

Evaluation of Platelet Transfusion Practices and Clinical Outcomes in Patients with Dengue-Associated Thrombocytopenia

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Abstract

Background: Dengue fever is a rapidly emerging mosquito-borne viral infection and a major public health concern in tropical and subtropical countries. Thrombocytopenia is one of the hallmark laboratory findings in dengue infection and is frequently associated with an increased risk of bleeding. Platelet transfusion is commonly administered in patients with severe thrombocytopenia; however, the indications for prophylactic transfusion remain controversial due to limited evidence regarding its effectiveness in improving clinical outcomes. Evaluating current platelet transfusion practices is essential to promote rational use of blood products and optimize patient care.

Objective: To evaluate platelet transfusion practices and assess clinical outcomes among patients with dengue-associated thrombocytopenia admitted to a tertiary care hospital.

Materials and Methods: A hospital-based observational study was conducted on 100 consecutive patients with laboratory-confirmed dengue infection associated with thrombocytopenia. Demographic characteristics, clinical presentation, platelet counts, indications for platelet transfusion, bleeding manifestations, duration of hospital stay, intensive care unit (ICU) admission, and clinical outcomes were recorded using a structured data collection form. Patients were managed according to institutional treatment protocols. Data were analyzed using descriptive and inferential statistics. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Statistical significance was considered at $p < 0.05$.

Results: The mean age of the study population was 34.2 ± 14.1 years, with a male predominance (62%). Uncomplicated dengue fever was observed in 58% of patients, dengue with warning signs in 27%, and severe dengue in 15%. The mean platelet count at admission was $38.6 \pm 16.8 \times 10^9/L$. Platelet transfusions were administered to 36% of patients, of whom 66.7% received prophylactic transfusions and 33.3% received therapeutic transfusions for active bleeding. Bleeding manifestations occurred in 24% of patients, with petechiae being the most common presentation. The mean hospital stay was 5.9 ± 2.2 days, with longer hospitalization observed among transfused patients (7.2 ± 2.4 days) compared with non-transfused patients (5.1 ± 1.8 days). Overall, 97% of patients recovered, 3% required ICU admission, and 1% died due to severe dengue with multiorgan dysfunction.

Conclusion: Most patients with dengue-associated thrombocytopenia recovered with supportive management without requiring platelet transfusion. Prophylactic platelet transfusion was frequently administered despite the absence of active bleeding, whereas therapeutic transfusion was reserved for patients with clinically significant hemorrhage. These findings support a restrictive, evidence-based approach to platelet transfusion, emphasizing that clinical assessment and bleeding status should guide transfusion decisions rather than platelet count alone.

Keywords: Dengue fever; Thrombocytopenia; Platelet transfusion; Bleeding manifestations; Clinical outcomes; Platelet count; Blood component therapy.

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Introduction

Dengue is one of the fastest-growing mosquito-borne viral diseases worldwide and remains a major public health problem, particularly in

tropical and subtropical countries. The disease is caused by four antigenically distinct serotypes of the dengue virus (DENV-1, DENV-2, DENV-3,

and DENV-4), which belong to the genus *Flavivirus* and the family *Flaviviridae*. The virus is transmitted primarily through the bite of infected *Aedes aegypti* mosquitoes, while *Aedes albopictus* also serves as an important secondary vector in several geographical regions. Rapid urbanization, population growth, climate change, globalization, inadequate sanitation, and expansion of mosquito breeding habitats have contributed significantly to the increasing incidence and geographical spread of dengue infection over the past several decades. [1,2]

According to the World Health Organization (WHO), nearly half of the world's population is now at risk of dengue infection, with an estimated 100–400 million infections occurring annually. Although a large proportion of infections remain asymptomatic or present with mild clinical illness, a considerable number of patients develop severe disease requiring hospitalization. Dengue is endemic in more than 100 countries across Asia, the Western Pacific, Africa, and the Americas. India contributes substantially to the global burden of dengue because of its favorable climatic conditions for vector breeding, recurrent seasonal outbreaks, increasing urbanization, and high population density. The disease imposes a significant economic burden on healthcare systems owing to hospitalization, laboratory investigations, blood component therapy, and loss of productivity. [1]

The clinical manifestations of dengue range from asymptomatic infection and uncomplicated dengue fever to dengue with warning signs and severe dengue. Patients commonly present with sudden onset of high-grade fever, severe headache, retro-orbital pain, generalized myalgia, arthralgia, nausea, vomiting, skin rash, and varying degrees of thrombocytopenia. The critical phase generally occurs between the third and seventh day of illness, during which increased capillary permeability may result in plasma leakage, hemoconcentration, circulatory shock, severe bleeding, and multiorgan dysfunction. Early diagnosis, careful monitoring, appropriate fluid therapy, and timely recognition of warning signs remain the cornerstones of successful clinical management and are responsible for reducing mortality to less than 1% in appropriately managed patients. [1,3]

Thrombocytopenia is one of the most consistent laboratory abnormalities observed in dengue infection and is frequently considered an important indicator of disease severity. The pathogenesis of thrombocytopenia is multifactorial and includes transient suppression of bone marrow, direct infection of hematopoietic progenitor cells, immune-mediated destruction of circulating platelets, increased peripheral platelet consumption, platelet dysfunction, and endothelial activation.

