

Predictors of Outcome in Management of Head Trauma: A Retrospective Study

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ABSTRACT

Background: Traumatic brain injury (TBI) is a leading cause of mortality and morbidity worldwide, particularly in low- and middle-income countries. Identifying predictors of outcomes is essential to improve management strategies and patient prognosis.

Objective: To assess clinical and radiological predictors of outcomes in patients with head trauma admitted to Mardan Medical Complex, Bacha Khan Medical College, Mardan.

Material and Methods: This retrospective observational study was conducted at Mardan Medical Complex, Bacha Khan Medical College, Mardan, over twelve months, from January to December 2023. A total of 354 patients admitted with head trauma were included. Patient data, including demographics, Glasgow Coma Scale (GCS) on admission, mechanism of injury, CT findings, timing of intervention, and type of management, were collected. Outcomes were categorized as favorable (good recovery, moderate disability) or unfavorable (severe disability, vegetative state, death) using the Glasgow Outcome Scale. Data were analyzed using SPSS version 25, employing chi-square tests to assess associations. A p-value <0.05 was considered statistically significant.

Results: The mean age of patients was 49.45 ± 18.64 years. Favorable outcomes were observed in 244 (68.9%) patients, while 110 (31.1%) had unfavorable outcomes. Patients with mild GCS had favorable outcomes in 69.1% of cases, while severe GCS cases had favorable outcomes in 79.1%. Early intervention resulted in favorable outcomes in 70.8% of cases, compared to 63.8% for delayed interventions. None of the predictors demonstrated statistically significant associations with outcomes.

Conclusion: Although no statistically significant associations were observed, trends in GCS scores, CT findings, timing of intervention, and type of management highlight their potential roles in influencing outcomes. Further research is needed to validate these findings and enhance prognostic accuracy.

Keywords: Traumatic brain injury, Glasgow Coma Scale, Head trauma, Predictors, Clinical outcomes, Retrospective study..

1. INTRODUCTION:

Traumatic brain injury (TBI) is a significant global health issue, contributing to considerable morbidity and mortality across all age groups. Despite advancements in emergency care and neurosurgery, the heterogeneity of TBI outcomes highlights the need to identify robust predictors to improve prognosis and guide management [1,2]. TBI encompasses a spectrum of injuries, from mild concussions to severe brain trauma, and is a leading cause of trauma-related deaths worldwide [3,4].

Clinical parameters such as the Glasgow Coma Scale (GCS) remain critical in assessing TBI severity. Lower GCS scores are strongly associated with poor outcomes, especially when combined with signs of raised intracranial pressure or abnormal pupillary responses [5]. Radiological findings, including subdural hematomas, midline shifts, and obliterated basal cisterns, further refine prognostication by revealing the extent of brain injury [6,7]. Advanced age is another negative prognostic factor, as older patients are more prone to systemic complications and slower recovery [8].

Emerging biomarkers have also demonstrated potential in predicting TBI outcomes. The neutrophil-to-lymphocyte ratio (NLR) and serum glucose-to-potassium ratio are novel indicators of systemic inflammation and metabolic derangements, which have been linked to higher mortality and poor functional recovery [9,10]. Moreover, extracranial injuries, such as thoracic trauma and polytrauma, exacerbate TBI severity by increasing the inflammatory response and impairing oxygen delivery to the brain [11].

In pediatric populations, TBI outcomes tend to be better due to greater neuroplasticity and aggressive treatment protocols, whereas elderly patients often experience compounded risks from comorbidities and reduced physiological resilience [12]. Recent advances in machine learning offer promising avenues for improving prognostic models by integrating complex datasets. These tools outperform traditional statistical methods in predicting long-term outcomes, particularly in pediatric and severe TBI cases [13].

This study aims to evaluate predictors of outcomes in TBI through a retrospective analysis of demographic, clinical, and radiological factors. By understanding these predictors, we seek to improve clinical decision-making and optimize patient outcomes.

2. MATERIAL AND METHODS

This retrospective observational study was conducted to assess predictors of outcomes in the management of head trauma. The study was carried out at Mardan Medical Complex, Bacha Khan Medical College, Mardan, over twelve months, from January to December 2023. The sample size was calculated using the prevalence of unfavorable outcomes reported in a study by Nigussie B et al., where 36% of patients had unfavorable outcomes. At a 95% confidence level and a margin of error of 5%, the calculated sample size was 354 patients [13]. Consecutive sampling was employed to include all eligible patients who met the inclusion criteria during the study period.

