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PROGNOSTIC SIGNIFICANCE OF PLATELET COUNT IN TRAUMATIC BRAIN INJURY: A PROSPECTIVE CROSS-SECTIONAL STUDY

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Abstract

Platelet count is a crucial clinical parameter in the management of trauma patients. In cases of traumatic brain injury (TBI), a low platelet count has been independently associated with poorer outcomes. This study aims to evaluate the direct relationship between admission platelet count in the trauma unit and the outcomes of TBI, including extradural hematoma, subdural hematoma, cerebral contusions, traumatic intraventricular hemorrhage, and subarachnoid hemorrhage. Early identification of thrombocytopenia in TBI patients may help guide targeted interventions, improve management strategies, and potentially enhance patient survival and recovery.

Introduction: *Platelet count is an important clinical parameter for guiding the management of trauma patients. In patients with TBI, low platelet count is known to independently predict worse outcomes. The role of this study is to determine the direct relationship between platelet count on admission in trauma unit and outcome of TBI including extradural, subdural hematoma, contusion and traumatic interventricular bleed, subarachnoid hemorrhage. Thrombocytopenia was indicative of worsening contusions in patients admitted with severe traumatic brain injury[1]. It represents a standalone risk factor for mortality among those with moderate-to-severe TBI[2]. thrombocytopenia upon admission is associated with an increased risk of progression of hemorrhagic injuries (PHI).*

Methodology: *A cross-sectional study was conducted at the Department of Neurosurgery, JPMC, Karachi. Duration of the research was 6 months and a total number of 150 patients were included. All patients had a history of head trauma by any means including RTA, fall and assault. Patients with any intracranial insult already taking blood thinners like aspirin and clopidogrel and those with polytrauma were excluded. Assessment was done using hematology showing number of platelets per microliter of blood at the time of admission and also using a questionnaire. Whereas, outcome was assessed based on the*

Glasgow Coma Scale on arrival and post management including surgical and conservative.

Results: *Age and Glasgow Coma Scale (GCS) scores at admission and discharge were substantially correlated with postoperative platelet levels. Low platelet counts (<100,000) were more common in patients aged 50–70, but younger patients (10–30 years) recovered better (>60% with counts >150,000). While mortality cases had very low numbers (96% <100,000), higher GCS at discharge (14–15) was associated with better outcomes (77% >150,000). GCS at arrival was also significant, with larger platelet counts associated with better neurological state. Despite the lower anticipated cell numbers, there was no significant correlation with comorbidities (p = 0.661). Comorbidities had no discernible effect on platelet counts, however age and neurological condition are important predictors.*

Conclusion: *Platelet count at admission is significantly associated with predicting outcome of TBI. Decreased platelet counts or thrombocytopenia at admission is associated with poor outcome post neurosurgical management.*

INTRODUCTION

Traumatic brain injury occurs when there is a high velocity blow to head or an object that passes through brain tissue such as bullet or a fragment of fractured skull bone. The severity of traumatic brain injury is classified as mild, moderate and severe on the basis of widely used neurological assessment tool that is GCS (glasgow coma scale). TBI is categorized as follows:

- **Mild TBI**: GCS score of **13–15**, indicating minor neurological impairment which includes loss of consciousness for a brief period of time or a simple headache.
- **Moderate TBI**: GCS score of **9–12**, suggesting more significant brain injury with potential long-term deficits including dementia, one sided weakness or seizures
- **Severe TBI**: GCS score of **3–8**, associated with a high risk of morbidity and mortality [1].

A higher GCS score reflects better neurological function and a milder degree of brain injury, while a lower GCS score indicates more severe dysfunction. This classification helps us guiding the prognosis and management strategies for TBI patients.

Traumatic brain injury can cause wide range of symptoms including physical, psychological as well as sensory symptoms. Physical symptoms can include headache, seizures, nausea, vomiting and vertigo or stroke-like symptoms. Some signs or symptoms can appear immediately after the injury and some can take few days or weeks to appear.