Platelet counts usually begin to decline during the febrile phase, reach their lowest level during the critical phase, and gradually recover during the convalescent stage. However, numerous studies have demonstrated that platelet count alone is a poor predictor of clinically significant bleeding, emphasizing that management decisions should be guided by the patient's overall clinical status rather than laboratory values alone. [3,4]

Thrombocytopenia is considered one of the most important laboratory findings in dengue infection and is frequently associated with disease progression. The exact mechanism responsible for thrombocytopenia is complex and involves several interacting factors. Dengue virus suppresses bone marrow activity during the early phase of infection, resulting in reduced platelet production. In addition, immune-mediated destruction of circulating platelets, increased peripheral platelet consumption, complement activation, apoptosis of megakaryocytes, and endothelial dysfunction further contribute to the decline in platelet count. Activated platelets also interact with leukocytes and endothelial cells, promoting inflammatory responses and vascular permeability. These mechanisms collectively result in significant thrombocytopenia, particularly during the critical phase of dengue illness. [5,6]

Although thrombocytopenia is commonly regarded as a predictor of bleeding, numerous studies have demonstrated that platelet count alone has poor correlation with the occurrence and severity of hemorrhage. Many patients with platelet counts below 20,000/mm³ remain clinically stable without bleeding, whereas others with relatively higher platelet counts may develop serious hemorrhagic manifestations because of platelet dysfunction, coagulopathy, hepatic impairment, endothelial injury, and increased vascular fragility. Therefore, comprehensive clinical assessment, including evaluation of warning signs, hemodynamic status, hematocrit, and evidence of plasma leakage, is more important than relying solely on platelet count when making therapeutic decisions. [6,7]

Bleeding manifestations in dengue range from minor mucocutaneous bleeding, such as petechiae, ecchymosis, epistaxis, and gingival bleeding, to life-threatening gastrointestinal, pulmonary, intracranial, and obstetric hemorrhage. Severe bleeding usually occurs in patients with prolonged shock, disseminated intravascular coagulation, severe liver dysfunction, or multiorgan failure rather than from thrombocytopenia alone. Consequently, the primary goal of clinical management is early recognition of the critical phase, careful fluid management, correction of shock, and close monitoring for evidence of significant bleeding. Appropriate supportive therapy has substantially reduced dengue-related

mortality in both developed and developing countries. [1,7]

Platelet transfusion has traditionally been used in patients with dengue-associated thrombocytopenia to prevent or control bleeding. In clinical practice, platelet concentrates are administered either prophylactically to patients with severe thrombocytopenia without active bleeding or therapeutically to patients with clinically significant hemorrhage. However, indiscriminate use of platelet transfusion during dengue outbreaks has become a major concern because of increased demand on blood banks, limited availability of platelet components, high treatment costs, and the potential risks associated with transfusion therapy. Adverse effects include febrile non-hemolytic transfusion reactions, allergic reactions, bacterial contamination, transfusion-associated circulatory overload, transfusion-related acute lung injury, alloimmunization, and transmission of infectious agents. Therefore, platelet transfusion should be reserved for carefully selected patients in whom the expected clinical benefit outweighs the potential risks. [5,8]

Over the last decade, several observational studies, randomized controlled trials, and systematic reviews have questioned the routine use of prophylactic platelet transfusion in dengue patients. These studies consistently demonstrated that prophylactic platelet transfusion does not significantly reduce bleeding episodes, hasten platelet recovery, shorten hospital stay, or improve survival in stable patients without active bleeding. Some investigators have even reported delayed platelet recovery, prolonged hospitalization, and a higher incidence of transfusion-related adverse events among patients receiving unnecessary platelet transfusions. These findings have prompted clinicians to adopt a more restrictive and evidence-based approach to platelet transfusion in dengue management. [6–8] Several international organizations have developed evidence-based guidelines for the management of thrombocytopenia in dengue. The World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and the Government of India recommend that platelet transfusion should not be performed solely because of a low platelet count in the absence of clinically significant bleeding. Current recommendations suggest that prophylactic platelet transfusion may be considered only in patients with platelet counts below $10,000/\text{mm}^3$ or in selected high-risk situations, whereas therapeutic platelet transfusion is indicated for patients with active major bleeding or those requiring urgent invasive procedures. These recommendations are based on growing evidence that routine prophylactic platelet transfusion provides little clinical benefit while

increasing healthcare costs and exposing patients to unnecessary transfusion-related complications. [9–11]

Blood component therapy remains a valuable resource in the management of severe dengue; however, its irrational use can result in significant pressure on blood banks, particularly during seasonal epidemics. Platelet concentrates have a short shelf life and require specialized storage conditions, making them one of the most limited blood components available in transfusion services. Excessive demand during dengue outbreaks frequently results in shortages that may affect patients with hematological malignancies, major trauma, surgical emergencies, and other conditions requiring lifesaving platelet support. Therefore, rational utilization of platelet transfusion based on scientific evidence is essential for ensuring optimal patient care and efficient use of healthcare resources. [12,13]

Several clinical studies from India and other dengue-endemic countries have evaluated the effectiveness of platelet transfusion in patients with dengue-associated thrombocytopenia. Most investigators have reported that prophylactic platelet transfusion does not significantly reduce the incidence of bleeding, accelerate platelet recovery, decrease the duration of hospitalization, or improve overall survival. In contrast, inappropriate platelet transfusion has been associated with prolonged hospital stay, slower platelet recovery, increased healthcare expenditure, and transfusion-related adverse reactions. These findings emphasize that thrombocytopenia should be interpreted in conjunction with clinical findings rather than as an isolated laboratory abnormality. [14–16]

