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Impact of Blood Transfusion Practices on the Management and Outcome of Thrombocytopenia in Critically ill Patients

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Abstract **Original Research Article**

Purpose: Thrombocytopenia is common in intensive care unit (ICU) patients and is associated with adverse outcomes. We aimed to describe the frequency, severity and clinical impact of thrombocytopenia in a critically ill patients, with a focus on transfusion practices. ***Methods:*** We conducted a single-center prospective study of 98 adult patients admitted to ICU in a tertiary care hospital. Thrombocytopenia was defined as a platelet count $<150\times10^9$/L and classified by severity. Data on demographics, illness severity (APACHE II), platelet counts, bleeding events, transfusion requirements and clinical outcomes were collected. Logistic regression analysis was used to assess predictors of mortality. ***Results:*** Among 98 ICU patients, 38 (38.8%) had thrombocytopenia. Severity distribution was: mild 42.1%, moderate 23.7%, severe 18.4% and very severe 15.8%. Patients with thrombocytopenia had higher APACHE II scores ($p<0.001$) and higher 90-day mortality (68.4% vs. 21.7%, $p= 0.013$). Platelet transfusions were administered to 16 (42.1%) thrombocytopenic patients, with most transfusions given at platelet counts $<50\times10^9$/L. In multivariate analysis, thrombocytopenia (OR 8.45, 95% CI 2.80–25.52) and APACHE II score (OR 1.11, 95% CI 1.04–1.19) were independent predictors of mortality. ***Conclusion:*** Thrombocytopenia occurs in more than one-third of critically ill ICU patients and is independently associated with increased mortality. Platelet transfusions are commonly used in severe thrombocytopenia, highlighting the need for evidence-based transfusion strategies.

Keywords: APACHE II, critically ill patients, Intensive care unit, Mortality, Platelet transfusion, Thrombocytopenia.

INTRODUCTION

Thrombocytopenia, which is defined as a platelet count below 150×10^9/L, is one of the most common hematological abnormalities encountered in intensive care unit (ICU) patients, with a reported prevalence ranging from 30% to 45% depending on study population and diagnostic criteria [1,2]. It develops through multiple pathophysiological mechanisms including- impaired platelet production, increased peripheral destruction or consumption, splenic sequestration and dilution following massive fluid resuscitation or blood transfusion [3]. In critically ill patients, additional factors such as sepsis, disseminated intravascular coagulation (DIC), major surgery, trauma and drug-induced thrombocytopenia further contribute to platelet depletion. Thrombocytopenia is not merely a laboratory abnormality but also an important marker of disease severity and adverse clinical outcomes. Previous studies have consistently demonstrated its association with an increased risk of bleeding, greater transfusion requirements, prolonged ICU and hospital stay, multiple organ dysfunction and higher mortality [4,5]. Platelet transfusions are frequently administered in ICU patients to prevent or treat bleeding in thrombocytopenic patients. Nevertheless, the optimal platelet transfusion threshold remains controversial, particularly among non-hematological critically ill patients without active bleeding. Current clinical practice varies considerably because of limited high-quality evidence based specific transfusion strategies, differences in institutional

protocols and clinician preferences [6,7]. Furthermore, platelet transfusions are not without risk, as they may be associated with transfusion-related adverse reactions, alloimmunization, transfusion-associated circulatory overload and increased healthcare costs. Therefore, a careful balance between the potential benefits and risks of transfusion is essential to optimize patient outcomes. The Acute Physiology and Chronic Health Evaluation II (APACHE II) score is a well-established and widely validated prognostic tool for assessing disease severity and predicting mortality among ICU patients [8]. Integrating thrombocytopenia with established severity scoring systems may improve risk stratification and facilitate early identification of patients at high risk for adverse outcomes. In this context, we conducted a prospective cohort study to evaluate the frequency, severity and clinical impact of thrombocytopenia in critically ill patients, with particular emphasis on blood transfusion practices and their relationship with patient outcomes. Additionally, we aimed to identify thrombocytopenia and APACHE II score as independent predictors of 90-day mortality, while exploring other clinical factors associated with the development of thrombocytopenia in the ICU patients.