Platelets play a crucial role in maintaining homeostasis and coagulation which are vital for controlling hemorrhage and preventing secondary brain injury in-case of traumatic brain injuries. [2]Thrombocytopenia at the time of hospital admission and thrombocytopenia during the hospital stay can serve as a significant prognostic marker, influencing clinical decisions and patient outcomes. Many studies suggest that thrombocytopenia can be an isolated prognostic marker in predicting the outcomes of TBI. Patients with platelets count of less than 150,000 is associated with worst outcomes even after doing neurosurgical intervention in severe cases of TBI [1]. Severe TBI patients with thrombocytopenia are more likely to develop secondary hemorrhages, including expansion contusion [1], subdural and extradural hematomas or intraventricular bleeding. Patient with thrombocytopenia requires more critical care as compare to those with optimal platelet counts. Elderly Patients with **thrombocytopenia** are at a higher risk of hemorrhagic complications, which may necessitate **prolonged hospital stays** and **ICU admissions** for close monitoring and platelet transfusion [3]. The reduced platelet count increases the likelihood of hematoma expansion, delayed bleeding, and secondary brain injury, making continuous neurological assessment essential. These patients require **frequent platelet level monitoring, possible transfusions, and immediate intervention** in case of worsening symptoms. Early identification and

management of thrombocytopenia in TBI can help improve patient outcomes and reduce the risk of severe complications [3] [4].

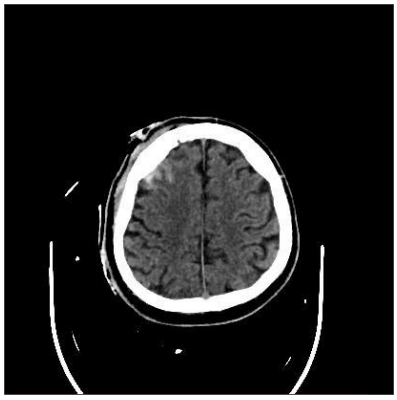
The patients who had platelet count of less than 150,000 are associated with higher risk of contusion expansion and associated with worst outcomes, [1] while patient who are already on antiplatelet drugs or anticoagulant platelet counts of less than 135,000 is predictive of worsening radiological and clinical outcomes along with that it limits the option of doing appropriate surgical inventions timely [1].Traumatic brain injury (TBI) in older patients is associated with significantly low platelet counts at the time of admission and may serve as an important prognostic factor for poor outcomes in this population [3] [4].Researches have shown that Traumatic brain injury can cause systemic changes and activation of coagulating factors the mechanism of which is being unexplained .In case of moderate or severe traumatic brain injury thrombocytopenia on initial evaluation is found to be present in approximately 14% of the patients and coagulopathy in 21% of the patients and as the day passes by incidence of thrombocytopenia and coagulopathy can increase up to 41 and 46 % respectively [4]. Some studies suggest that decrease platelet count is accountable for both the consumptive processes and dilutions effects. while dysfunctional platelets contribute in homeostatic instability and studies suggest that platelets impairment can exist even when the platelets count are normal [2] [6].

SCAN 1 :

Non-contrast axial CT of the brain demonstrates a hyperdense crescent-shaped collection along the right cerebral hemisphere consistent with an acute subdural hematoma. There is associated significant midline shift towards the left, indicating substantial mass effect.

SCAN 2:

Non-contrast axial CT of the brain reveals subarachnoid hemorrhage localized to the right frontal region, accompanied by an underlying cortical contusion with no midline shift.



SCAN 3:

Non-contrast axial CT of the brain demonstrates a left parietal skull fracture with elevation of the bone fragment. An underlying hyperdense epidural hematoma is noted, along with a subgaleal soft tissue collection, likely representing hematoma or edema. No significant midline shift is seen at present.

MATERIAL AND METHODS:

This was a **prospective cross-sectional study** conducted at the Neurotrauma Unit of Jinnah Postgraduate Medical Centre (JPMC) over a period of four months from 4-April-2024 to 4-August-2024. The study aimed to assess factors associated with poor prognostic outcomes related to decreased platelet count in patients undergoing management for traumatic brain injury (TBI).