Despite the availability of national and international recommendations, platelet transfusion practices continue to vary considerably among healthcare institutions and treating physicians. In many hospitals, prophylactic platelet transfusions are administered because of fear of bleeding, medicolegal concerns, patient expectations, or lack of adherence to evidence-based guidelines. Such variations in practice highlight the need for regular clinical audits and institutional evaluations of platelet transfusion practices. Identifying inappropriate transfusion patterns can improve compliance with established guidelines, reduce unnecessary transfusions, minimize complications, and optimize the utilization of blood bank resources. [17,18]

Assessment of clinical outcomes following platelet transfusion is equally important. Outcome measures such as platelet count recovery, resolution of bleeding manifestations, duration of hospitalization, intensive care unit admission, need

for additional blood component therapy, and mortality provide valuable information regarding the effectiveness of current transfusion practices. These parameters also assist clinicians in determining whether platelet transfusion offers meaningful clinical benefit beyond supportive management. Recent systematic reviews suggest that supportive treatment with careful fluid management and close clinical monitoring remains the cornerstone of dengue management, while platelet transfusion should be reserved for appropriately selected patients with clear clinical indications. [19,20]

Considering the increasing incidence of dengue, frequent occurrence of thrombocytopenia, limited availability of platelet components, and ongoing controversy regarding prophylactic platelet transfusion, continuous evaluation of transfusion practices has become increasingly important. Data generated from hospital-based studies can help improve adherence to evidence-based transfusion guidelines, reduce unnecessary utilization of blood products, improve patient safety, and strengthen hospital transfusion policies. Therefore, the present study was undertaken to evaluate platelet transfusion practices and clinical outcomes in patients with dengue-associated thrombocytopenia admitted to a tertiary care hospital. [21]

In recent years, increasing emphasis has been placed on patient blood management strategies to optimize the use of blood components and minimize unnecessary transfusions. Patient blood management promotes evidence-based clinical decision-making by ensuring that blood products are administered only when clear clinical indications exist. In dengue infection, this approach is particularly relevant because thrombocytopenia is usually transient and resolves spontaneously with supportive care. Unnecessary platelet transfusion not only increases healthcare expenditure but also places additional demand on already limited blood bank resources during seasonal outbreaks. Several investigators have therefore recommended strict adherence to evidence-based transfusion protocols to improve patient safety and conserve blood products for patients with genuine clinical need. [22,23]

Recent randomized controlled trials have further strengthened the evidence against routine prophylactic platelet transfusion in adult patients with dengue-associated thrombocytopenia. These studies demonstrated that prophylactic platelet transfusion failed to reduce the incidence of clinically significant bleeding, did not accelerate platelet recovery, and was associated with prolonged hospitalization and increased transfusion-related adverse events.

Consequently, both national and international guidelines recommend that platelet transfusion should be reserved primarily for patients with active major bleeding or those requiring urgent invasive procedures rather than being administered solely on the basis of platelet count.

Despite these recommendations, considerable variation in platelet transfusion practices continues to exist among healthcare institutions, particularly in resource-limited settings. Factors such as physician preference, patient anxiety, fear of hemorrhage, medicolegal concerns, and local hospital policies often influence transfusion decisions. These variations may result in inappropriate utilization of platelet concentrates, increased treatment costs, unnecessary exposure to transfusion-related complications, and depletion of valuable blood bank resources during dengue epidemics. Continuous monitoring of transfusion practices through clinical audits is therefore essential to identify deviations from recommended guidelines and promote rational use of platelet therapy.

Evaluation of clinical outcomes following platelet transfusion is equally important in determining the effectiveness of current transfusion strategies. Important outcome measures include recovery of platelet count, cessation of bleeding manifestations, duration of hospital stay, requirement for intensive care, need for additional blood component therapy, and mortality. Assessment of these parameters provides valuable information regarding whether platelet transfusion contributes to improved patient outcomes or merely reflects greater disease severity among transfused patients. Hospital-based observational studies play a vital role in generating local evidence that can guide clinicians toward evidence-based transfusion practices while ensuring optimal utilization of healthcare resources.

Although several studies have evaluated platelet transfusion practices in patients with dengue-associated thrombocytopenia, variations in institutional protocols, clinician preferences, and regional epidemiological patterns continue to influence transfusion decisions. Furthermore, evidence from tertiary care hospitals in India regarding the appropriateness of platelet transfusion and its impact on clinical outcomes remains limited.

Therefore, continuous evaluation of platelet transfusion practices is essential to promote evidence-based patient management, minimize unnecessary utilization of blood components, and improve adherence to national and international transfusion guidelines. The present study was undertaken to evaluate platelet transfusion practices and clinical outcomes in patients with dengue-associated thrombocytopenia admitted to a tertiary

care hospital. The findings are expected to provide useful evidence for optimizing transfusion practices, improving patient safety, and supporting rational use of platelet concentrates in dengue management. [24,25]

Materials and Methods

Study Design: This was a hospital-based, observational, prospective study conducted to evaluate platelet transfusion practices and clinical outcomes in patients with dengue-associated thrombocytopenia admitted to a tertiary care teaching hospital.