METHODOLOGY

Study design and setting

This was a single-center prospective study conducted in the intensive care unit of a tertiary care hospital in Bangladesh over a six-month period. The study was approved by the ethical review committee and registered at the institutional data compliance center. Informed written consent was obtained from patients or their surrogates.

Population

We enrolled 98 consecutive adult patients (age ≥18 years) who were acutely admitted to the ICU. Patients with elective open-heart surgery during current hospitalisation and those who declined consent were excluded.

Data collection

Data were collected using a pre-designed structured case record form. Baseline variables included demographics, comorbidities, illness severity (APACHE II score), platelet count and presence of bleeding. Daily data during ICU stay included platelet counts, bleeding events, thrombotic events, life-support interventions and transfusions requirements. For platelet transfusions, we recorded indication (prophylactic, pre-procedural, therapeutic) and pre-transfusion platelet count. Patients were followed for 90 days to observe the outcome variables.

Definitions

- **Thrombocytopenia:** Platelet count $<150\times10^9$/L [9].
- **Severity grades:** Mild ($100\text{-}149\times10^9$/L), moderate ($50\text{-}99\times10^9$/L), severe ($20\text{-}49\times10^9$/L), very severe ($<20\times10^9$/L) [9].
- **Bleeding:** Graded using modified WHO criteria (Grade 1-4) [9].

Outcomes

Primary outcome was the frequency of thrombocytopenia. Secondary outcomes included 90-day mortality, days alive without life-support, bleeding events, thrombotic events and transfusion requirements.

Statistical analysis

Data analyses were performed using SPSS version 26.0, Categorical variables are reported as frequency with percentage (%), continuous variables as medians with interquartile range (IQR) or mean with standard deviation (±SD) as appropriate. Comparisons were performed using Chi-square test or Fisher's exact test for categorical data and Student's t-test or ANOVA test for continuous data. Logistic regression analysis was used to assess associations between thrombocytopenia and 90-day mortality, adjusted for potential confounders including age, sex, APACHE II score and septic shock. A p value <0.05 considered statistically significant.

RESULTS

Baseline characteristics

We analyzed 98 patients with a median age of 62 years (IQR 48-74); 41 (41.8%) were female. Baseline characteristics stratified by thrombocytopenia status are shown in Table 1. Patients with thrombocytopenia were more often male, had higher APACHE II scores, and more frequently presented with septic shock and bleeding at baseline (Table- 1).

Table- 1: Baseline characteristics of the study population (N=98)

Characteristics	All patients (N=98)	Patients without thrombocytopenia (n=60)	Patients having thrombocytopenia (n=38)	p-value
Age, years, median (IQR)	62 (48-74)	63 (47–75)	61 (49–72)	0.552
Female sex, n (%)	41 (41.8)	30 (50.0)	11 (28.9)	0.037
APACHE II score, mean (±SD)	21.5 (±7.2)	18.9 (±6.1)	25.7 (±7.4)	<0.001
Septic shock, n (%)	22 (22.4)	8 (13.3)	14 (36.8)	0.006
Bleeding at baseline, n (%)	16 (16.3)	6 (10.0)	10 (26.3)	0.031
Platelet count, $\times10^9$/L, median (IQR)	198(132–284)	256 (188–321)	87 (52–124)	<0.001

Frequency and severity of thrombocytopenia

Among the study patients, thrombocytopenia was occurred in 38 (38.8%) patients (Figure- 1). Severity distribution among thrombocytopenic patients was as: mild 16 (42.1%), moderate 9 (23.7%), severe 7 (18.4%) and very severe 6 (15.8%) (Figure- 2).

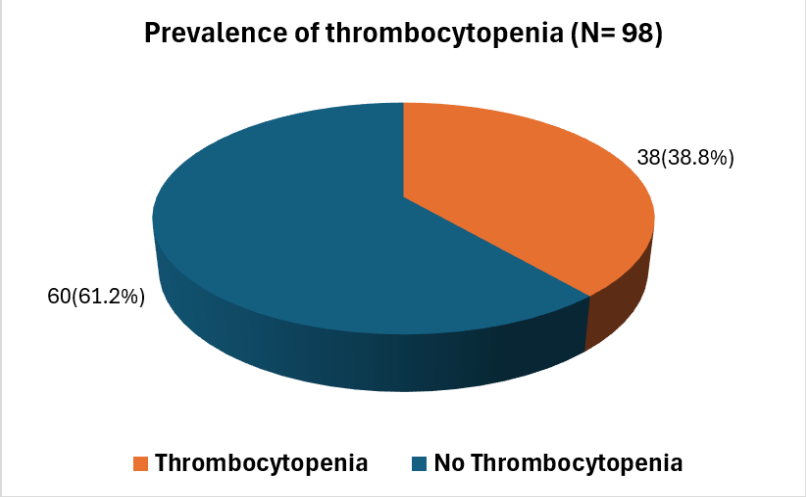

Figure 1: Prevalence of thrombocytopenia among the study population (N=98)