Patients included in the study were those who underwent surgical management for TBI, with both preoperative and postoperative platelet counts available.

Inclusion criteria were as follows:

- Age between 10 and 70 years
- Availability of complete clinical data, including **Glasgow Coma Scale (GCS) scores** at the time of arrival and at discharge
- **Postoperative platelet count** recorded within **24 hours** following either conservative or surgical treatment of TBI

Exclusion criteria included:

- Incomplete or missing data
- Presence of known hematological disorders
- History of using antiplatelet or anticoagulant (blood thinner) medications

A total of **150 patients** diagnosed with TBI and admitted to JPMC were enrolled in the study. The **primary outcome variable** was the **postoperative platelet count**, which was analyzed to determine its predictive value in assessing the **prognosis of TBI patients**.

The primary outcome variable was platelet count after surgery, categorized into:

- 150,000/µL
- <150,000/µL
- <100,000/µL

Independent variables included:

- **Age group** (10–30 years, 30–50 years, 50–70 years).
- **GCS at arrival** (<5, 6–8, 8–14)
- **GCS at discharge** (9–11, 12–13, 14–15, mortality)
- **Presence of comorbidities** (Hypertension, Diabetes Mellitus, Chronic Kidney Disease, or None)

Data were extracted from patient medical records and entered into a structured database for analysis. Data were analyzed using **IBM SPSS version 27.** Descriptive statistics were used to summarize categorical variables as frequencies and percentages. The **Pearson Chi-Square test** was employed to

evaluate the association between postoperative platelet count and the independent variables. A p-value of **<0.05** was considered statistically significant.

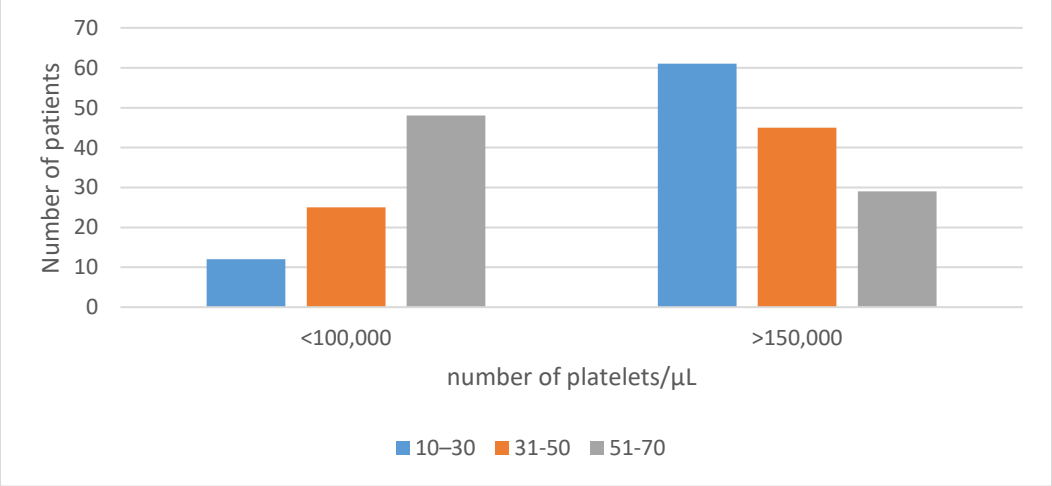
RESULT:

The analysis reveals significant associations between postoperative platelet count and the variables of age, Glasgow Coma Scale (GCS) at arrival, and GCS at discharge. Patients aged 50–70 years showed a higher incidence of low platelet counts (<100,000), whereas younger individuals, particularly those aged 10–30 years (most commonly affected group), had better platelet recovery, with over 60% having platelet counts above 150,000(*see Table 1 and Figure 1)* .