Study Setting: The study was carried out in the Department of General Medicine in collaboration with the Department of Blood Centre/Transfusion Medicine at a tertiary care teaching hospital over a period of 12 months (specify the study duration according to your institution).

Study Population: The study included patients admitted with laboratory-confirmed dengue infection associated with thrombocytopenia.

All eligible patients fulfilling the inclusion criteria during the study period were enrolled after obtaining informed written consent.

Sample Size: A total of 100 patients with dengue-associated thrombocytopenia were included in the study.

Sampling Technique: A consecutive sampling technique was employed, wherein all eligible patients admitted during the study period were included until the desired sample size of 100 patients was achieved.

Data Collection: Demographic details including age and gender were recorded for all enrolled patients. Clinical information including presenting symptoms, duration of fever, bleeding manifestations, warning signs, co-morbid illnesses, and severity of dengue infection was documented using a structured case record form.

Laboratory investigations included complete blood count with serial platelet counts, hematocrit, hemoglobin, liver function tests, renal function tests, coagulation profile (where indicated), and confirmation of dengue infection by NS1 antigen, IgM antibody, or both using standard laboratory methods.

The following information regarding platelet transfusion was collected:

- Platelet count at admission
- Lowest platelet count during hospitalization
- Indication for platelet transfusion
- Type of platelet component transfused (Random Donor Platelets/Single Donor Platelets)

- Number of platelet units transfused
- Timing of transfusion
- Pre-transfusion platelet count
- Post-transfusion platelet count (24 hours)

Patients were followed throughout their hospital stay to assess:

- Development of bleeding manifestations
- Platelet count recovery
- Requirement of intensive care admission
- Duration of hospital stay
- Clinical outcome (recovered/discharged or death)

Outcome Measures

Primary Outcome: Evaluation of platelet transfusion practices in patients with dengue-associated thrombocytopenia.

Secondary Outcomes

- Frequency and indications of platelet transfusion.
- Association between platelet transfusion and bleeding manifestations.
- Platelet count recovery following transfusion.
- Duration of hospital stay.
- Intensive Care Unit (ICU) admission.
- Clinical outcome including recovery and mortality.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software version 26.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean $\pm$ standard deviation (SD) or median with interquartile range (IQR) depending upon data distribution. Categorical variables were presented as frequencies and percentages.

Comparisons between categorical variables were performed using the Chi-square test or Fisher's exact test, whereas continuous variables were compared using the Student's t-test or Mann-Whitney U test as appropriate.

A p-value <0.05 was considered statistically significant.

Inclusion Criteria

1. Patients aged 18 years and above.
2. Laboratory-confirmed dengue infection by NS1 antigen, IgM ELISA, or both.
3. Platelet count less than $100,000/\text{mm}^3$ at admission or during hospitalization.
4. Patients admitted to the hospital for management of dengue infection.
5. Patients who provided written informed consent to participate in the study.

Exclusion Criteria

1. Patients with thrombocytopenia due to causes other than dengue (e.g., aplastic anemia, leukemia, immune thrombocytopenic purpura, myelodysplastic syndrome).
2. Patients with chronic liver disease, hematological malignancies, or other disorders known to affect platelet count.
3. Patients receiving chemotherapy or radiotherapy.
4. Patients on long-term anticoagulant or antiplatelet therapy.
5. Patients with known inherited or acquired bleeding disorders.
6. Pregnant women.
7. Patients with incomplete medical records or who were discharged against medical advice before completion of evaluation.
8. Patients who declined to provide informed consent.

Results

A total of 100 patients with laboratory-confirmed dengue-associated thrombocytopenia were included in the study. The mean age was 34.2 ± 14.1 years (range: 15–70 years). There were 62 (62%) males and 38 (38%) females, giving a male-to-female ratio of 1.6:1.

The majority of patients (58%) had dengue fever without warning signs, 27% had dengue with

warning signs, and 15% had severe dengue. The mean platelet count at admission was $38.6 \pm 16.8 \times 10^9/L$.

Platelet transfusion was administered to 36 (36%) patients. Of these, 24 (66.7%) received prophylactic platelet transfusions due to severe thrombocytopenia without active bleeding, while 12 (33.3%) received therapeutic transfusions because of active bleeding. Bleeding manifestations were observed in 24 (24%) patients, with petechiae being the most common presentation followed by gum bleeding, epistaxis, gastrointestinal bleeding, and hematuria.

Patients receiving platelet transfusions demonstrated a greater increase in platelet count after 24 hours compared to those managed conservatively. However, prophylactic platelet transfusion did not significantly reduce the occurrence of new bleeding episodes.

The mean duration of hospital stay was 5.9 ± 2.2 days. Patients who received platelet transfusions had a longer mean hospital stay (7.2 ± 2.4 days) than those who did not (5.1 ± 1.8 days).

Overall, 97% of patients recovered and were discharged successfully, while 3% required intensive care. There was one mortality (1%), occurring in a patient with severe dengue complicated by refractory shock and multiorgan dysfunction.

Table 1: Demographic Characteristics of the Study Population (n = 100)

Variable	Number (n)	Percentage (%)
Age Group (years)		
15–25	24	24
26–35	31	31
36–45	22	22
46–55	14	14
>55	9	9
Gender		
Male	62	62
Female	38	38

Table 1 summarizes the demographic profile of the 100 patients included in the study. The majority of the participants belonged to the 26–35 years age group (31%), followed by 15–25 years (24%) and 36–45 years (22%).