Patients of all ages with a confirmed diagnosis of head trauma were included, provided they were admitted and managed at Mardan Medical Complex, Bacha Khan Medical College, Mardan and had complete medical records. Patients with incomplete medical records, those transferred to another facility during treatment, and those with non-traumatic brain injuries such as stroke or tumors were excluded from the study. Data were collected retrospectively from patient records, and a structured form was used to extract clinical and demographic information. The dependent variable was the outcome, assessed using the Glasgow Outcome Scale (GOS), which categorized patients into good recovery, moderate disability, severe disability, vegetative state, or death. For analysis purposes, outcomes were further grouped into favorable (good recovery, moderate disability) and unfavorable (severe disability, vegetative state, death) categories. Independent variables included patient-related factors such as age and Glasgow Coma Scale (GCS) on admission, injury-related factors such as mechanism of injury (road traffic accident, fall, assault) and CT findings (intracranial hemorrhage, midline shift), and treatment-related factors such as timing of intervention (early or delayed) and type of management (surgical or conservative).

Data were analyzed using SPSS version 25. Descriptive statistics summarized patient characteristics and outcomes, with categorical variables presented as frequencies and percentages and continuous variables as means and standard deviations. For statistical analysis, chi-square tests were used to compare categorical variables with the binary outcome categories (favorable and unfavorable outcomes). A p-value of less than 0.05 was considered statistically significant.

3. RESULTS

The study included a total of 354 patients with head trauma. The mean age of the patients was 49.45 years with a standard deviation of 18.639 years.

The outcome variable categorized patients into favorable outcomes (good recovery and moderate disability) and unfavorable outcomes (severe disability, vegetative state, and death). Among the total of 354 patients, 244 (68.9%) had favorable outcomes, while 110 (31.1%) had unfavorable outcomes. (Fig. 1)

The analysis evaluated the association of patient characteristics and clinical predictors with outcomes classified as favorable (good recovery, moderate disability) or unfavorable (severe disability, vegetative state, death). While none of the predictors demonstrated statistically significant associations with outcomes, some trends were observed.

Patients with mild GCS had favorable outcomes in 150 (69.1%) of cases, while 67 (30.9%) experienced unfavorable outcomes. Those with moderate GCS had favorable outcomes in 60 (63.8%) and unfavorable outcomes in 34 (36.2%). Interestingly, patients with severe GCS showed the highest proportion of favorable outcomes at 34 (79.1%), with only 9 (20.9%) experiencing unfavorable outcomes. This trend may suggest effective interventions for patients with severe injuries, though further investigation is needed to confirm this.

The mechanism of injury did not show a significant relationship with outcomes, but differences in trends were evident. Among patients involved in road traffic accidents, 110 (66.7%) had favorable outcomes, while 55 (33.3%) had unfavorable

outcomes. Patients who experienced falls had similar results, with 85 (68.0%) showing favorable outcomes and 40 (32.0%) having unfavorable outcomes. However, those who sustained injuries from assaults had the highest proportion of favorable outcomes at 49 (76.6%), with 15 (23.4%) experiencing unfavorable outcomes.

Regarding CT findings, patients with intracranial hemorrhage had favorable outcomes in 84 (64.1%) of cases and unfavorable outcomes in 47 (35.9%). Those with a midline shift showed favorable outcomes in 75 (73.5%), while 27 (26.5%) experienced unfavorable outcomes. Patients with normal CT findings had favorable outcomes in 85 (70.2%) and unfavorable outcomes in 36 (29.8%). These results suggest that while specific CT findings did not significantly influence outcomes, patients with midline shifts appeared to fare slightly better.

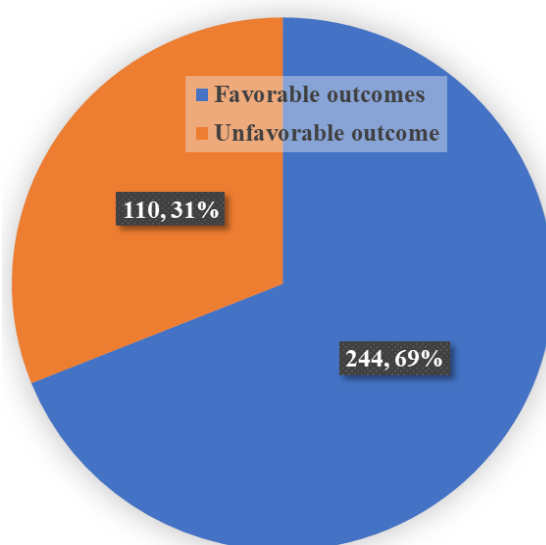
Timing of intervention also did not show a statistically significant association with outcomes. Among patients who received early intervention, 184 (70.8%) had favorable outcomes, compared to 76 (29.2%) with unfavorable outcomes. Those who received delayed intervention had favorable outcomes in 60 (63.8%) and unfavorable outcomes in 34 (36.2%).

Lastly, the type of management did not significantly affect outcomes. Patients managed surgically had favorable outcomes in 123 (66.5%) and unfavorable outcomes in 62 (33.5%). Those managed conservatively had slightly better results, with 121 (71.6%) achieving favorable outcomes and 48 (28.4%) experiencing unfavorable outcomes. (Table 1).