Table 1. *Postoperative Platelet Counts by Age Group*

Age Group (years)	% with Platelet Count <100,000	% with Platelet Count >150,000
10-30	12%	61%
31-50	25%	45%
51-70	48%	29%

Figure 1. *Bar graph showing platelet recovery across age groups.*



GCS at discharge demonstrated the strongest association, with patients scoring 14–15 exhibiting the most favorable outcomes—over 77% had platelet counts exceeding 150,000. Conversely, mortality group had extremely poor outcomes, with 96% presenting platelet counts below 100,000(*see Figure 2).*

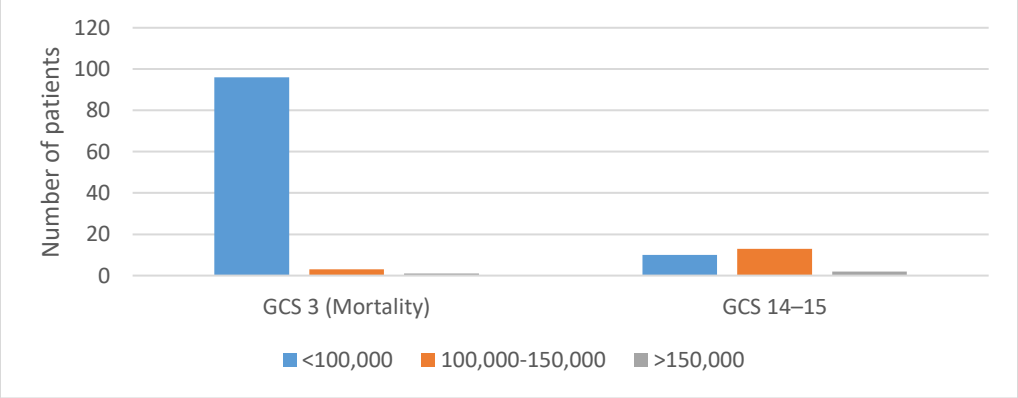


Figure 2. *relationship between platelet count and GCS of patients*

Similarly, GCS on arrival also showed a statistically significant relationship, where better neurological status (GCS 8–14) correlated with higher platelet counts, while severely impaired patients (GCS <5) fared worse (refer to Table 2).

Table 2. *Association between GCS on Arrival and Postoperative Platelet Count*

GCS on Arrival	% with Platelet Count <100,000	% with Platelet Count >150,000
<5	85%	5%
5-7	52%	22%
8-14	18%	60%

In contrast, no statistically significant association was found between comorbidities (such as hypertension, diabetes, or chronic kidney disease) and postoperative platelet counts (p = 0.661). However, this finding should be interpreted cautiously, as the validity of the chi-square test was limited due to a high number of expected cell counts being less than 5. Overall, these results suggest that age and neurological status both before and after surgery are important predictor of platelet recovery, while comorbidities may not have a clear impact in this study*(see table 3 and 4)*.

Table 3: Pearson Chi-Square Tests for Platelet Count After Surgery

Variable	Chi-square	df	Sig. (p-value)	Notes
Age	17.303	4	0.002	* Significant at the 0.05 level
GCS Discharge	108.394	6	0.000	* Significant at the 0.05 level
GCS Arrival	39.785	4	<0.001	Significant [b] >20% of cells < 5 expected count
Comorbidities	4.117	6	0.661	[b] >20% of cells < 5 expected count [c] Min expected count < 1