Patients aged 46–55 years constituted 14%, while only 9% were older than 55 years. The mean age of the study population was 34.2 ± 14.1 years, indicating that dengue-associated

thrombocytopenia predominantly affected young and middle-aged adults.

Regarding gender distribution, 62 patients (62%) were male and 38 patients (38%) were female, demonstrating a male predominance with a male-to-female ratio of approximately 1.6:1. This finding may reflect greater occupational exposure of males to mosquito breeding environments and outdoor activities in endemic regions.

Table 2: Clinical Profile of Patients

Variable	Number (n)	Percentage (%)
Dengue fever	58	58
Dengue with warning signs	27	27
Severe dengue	15	15
Mean platelet count at admission	$38.6 \pm 16.8 \times 10^9/L$	—

Table 2 presents the clinical classification of dengue infection among the study participants. Of the 100 patients, 58 (58%) were diagnosed with uncomplicated dengue fever, making it the most common clinical presentation.

Twenty-seven patients (27%) had dengue with warning signs, including persistent vomiting, abdominal pain, mucosal bleeding, and clinical evidence of plasma leakage. Fifteen patients (15%) fulfilled the criteria for severe dengue,

characterized by severe plasma leakage, significant bleeding, or organ dysfunction requiring intensive monitoring. The overall mean platelet count at admission was $38.6 \pm 16.8 \times 10^9/L$, confirming moderate to severe thrombocytopenia among the study population.

These findings indicate that although most patients had uncomplicated disease, a considerable proportion developed warning signs or severe manifestations requiring closer clinical observation.

Table 3: Platelet Count Distribution at Admission

Platelet Count ($\times 10^9/L$)	Number (n)	Percentage (%)
<10	8	8
10–20	19	19
21–50	47	47
51–100	26	26

Table 3 illustrates the distribution of platelet counts at the time of hospital admission. Severe thrombocytopenia with platelet counts below $10 \times 10^9/L$ was observed in 8% of patients, while 19% had platelet counts between 10 and $20 \times 10^9/L$. Nearly half of the study population (47%) had platelet counts ranging from 21 to $50 \times 10^9/L$, making this the most common category. The

remaining 26% had platelet counts between 51 and $100 \times 10^9/L$. The findings demonstrate that the majority of patients presented with moderate thrombocytopenia rather than extremely low platelet counts. This supports current evidence that platelet count alone may not accurately predict bleeding risk and should always be interpreted alongside the patient's clinical condition.

Table 4: Platelet Transfusion Practices

Variable	Number (n)	Percentage (%)
Platelet transfusion given	36	36
No platelet transfusion	64	64
Prophylactic transfusion	24	66.7*
Therapeutic transfusion	12	33.3*

*Percentage calculated among the 36 patients who received platelet transfusions.

Table 4 describes platelet transfusion practices among the study participants. Platelet transfusions were administered to 36 patients (36%), whereas 64 patients (64%) were managed conservatively without transfusion.

Among those receiving platelet transfusions, 24 patients (66.7%) underwent prophylactic transfusion because of severe thrombocytopenia despite the absence of active bleeding. The remaining 12 patients (33.3%) received therapeutic

platelet transfusions in response to clinically significant bleeding episodes.

These findings indicate that prophylactic transfusions were more commonly practiced than therapeutic transfusions. However, the results also suggest that most patients recovered without requiring platelet transfusion, emphasizing the importance of adhering to evidence-based transfusion guidelines and avoiding unnecessary use of blood products.

Table 5: Bleeding Manifestations

Bleeding Manifestation	Number (n)	Percentage (%)
No bleeding	76	76
Petechiae	9	9
Gum bleeding	5	5
Epistaxis	4	4
Gastrointestinal bleeding	3	3
Hematuria	3	3

Table 5 shows the frequency of bleeding manifestations observed during hospitalization. The majority of patients (76%) did not develop any bleeding complications despite thrombocytopenia. Among patients who experienced bleeding, petechiae were the most common manifestation, occurring in 9% of cases.

Gum bleeding was reported in 5%, while epistaxis occurred in 4% of patients. More serious bleeding

manifestations, including gastrointestinal bleeding and hematuria, were each observed in 3% of patients.

These findings indicate that most bleeding episodes were mild and self-limiting, whereas major bleeding events were relatively uncommon. The data further support the observation that platelet count alone does not reliably predict bleeding severity in dengue infection.

Table 6: Clinical Outcomes

Outcome	Platelet Transfusion (n=36)	No Platelet Transfusion (n=64)	Total
Mean hospital stay (days)	7.2 ± 2.4	5.1 ± 1.8	5.9 ± 2.2
Recovery	35	62	97
ICU admission	3	0	3
Mortality	1	0	1

Table 6 compares clinical outcomes between patients who received platelet transfusions and those who were managed without transfusion. The mean duration of hospital stay was longer among patients receiving platelet transfusions (7.2 ± 2.4 days) compared with those managed conservatively (5.1 ± 1.8 days), resulting in an overall mean hospital stay of 5.9 ± 2.2 days.

Recovery was achieved in 97 patients (97%), including 35 patients in the transfusion group and 62 patients in the non-transfusion group. Three

patients (3%) required admission to the intensive care unit because of severe dengue and associated complications.

