male and female patients. GCS scores in RTA patients are initially recorded to assess the immediate impact of the injury on neurological function. The gender might have an influence on long-term trauma outcomes, however, there is no biological reason for a significant difference in GCS scores between the two genders.

Normal SBP was observed in majority of the patients and it was not associated with GCS. The mean HR of the patients was slightly lower than the normal rate and it was associated with GCS motor responses. RR had a significant association with GCS eye responses. SPO₂ is the only vital sign associated with eye, motor and verbal responsiveness of GCS. The response to trauma varies among individuals depending on their general health, age and physiological factors responsible for the robust coping mechanism. The impairment in the neurological function may occur irrespective of the initial changes in vital signs as these are not sensitive indicators of early dysfunction. GCS scores are used to analyse the level of consciousness in terms of eye, verbal and motor response. It determines the brain integrity and functions. It may not directly measure the important functions of the respiratory and cardiovascular systems. These underlying factors could explain the reason for the

insignificant association observed in the study. Norwegian and American Trauma Registry reports confirm this finding as 97% and 98% of surviving trauma patients, respectively had normal vital signs.(29) In a systematic review by Totten et al, vital signs have been suggested to have a low sensitivity and high specificity among injury patients.(30)

GCS had significant association with different types of collision. The patients who sustained head collision scored the lowest indicating the severely reduced level of consciousness among all the patients. The force exerted on the head may vary in magnitude and direction depending on the type of collision. Apart from the mechanism of injury, the severity of the collision impact is also likely to cause severe injuries, consequently reduced GCS scores. GCS had a significant association with Emergency Department outcomes. GCS, in spite of being a valuable tool, has limitations in prognosticating the long- term outcome independently. However, the scores might be used as one of the factors to be considered in predicting the outcome and treatment allocation. Emergency department is an important and burdened unit of a hospital and GCS scores aid in deciding the requirement of further investigation and line of treatment. The decisions then lead to shifting the patients to other appropriate units, therefore, reducing the burden of ED.

The study has a limitation of being conducted at one Trauma Unit only. A comprehensive follow-up research on a larger cohort of patients from multiple trauma units is required to have a more precise picture on association of GCS with vitals. The robust information on co-morbidities, medications, alcohol consumption and sleeping pattern is also required for improved and accurate outcomes.

Conclusion:

This study highlights the epidemiological and clinical profile of RTI victims admitted to the emergency department and underscores the prognostic relevance of the GCS in this population. RTIs predominantly affected young adult males, with a clear seasonal peak observed in December. Neurological assessment revealed a wide spectrum of impairment across eye, verbal, and motor responses, reflecting varying injury severity at presentation.

Demographic factors such as age and gender were not significantly associated with GCS scores, indicating that neurological status following RTI is largely independent of these variables. Among physiological parameters, oxygen saturation demonstrated a consistent and significant association with all components and the total GCS score, highlighting its importance as a key indicator of neurological compromise. In contrast, systolic blood pressure and respiratory rate showed limited association, while heart rate was selectively associated with motor response. The mechanism of collision was significantly associated with eye, verbal, motor, and total GCS scores, with collisions involving head impact, pedestrians, and fixed objects showing greater neurological impairment. Furthermore, GCS scores were strongly associated with emergency department disposition, effectively distinguishing patients who were discharged or admitted to the ward from those requiring higher levels of care. In conclusion, GCS remains a robust and clinically valuable tool for early neurological assessment, triage, and disposition planning in RTI patients. When combined with oxygen saturation and mechanism of injury, GCS can enhance early risk stratification and inform timely clinical decision-making in emergency care settings.

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Tables

Table- 1: Association of GCS with age

GCS Responses	Age (years)	p-value
GCS Eye		
No response	35.41+14.86	0.143
To pain	34.32+14.52	
To sound	31.53+14.23	
Spontaneous	33.00+14.43	
GCS verbal		
None	36.21+15.61	0.293
Sounds	33.43+16.78	
Words	33.22+13.95	
Confused	34.21+14.73	
Oriented	32.01+14.19	
GCS Motor		
None	38.23+18.10	0.440
Extension	36.18+13.28	
Abnormal flexion	34.54+14.88	
Normal flexion	33.74+14.19	
Localising	32.44+14.96	
Obeys commands	32.58+14.06	

Table-2: Association of GCS with gender

GCS Responses	Gender		p-value
	Male	Female	
GCS Eye	3.04+0.93	3.12+0.95	0.470
GCS Verbal	4+1.92	3.81+1.24	0.811
GCS Motor	5.26+2.43	5.02+1.35	0.772
Total GCS	12.17+3.06	11.67+3.54	0.247