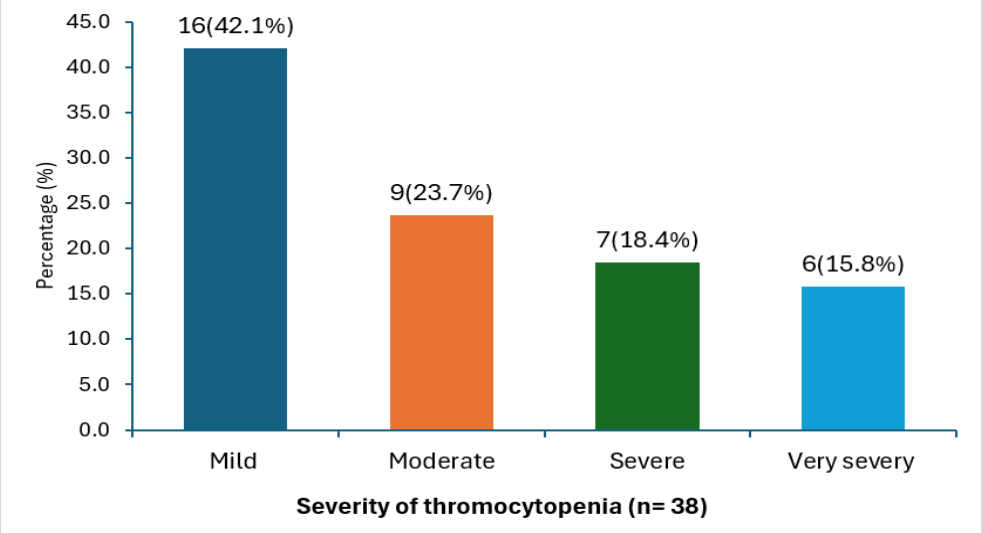

Figure 2: Severity distribution among thrombocytopenic patients (n= 38)

Comparison with international data (PLOT-ICU) [9]

To contextualize our findings, we compared our cohort with the international PLOT-ICU study (n=1166) (Table 2). While our prevalence was slightly lower, the severity distribution and clinical profile were similar, supporting the external validity of our data.

Table- 2: Comparison with international PLOT-ICU cohort [9]

Parameter	Current cohort (n=98)	PLOT-ICU cohort (n=1166)
Thrombocytopenia prevalence	38.8%	43.2%
Baseline thrombocytopenia	22.4%	23.4%
ICU-acquired thrombocytopenia	16.3%	19.8%
Severity among thrombocytopenic patients:		
– Mild	42.1%	42.5%
– Moderate	23.7%	31.0%
– Severe	18.4%	12.9%
– Very severe	15.8%	13.7%
90-day mortality in thrombocytopenia	68.4%	34.6%

Platelet transfusions and practices

Among thrombocytopenic patients, 16 (42.1%) received at least one platelet transfusion. Most transfusions were prophylactic, with median pre-transfusion counts varying by indication. Transfusion practices are detailed in Table- 3.

Table 3: Platelet transfusion practices in thrombocytopenic patients (n=38)

Parameter	n (%) or median (IQR)
Patients receiving ≥1 platelet transfusion, n (%)	16 (42.1%)
Transfusions per patient, median (IQR)	2 (1-4)
Indications for transfusion:	
– Prophylactic	10 (62.5%)
– Therapeutic	4 (25.0%)
– Pre-procedural	2 (12.5%)
Pre-transfusion platelet count ($\times 10^9$/L):	
– Prophylactic transfusions	18 (10-32)
– Therapeutic transfusions	35 (22-58)
– Pre-procedural transfusions	28 (20-45)
Transfusion at platelet count <50×10^9/L	14 (87.5%)
Transfusion at platelet count <20×10^9/L	8 (50.0%)

Risk factors for thrombocytopenia development

We identified several baseline factors associated with the development of thrombocytopenia during ICU stay of the study patients. In multivariate analysis, higher APACHE II score, septic shock, and baseline bleeding were independently associated with thrombocytopenia (Table 4).