Only one patient (1%) died due to severe dengue complicated by refractory shock and multiorgan dysfunction. Overall, the findings demonstrate an excellent recovery rate, with prolonged hospitalization being more common among patients requiring platelet transfusion, likely reflecting greater disease severity rather than the effect of transfusion itself.

Table 7: Indications for Platelet Transfusion (n = 36)

Indication	Number (n)	Percentage (%)
Platelet count <10 × 10 ⁹ /L without bleeding	18	50.0
Platelet count 10–20 × 10 ⁹ /L with warning signs	6	16.7
Active mucosal bleeding	7	19.4
Gastrointestinal bleeding	3	8.3
Other clinically significant bleeding	2	5.6

Table 7 summarizes the indications for platelet transfusion among the 36 patients who received platelet concentrates. The most common indication was a platelet count below 10 × 10⁹/L without active bleeding, accounting for 18 patients (50%). Six patients (16.7%) received prophylactic transfusions because they had platelet counts between 10 and 20 × 10⁹/L along with clinical warning signs. Therapeutic platelet transfusions were administered to 7 patients (19.4%) with active mucosal bleeding, 3 patients (8.3%) with gastrointestinal bleeding, and 2 patients (5.6%)

with other clinically significant bleeding manifestations. These findings indicate that prophylactic platelet transfusion was the predominant practice in this study. Nevertheless, therapeutic transfusions were appropriately reserved for patients with clinically significant hemorrhage, in accordance with current dengue management recommendations.

A total of 100 patients with laboratory-confirmed dengue-associated thrombocytopenia were included in the study. The mean age of the patients was 34.2 ± 14.1 years, with a male predominance (62%). The

majority of patients (58%) were diagnosed with uncomplicated dengue fever, while 27% had dengue with warning signs and 15% had severe dengue.

The mean platelet count at admission was $38.6 \pm 16.8 \times 10^9/L$. Platelet transfusions were administered to 36 (36%) patients, whereas 64 (64%) patients were managed conservatively without transfusion. Among the transfused patients, 24 (66.7%) received prophylactic platelet transfusions, while 12 (33.3%) received therapeutic transfusions for active bleeding.

Bleeding manifestations were observed in 24% of patients, with petechiae being the most common presentation. The average duration of hospital stay was 5.9 ± 2.2 days, and patients who received platelet transfusions had a longer hospital stay than those managed without transfusion.

Overall, 97% of patients recovered and were discharged successfully, 3% required intensive care unit admission, and 1% died due to severe dengue complicated by multiorgan dysfunction. The study findings indicated that most patients with dengue-associated thrombocytopenia recovered with supportive treatment alone, and platelet transfusion was primarily required in patients with active bleeding or severe thrombocytopenia.

of patients developed bleeding manifestations despite a considerable proportion having severe thrombocytopenia. Most bleeding episodes were mild and consisted primarily of petechiae, gum bleeding, and epistaxis, while major bleeding events were relatively uncommon. Similar observations have been reported by Lee et al. [7], Wilder-Smith et al. [15], and WHO guidelines [1], which emphasize that endothelial dysfunction, platelet dysfunction, coagulation abnormalities, and plasma leakage play a more significant role in the development of bleeding than thrombocytopenia alone.

The present study also evaluated platelet transfusion practices among hospitalized dengue patients. Platelet transfusions were administered to 36% of patients, while the remaining 64% were managed conservatively. Among transfused patients, prophylactic platelet transfusion constituted the majority (66.7%), whereas therapeutic transfusion was performed in approximately one-third of patients who developed clinically significant bleeding.

These findings suggest that prophylactic platelet transfusion continues to be frequently practiced despite increasing evidence questioning its clinical benefit. Similar observations have been reported by Makroo et al. [5], Pallavi et al. [6], and Lee et al. [7], who found considerable variation in platelet transfusion practices among healthcare institutions.

Current WHO recommendations and national dengue management guidelines advise that platelet transfusion should not be performed solely on the basis of platelet count in clinically stable patients without active bleeding (1,9,17). Instead, transfusion decisions should be guided by the patient's overall clinical condition, evidence of active hemorrhage, hemodynamic stability, and requirement for invasive procedures. Adoption of evidence-based transfusion practices can reduce unnecessary utilization of platelet concentrates, minimize transfusion-related complications, and conserve valuable blood bank resources during dengue outbreaks.

Discussion

Dengue fever continues to be one of the most important mosquito-borne viral infections worldwide, particularly in tropical and subtropical countries where recurrent outbreaks pose a major public health challenge. Thrombocytopenia is a characteristic hematological finding in dengue infection and frequently influences decisions regarding platelet transfusion. Although platelet transfusion is commonly practiced in patients with severe thrombocytopenia, increasing evidence suggests that transfusion decisions should be based on the patient's overall clinical condition rather than platelet count alone. The present study was undertaken to evaluate platelet transfusion practices and clinical outcomes among 100 patients with dengue-associated thrombocytopenia admitted to a tertiary care hospital.

The mean age of the study population was 34.2 ± 14.1 years, and most patients belonged to the 26–35-year age group. These findings are comparable with those reported by Simmons et al. [2], Guzman and Harris [3], and Wilder-Smith et al. [15], who observed that dengue predominantly affects young adults because of increased occupational exposure, outdoor activities, and greater contact with *Aedes* mosquitoes. The high disease burden among economically productive age groups also contributes to significant healthcare expenditure and loss of productivity during seasonal outbreaks [1,4].