Table 1: Association of Predictors with Outcome

Predictor Variable	Subgroup	Favorable Outcomes n(%)	Unfavorable Outcomes n(%)	Total (n)	p-value
GCS on Admission	Mild	150 (69.1%)	67 (30.9%)	217	0.201
	Moderate	60 (63.8%)	34 (36.2%)	94	
	Severe	34 (79.1%)	9 (20.9%)	43	
Mechanism of Injury	Road Traffic Accident	110 (66.7%)	55 (33.3%)	165	0.335
	Fall	85 (68.0%)	40 (32.0%)	125	
	Assault	49 (76.6%)	15 (23.4%)	64	
CT Findings	Intracranial Hemorrhage	84 (64.1%)	47 (35.9%)	131	0.284
	Midline Shift	75 (73.5%)	27 (26.5%)	102	
	Normal	85 (70.2%)	36 (29.8%)	121	
Timing of Intervention	Early	184 (70.8%)	76 (29.2%)	260	0.213
	Delayed	60 (63.8%)	34 (36.2%)	94	
Type of Management	Surgical	123 (66.5%)	62 (33.5%)	185	0.299
	Conservative	121 (71.6%)	48 (28.4%)	169	

Fig. 1: Frequency of Outcome (Favorable outcome and Unfavorable outcome)



4. DISCUSSION

Traumatic brain injury (TBI) remains a significant global health challenge, contributing to high rates of morbidity and mortality, particularly in low- and middle-income countries. This study aimed to explore predictors of outcomes in head trauma, focusing on clinical and radiological parameters. Although no statistically significant associations were identified, the observed trends align with previous research and provide insights into factors influencing recovery and prognosis.

Patients with **mild GCS** in our study had favorable outcomes in **69.1%** of cases, while those with **severe GCS** showed favorable outcomes in **79.1%**. Nigussie et al. [13] identified GCS on admission, time of arrival, and oxygen saturation as significant predictors of unfavorable outcomes. Similarly, Rafiee et al. [14] highlighted that patients with GCS <8 had a significantly increased likelihood of mortality (OR: 62.99), emphasizing the importance of early management. Baum et al. [15] reinforced that GCS is a reliable tool for predicting outcomes in TBI patients. While the findings in our study did not achieve statistical significance, these trends suggest that timely and targeted interventions may improve outcomes, particularly in severe cases.

The **mechanism of injury** also revealed notable trends. In our study, **assault-related injuries** showed the highest proportion of favorable outcomes (**76.6%**), followed by **falls (68.0%)** and **road traffic accidents (RTAs) (66.7%)**. Shrestha et al. [16] reported that RTAs are the leading cause of severe head injuries and are often associated with poorer outcomes due to high injury severity and coexisting injuries. Similarly, Dibera et al. [17] noted that delayed presentation and additional trauma in RTA cases contribute to unfavorable outcomes. The relatively better outcomes seen in assault-related injuries in our study might reflect differences in injury mechanisms or care pathways.

Radiological findings in our study highlighted that patients with **intracranial hemorrhage** had favorable outcomes in **64.1%** of cases, while those with **midline shifts** exhibited slightly better outcomes (**73.5%**). Liu et al. [18] identified intracerebral hemorrhage as a critical factor associated with poor prognosis (OR: 20.11, $p = 0.01$). Nigussie et al. [13] and Baum et al. [15] similarly emphasized the significance of midline shifts and other CT abnormalities in determining outcomes. Although not statistically significant, the trends in our data reinforce the importance of CT imaging in guiding clinical decisions.

Timing of intervention showed trends favoring **early treatment**, with favorable outcomes observed in **70.8%** of cases receiving early interventions, compared to **63.8%** for delayed interventions. Nigussie et al. [13] and Dibera et al. [17] both highlighted the critical role of timely hospital arrival in reducing unfavorable outcomes. Regarding management, patients treated **conservatively** achieved favorable outcomes in **71.6%** of cases, compared to **66.5%** for those managed surgically. This aligns with findings by Marbun et al. [19], who emphasized the importance of individualized treatment based on clinical stability and physiological parameters.

While no statistically significant associations were identified in our study, these trends are consistent with global findings. Advanced predictive models, such as those described by Pease et al. [20], which integrate clinical and radiological data with machine learning algorithms, could refine prognostication and inform tailored treatment approaches. Despite the limitations of our study, including a small sample size and lack of significant associations, the findings highlight key areas for future research and the importance of timely and appropriate interventions to optimize outcomes in TBI patients.

5. CONCLUSION

This study highlights the trends in clinical and radiological predictors of outcomes in patients with head trauma. While no statistically significant associations were observed, the findings revealed that patients with mild and severe Glasgow Coma Scale (GCS) scores tended to have more favorable outcomes, emphasizing the importance of GCS as a key clinical indicator. Radiological findings such as intracranial hemorrhage and midline shifts also demonstrated trends associated with outcomes, underscoring the critical role of CT imaging in management and prognosis. Early interventions were associated with better outcomes, highlighting the need for timely access to care and treatment. Although conservative management showed slightly better results than surgical interventions, individualized treatment approaches remain essential to optimize patient recovery.

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