Table- 4: Risk factors for developing thrombocytopenia during ICU stay (n=98)

Risk factor	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	p-value
Male sex	2.45 (1.02–5.87)	2.12 (0.85–5.31)	0.108
APACHE II score (per point)	1.14 (1.07–1.22)	1.12 (1.04–1.20)	0.003
Septic shock	3.78 (1.42–10.05)	3.25 (1.18–8.93)	0.022
Baseline bleeding	3.22 (1.05–9.89)	2.88 (1.01–8.91)	0.048
Chronic liver failure	4.56 (1.12–18.57)	3.89 (0.91–16.62)	0.067
Hematological malignancy	5.12 (1.23–21.33)	4.45 (1.05–18.89)	0.042

Clinical outcomes

Patients with thrombocytopenia had higher 90-day mortality (68.4% vs. 21.7%, p= 0.013), more bleeding events (44.7% vs. 11.7%, p<0.001), and fewer days alive without life-support (median 65 vs. 85 days, p= 0.002). Furthermore, mortality was observed to increase directly with the severity of thrombocytopenia. Outcomes by thrombocytopenia severity are shown in Table- 5.

Table- 5: Clinical outcomes by thrombocytopenia status and severity (N=98)

Outcomes	Patients without thrombocytopenia (n=60)	Patients having thrombocytopenia (n=38)	Mild (n=16)	Moderate (n=9)	Severe (n=7)	Very severe (n=6)
90-day mortality, n (%)	13 (21.7)	26 (68.4)	3 (18.8)	3 (33.3)	4 (57.1)	5 (83.3)
Any bleeding in ICU, n (%)	7 (11.7)	17 (44.7)	3 (18.8)	4 (44.4)	4 (57.1)	6 (100)
Grade 3–4 bleeding, n (%)	1 (1.7)	9 (23.7)	1 (6.3)	2 (22.2)	3 (42.9)	3 (50.0)
Platelet transfusion, n (%)	0 (0)	16 (42.1)	2 (12.5)	3 (33.3)	5 (71.4)	6 (100)
*RBC transfusion, n (%)	8 (13.3)	18 (47.4)	5 (31.3)	4 (44.4)	5 (71.4)	4 (66.7)
Days alive without life-support, median (IQR)	85 (72–89)	65 (0–82)	78 (0–86)	70 (0–81)	42 (0–68)	15 (0–35)
ICU length of stay, days, median (IQR)	7 (4–11)	10 (6–16)	8 (5–12)	9 (6–14)	12 (8–18)	14 (9–21)

*RBC= Red Blood Cell

Association between thrombocytopenia and mortality

In unadjusted analysis, thrombocytopenia was associated with increased 90-day mortality (OR 7.62, 95% CI 3.12–18.62). In the fully adjusted multivariate model (adjusted for age, sex, APACHE II score, and septic shock), thrombocytopenia remained independently associated with 90-day mortality (OR 8.45, 95% CI 2.80–25.52). APACHE II score was also an independent predictor (adjusted OR 1.09, 95% CI 1.03–1.16) (Table- 6).

Table- 6: Logistic regression analysis of factors associated with 90-day mortality

Predictor variable	Unadjusted OR	95% CI	Adjusted OR*	95% CI	Interpretation
Thrombocytopenia	7.62	3.12–18.62	8.45	2.80–25.52	Age, sex, APACHE II score, and septic shock independently associated with increased 90-day mortality
APACHE II score	-	-	1.09	1.03–1.16	Higher APACHE II score independently increased mortality risk

*Adjusted model included age, sex, APACHE II score and septic shock. OR = odds ratio; CI = confidence interval

Transfusion thresholds compared to guidelines

Table- 7 compares our transfusion practices with current guideline recommendations, showing that most prophylactic transfusions occurred at platelet counts above the conditionally recommended threshold of 10×10^9/L.