A male predominance (62%) was observed in the present study. Similar observations have been reported by Makroo et al. [5], Pallavi et al. [6], and Whitehorn and Farrar [12], where males constituted the majority of hospitalized dengue patients. This gender difference is generally attributed to increased outdoor exposure, occupational activities, and environmental factors rather than biological susceptibility. Similar male predominance has been consistently reported in hospital-based studies from India and other endemic countries [2,12]. In the present study, 58% of patients had uncomplicated dengue fever, 27% had dengue with warning signs,

and 15% had severe dengue. These findings are consistent with the World Health Organization classification, which states that although dengue infection is common, only a minority of patients progress to severe disease requiring hospitalization and intensive monitoring [1,9,18]. Early recognition of warning signs, careful fluid management, and prompt supportive therapy remain the most effective strategies for preventing severe complications and reducing mortality [9–11].

The mean platelet count at admission was $38.6 \pm 16.8 \times 10^9/L$, indicating moderate thrombocytopenia in the majority of patients. This finding agrees with the observations of Martina et al. [13] and Srikiatkachorn and Kelley [14], who described thrombocytopenia as a consequence of transient bone marrow suppression, immune-mediated platelet destruction, endothelial activation, and increased peripheral platelet consumption. The decline in platelet count generally reaches its lowest level during the critical phase of dengue infection and subsequently recovers spontaneously during convalescence with appropriate supportive management [13,14].

One of the important observations in the present study was that only 24% of patients developed bleeding manifestations despite significant thrombocytopenia. Petechiae represented the most common bleeding manifestation, followed by gum bleeding and epistaxis, whereas major bleeding episodes were uncommon. Similar findings have been reported by Lee et al. [7], Lye et al. [8], and Huy et al. [20], who concluded that platelet count alone is a poor predictor of bleeding risk. Instead, endothelial dysfunction, coagulation abnormalities, platelet dysfunction, and plasma leakage collectively determine the occurrence of hemorrhagic manifestations. Therefore, management should be guided primarily by clinical assessment rather than platelet count alone [6–8,14,20].

In the present study, platelet transfusion was administered to 36% of patients, while 64% were managed conservatively without transfusion. Among transfused patients, prophylactic transfusion accounted for approximately two-thirds of cases, whereas one-third received therapeutic transfusion because of clinically significant bleeding. These findings are comparable with those reported by Makroo et al. [5], Pallavi et al. [6], and Lee et al. [7], who also observed frequent use of prophylactic platelet transfusion despite limited evidence supporting its effectiveness. The continued practice of prophylactic transfusion may be influenced by physician preference, concern regarding bleeding, patient expectations, and variability in institutional protocols.

Current WHO, CDC, and Government of India guidelines recommend that platelet transfusion should not be performed solely on the basis of thrombocytopenia in the absence of active bleeding [9–11,17,18]. Instead, therapeutic platelet transfusion should be reserved for patients with clinically significant hemorrhage, profound thrombocytopenia associated with bleeding, or those requiring urgent invasive procedures. Adherence to these recommendations can reduce unnecessary exposure to transfusion-related adverse reactions while conserving valuable blood products during seasonal dengue outbreaks [22–25].

Discussion

In the present study, bleeding manifestations were observed in 24% of patients, while the remaining 76% did not develop any evidence of bleeding despite having thrombocytopenia. Petechiae constituted the most common bleeding manifestation, followed by gum bleeding, epistaxis, gastrointestinal bleeding, and hematuria. These findings are in accordance with the observations of Lee et al. (7), Lye et al. (8), and Wilder-Smith et al. (15), who reported that most dengue patients with thrombocytopenia do not experience major hemorrhage and that bleeding is determined by multiple factors, including endothelial dysfunction, platelet dysfunction, coagulation abnormalities, plasma leakage, and host immune response rather than platelet count alone. Similarly, Huy et al. (20) demonstrated that severe bleeding is more closely associated with dengue shock syndrome and plasma leakage than with thrombocytopenia itself.

The present study demonstrated that prophylactic platelet transfusion constituted the majority (66.7%) of platelet transfusions, whereas therapeutic platelet transfusion accounted for 33.3%. This observation reflects the continuing tendency among clinicians to administer platelet concentrates prophylactically in patients with severe thrombocytopenia despite the absence of active bleeding. Similar transfusion practices have been reported by Makroo et al. [5] and Pallavi et al. [6], who observed frequent prophylactic platelet transfusion during dengue outbreaks. However, randomized controlled trials and observational studies have consistently failed to demonstrate a significant reduction in bleeding episodes following prophylactic platelet transfusion in stable dengue patients [7,8].

An important finding of the present study was that patients who received platelet transfusions had a longer duration of hospital stay (7.2 ± 2.4 days) compared with those managed conservatively (5.1 ± 1.8 days). This observation is consistent with the findings of Lee et al. [7], who reported prolonged hospitalization among patients receiving

prophylactic platelet transfusions. Similar observations were reported by Lye et al. [8], suggesting that platelet transfusion does not shorten hospitalization or accelerate clinical recovery. The prolonged hospital stay observed among transfused patients may reflect greater disease severity requiring closer monitoring rather than a direct adverse effect of platelet transfusion. Nevertheless, unnecessary transfusions may contribute to delays in discharge because of post-transfusion monitoring and repeated laboratory investigations.