Table 4: Platelet Count After Surgery by Demographics and Clinical Variables

Variable	Category	>150,000 Count (%)	<150,000 Count (%)	<100,000 Count (%)
Age	10-30 years	20 (60.6%)	10 (30.3%)	3 (9.1%)
	30–50 years	36 (50.0%)	17 (23.6%)	19 (26.4%)
	50–70 years	13 (28.9%)	9 (20.0%)	23 (51.1%)
	Total	69 (46.0%)	36 (24.0%)	45 (30.0%)
GCS at Discharge	9–11	0 (0.0%)	8 (38.1%)	13 (61.9%)
	12-13	15 (44.1%)	14 (41.2%)	5 (14.7%)
	14-15	54 (77.1%)	13 (18.6%)	3 (4.3%)
Mortality		0 (0.0%)	1 (4.0%)	24 (96.0%)
	Total	69 (46.0%)	36 (24.0%)	45 (30.0%)
GCS at Arrival	<5	0 (0.0%)	1 (8.3%)	11 (91.7%)
	6-8	31 (36.9%)	24 (28.6%)	29 (34.5%)
	8-14	38 (70.4%)	11 (20.4%)	5 (9.3%)
	Total	(46.0%)	36 (24.0%)	45 (30.0%)

Comorbidities	HTN	14 (38.9%)	11 (30.6%)	11 (30.6%)
	DM	15 (57.7%)	4 (15.4%)	7 (26.9%)
	CKD	2 (66.7%)	1 (33.3%)	0 (0.0%)
	None	38 (44.7%)	20 (23.5%)	27 (31.8%)
	Total	69 (46.0%)	36 (24.0%)	45 (30.0%)

DISCUSSION:

This study highlights how important platelet count is in predicting the outcomes of patients with traumatic brain injury (TBI) [6]. Our results proved that patients who had normal or higher platelet levels at the time of admission, especially those above 150,000/μL recover better, with significant improvements in their Glasgow Coma Scale (GCS) scores after treatment. On the other hand, patients with low platelet counts, particularly those below 100,000/μL, showed little to no improvement [7]and had higher risks of complications or death. This suggests that low platelet count (thrombocytopenia) may directly contribute to worse outcomes, possibly due to poor blood clotting and increased bleeding within the brain. The patients who were already on blood thinners were excluded and there's was an independent effect of platelet count. These findings support the idea that early detection of low platelet levels and timely treatments such as transfusion could help improve survival and recovery in TBI patients. Overall, checking platelet levels at admission can be a simple but valuable tool for prediction of how well a patient recover and prognosis of the patient [7].

The analysis of platelet counts after surgery in relation to age, gender, GCS on arrival, nature of trauma, and platelet count at arrival reveals several important trends. A total of 150 patients were analyzed, with the majority being male (56%) and within the 30–50 years age group (48%). Notably, this age group also had the highest frequency of post-surgical platelet counts >150,000 (48.6%), followed by the 10–30 years group (54.5%). In contrast, the 50–70 years group showed the highest proportion (51.1%) with post-surgical platelet counts <100,000, suggesting a possible age-related impairment in platelet recovery or consumption coagulopathy post-trauma. Most patients (56%) arrived with a GCS score between 6 and 8, indicating moderate traumatic brain injury, which may influence platelet dynamics due to inflammatory responses and coagulopathy[3]. Regarding the nature of trauma, falls (41.3%) were the most common cause, slightly exceeding road traffic accidents (38%). Most patients had platelet counts at arrival between 200,000–300,000 (59.3%), yet 30% had counts drop to below 100,000 after surgery, indicating potential intraoperative platelet consumption or dilutional effects. The platelet dysfunction is also associated with mortality, and that brain injury is a significant predictor of platelet dysfunction [2] [8]Overall, these findings suggest age and initial platelet count may influence postoperative platelet levels, which could have implications for transfusion strategies and postoperative care in trauma patients.

CONCLUSION

As reported in this study, thrombocytopenia is a substantial prognostic factor for moderate-to-severe traumatic brain injury (TBI). Poorer neurological outcomes, higher mortality, and more critical care unit requirements were all strongly associated with lower platelet counts, particularly those that were below 100,000. Platelet recovery was greatly affected by age and GCS scores at admission and discharge; patients who were older and those with lower GCS scores turned out worse. Although comorbidities had no apparent impact on thrombocytopenia treatment and early identification are still important in improving the prognosis of TBI.

Ethical Approval: Not applicable

Competing interests: None

Authors' contributions: All authors contributed equally to the study.

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Availability of data and materials: All data of the correspondence is publicly available on databases such as PubMed and Google scholar.

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