Table- 7: Comparison of transfusion practices with guideline recommendations

Aspect	Current practice (n=38)	*ESICM guideline recommendation [13]
Prophylactic transfusion threshold	Median: 18×10^9/L (IQR 10–32)	$<10\times10^9$/L (conditional recommendation)
Patients transfused prophylactically	62.5%	Not specified
Pre-procedural transfusion for CVC	12.5% at median 28×10^9/L	No recommendation for 10–50×10^9/L
Therapeutic transfusion threshold	Median: 35×10^9/L	Based on clinical bleeding
Transfusions at $<10\times10^9$/L	50.0%	Recommended threshold

*ESICM= European Society of Intensive Care Medicine

DISCUSSION

In this prospective study of critically ill patients, thrombocytopenia occurred in 38.8% of patients and was independently associated with increased 90-day mortality, more bleeding events and greater use of life-support. Platelet transfusions were administered to 42.1% of thrombocytopenic patients, predominantly as prophylaxis, often at platelet counts below 50×10^9/L but above the 10×10^9/L threshold recommended by current guidelines [13].

Our findings are consistent with previous studies reporting thrombocytopenia prevalence of 30–45% in ICU populations [1,2,10]. The strong association between thrombocytopenia severity and mortality supports the notion that platelet count serves as a marker of disease severity and systemic inflammation [3,11]. The observed mortality gradient across severity categories underscores the prognostic value of serial platelet monitoring in critically ill patients.

When compared to the international PLOTICU cohort [9], our findings showed similar patterns in thrombocytopenia prevalence (38.8% vs. 43.2%) and severity distribution (e.g., severe/very severe 34.2% vs. 26.6% of thrombocytopenic patients), supporting the external validity of our data in terms of disease characteristics. However, our mortality rate among thrombocytopenic patients was higher (68.4% vs. 34.6%), which may reflect differences in case mix, illness severity, or healthcare resources.

Platelet transfusions were frequently used in our cohort, particularly in patients with severe and very severe thrombocytopenia. The high proportion of prophylactic transfusions (62.5%) contrasts with some earlier reports [6,12]; but aligns with more recent data suggesting a shift toward preventive transfusion in high-risk ICU patients [13]. Notably, most prophylactic transfusions occurred at platelet counts above the 10×10^9/L threshold conditionally recommended by ESICM guidelines [14], reflecting clinical caution in bleeding-prone critically ill patients.

The independent association between thrombocytopenia and mortality persisted after adjustment for APACHE II score and other confounders, suggesting that thrombocytopenia may contribute to poor outcomes beyond merely reflecting disease severity.

Possible mechanisms include increased bleeding risk, impaired immune function, and microvascular thrombosis [3,11]. This aligns with the PLOT-ICU findings, where baseline thrombocytopenia was independently associated with 90-day mortality even after adjustment for severity and comorbidities [9].

Our risk factor analysis identified higher APACHE II scores, septic shock, and baseline bleeding as predictors of thrombocytopenia development, consistent with findings from larger cohorts [9]. These factors may help clinicians identify patients at high risk for developing thrombocytopenia during ICU stay.

The comparison of our transfusion practices with guideline recommendations highlights the gap between evidence and practice in thrombocytopenia management. While guidelines conditionally recommend prophylactic transfusion only below 10×10^9/L, most transfusions in our cohort occurred at higher counts. This practice pattern, also observed in the PLOT-ICU study where 64.3% of in-ICU transfusions were prophylactic with a median pre-transfusion count of 15×10^9/L [9], suggests that clinicians may be adopting a more cautious approach in critically ill patients.

Strengths of our study include prospective design, use of standardized definitions, comprehensive outcome assessment and comparison with international data. Limitations include the single-center design, modest sample size, potential for residual confounding and lack of detailed data on underlying causes of thrombocytopenia.

CONCLUSION

Thrombocytopenia is common in critically ill patients and is independently associated with increased mortality, bleeding and transfusion requirements. Platelet transfusions are frequently administered, often as prophylaxis at platelet counts above current guideline thresholds. These findings, consistent with larger international studies, highlight the need for randomized trials to determine optimal platelet transfusion strategies in ICU patients with thrombocytopenia.

Conflicts of interest: All authors declared that there is no competing interest regarding this publication.

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