Table-3: Association of GCS with Vital signs

GCS Responses	Vital Signs			
	Systolic Blood Pressure	Heart Rate	Respiratory Rate	SPO ₂
GCS Eye				
No response	120.74+26.36	93.46+24.53	19.76+3.80	92.60+15.35
To pain	129.96+25.65	89.22+19.24	19.71+5.76	95.05+7.78
To sound	129.62+21.27	91.84+10.02	19.11+2.33	95.97+6.09
Spontaneous	132.74+75.61	89.34+16.10	20.87+7.49	96.34+6.59
p- value	0.525	0.179	0.003*	0.009*
GCS verbal				
None	118.64+27.44	92.84+24.33	19.74+4.15	92.46+16.08
Sounds	131.79+28.25	96.28+21.72	21.93+11.07	94.48+4.39
Words	129.60+21.85	90.39+15.60	19.40+2.55	95.74+3.20
Confused	128.84+20.89	88.29+17.26	19.97+7.23	96.14+3.99
Oriented	133.61+71.87	90.63+16.21	20.12+5.52	96.54+5.51
p- value	0.461	0.071	0.131	<0.001*
GCS Motor				
None	161.44+26.15	89.38+29.44	19.66+5.88	91.38+23.1
Extension	133.18+24.38	92.09+16.74	20.36+2.41	91+6.19
Abnormal flexion	131.98+24.05	97.66+19.17	21.19+3.10	94.33+4.14
Normal flexion	131.23+24.53	90.58+18.94	19.36+2.42	95.70+3.95
Localising	129.19+22.48	90+18.13	19.66+5.86	95.86+8.27
Obeys commands	129.42+48.51	89.42+16.38	20.11+6.48	96.13+6.73
p- value	0.233	0.047*	0.507	0.017*

Table-4: Association of GCS with type of collision and ED disposal

Types of Collision	GCS Responses			
	GCS Eye	GCS Verbal	GCS Motor	Total GCS
Head Collision	2.86+0.94	3.81+1.19	4.98+1.27	11.07+3.14
Fall from moving vehicle	3.26+1.04	3.84+1.38	5.05+1.54	11.84+4.14
Hit from back	3.20+0.83	4.09+1.08	5.36+1.08	12.66+2.62
Hit from side	3.00+0.77	4.36+0.92	4.90+1.13	12.27+2.32
Skid	3.22+0.78	4.23+0.92	5.54+0.79	13.01+2.14
Hit fixed object	2.93+0.95	3.91+1.19	6.56+9.61	11.37+3.07
Hit pedestrian	3.57+0.97	5.85+9.10	4.90+1.67	11.28+5.01
p- value	<0.001*	<0.001*	0.014*	<0.001*
ED Disposal				
Absconded	2.66+0.90	3.63+1.19	4.85+1.29	11.13+3.05
Died	2.31+0.89	3.03+1.28	4.00+1.54	9.34+3.12
Discharged	3.43+0.75	4.42+0.95	5.64+0.83	13.47+2.36
Ward	3.10+1.07	4.04+3.95	4.75+1.49	11.42+4.00
LAMA	2.59+0.71	3.76+0.83	4.72+1.01	11.10+1.78
Transferred to other hospital	2.42+0.67	3.01+0.70	5.88+7.62	10.38+2.03
p- value	<0.001*	<0.001*	<0.001*	<0.001*

Figures

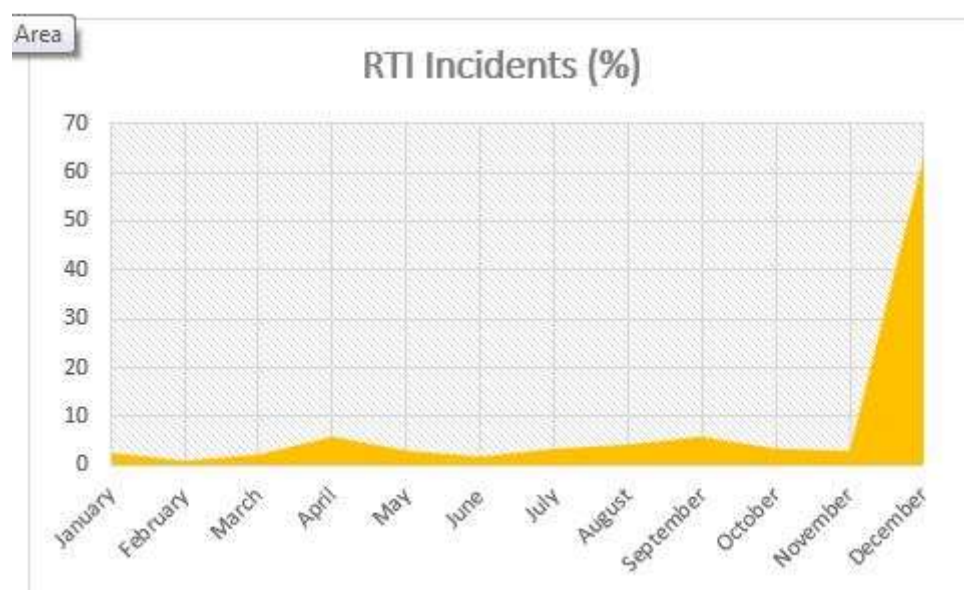


Figure-1: Month wise RTI incidents (%)