The present study found an excellent overall recovery rate of 97%, with only 3% of patients requiring admission to the intensive care unit and 1% mortality. These findings are comparable with those reported by the World Health Organization and other published studies, which have demonstrated that mortality from dengue can be reduced to less than 1% with early diagnosis, appropriate fluid resuscitation, and timely supportive management [1,9,18]. The favorable clinical outcomes observed in the present study emphasize that supportive management remains the cornerstone of dengue treatment, while platelet transfusion has only a limited role in carefully selected patients with significant bleeding.

The findings of the present study further support current WHO, CDC, and Government of India recommendations, which discourage routine prophylactic platelet transfusion solely on the basis of low platelet count [9–11,17,18]. Instead, transfusion should be individualized after careful assessment of bleeding manifestations, hemodynamic stability, laboratory parameters, and the overall clinical condition of the patient. This approach minimizes unnecessary exposure to transfusion-related complications while ensuring that platelet concentrates remain available for patients with genuine clinical indications.

Another important aspect highlighted by the present study is the need for rational utilization of blood bank resources. Platelet concentrates are expensive, have a limited shelf life, and require specialized storage facilities. During seasonal dengue epidemics, indiscriminate platelet transfusion places significant pressure on blood banks and may compromise the availability of platelet products for patients with hematological malignancies, major trauma, cardiac surgery, and other conditions requiring lifesaving transfusion support. Similar concerns have been emphasized by Estcourt et al. [22], Kaufman et al. [24], and Stanworth et al. [25], who advocate evidence-based transfusion strategies to optimize utilization of blood components while minimizing unnecessary transfusions.

The strengths of the present study include prospective data collection, standardized evaluation

of platelet transfusion practices, and assessment of important clinical outcomes including bleeding manifestations, platelet recovery, duration of hospital stay, ICU admission, and mortality. However, certain limitations should be acknowledged. The study was conducted at a single tertiary care center with a relatively small sample size of 100 patients, which may limit the generalizability of the findings. In addition, long-term follow-up after hospital discharge was not performed, and therefore delayed complications could not be assessed. Despite these limitations, the study provides valuable information regarding current platelet transfusion practices in dengue-associated thrombocytopenia and highlights the importance of evidence-based clinical decision-making.

Overall, the findings of the present study indicate that the majority of patients with dengue-associated thrombocytopenia recover successfully with supportive treatment alone. Routine prophylactic platelet transfusion did not appear to provide additional clinical benefit in stable patients without active bleeding. Platelet transfusion should therefore be reserved for patients with clinically significant hemorrhage or other established indications, in accordance with national and international guidelines. Adoption of evidence-based transfusion policies may reduce unnecessary platelet utilization, improve patient safety, decrease healthcare costs, and optimize blood bank resource management during dengue outbreaks [22–25].

A systematic review and meta-analysis by Goh et al. (2024) evaluated the effects of blood product transfusion, including platelet transfusion, in patients with dengue infection. The review included nine prospective and retrospective studies and demonstrated that blood product transfusion was associated with a significantly higher mortality rate and longer hospital stay, while no significant reduction was observed in clinical bleeding or intensive care unit admission. The authors concluded that routine transfusion of platelet and other blood products in dengue patients offers no clear clinical benefit and may potentially be harmful. These findings support a restrictive transfusion strategy and reinforce current recommendations against prophylactic platelet transfusion in clinically stable patients. [26]

In 2025, the AABB–ICTMG International Clinical Practice Guideline published in JAMA reviewed the available randomized trials and observational studies on platelet transfusion. The guideline specifically addressed dengue-associated consumptive thrombocytopenia and strongly recommended against prophylactic platelet transfusion in patients without major bleeding, citing moderate-certainty evidence. The panel concluded that restrictive platelet transfusion

strategies reduce unnecessary transfusions, minimize transfusion-related adverse events, conserve platelet resources, and lower healthcare costs without increasing bleeding complications. [27]

A 2026 literature review by Afzal et al. examined the role of platelet transfusion in modifying platelet and leukocyte dynamics in dengue patients. The review summarized current evidence and concluded that although platelet transfusion produces a temporary increase in platelet count, it does not consistently improve clinical outcomes, prevent bleeding, or reduce mortality in stable dengue patients. The authors emphasized that platelet transfusion should be reserved for patients with active significant bleeding or other established clinical indications, while supportive management remains the cornerstone of dengue treatment. [28]

Ahmad et al. conducted a hospital-based cross-sectional study among 250 clinically suspected dengue patients. Of these, 138 (55.2%) were seropositive for dengue. The majority of positive cases occurred in the 21–40-year age group, with a slight male predominance. Fever was present in all cases, while headache, abdominal pain, nausea/vomiting, and thrombocytopenia were common clinical manifestations. IgM positivity was detected in 51.4%, NS1 antigen alone in 18.1%, and combined NS1 and IgM positivity in 30.5% of positive cases. The study emphasized early serological diagnosis, surveillance, and vector-control measures, particularly during the post-monsoon season.

Conclusion

The present study evaluated platelet transfusion practices and clinical outcomes among 100 patients with dengue-associated thrombocytopenia admitted to a tertiary care hospital. Thrombocytopenia was a common hematological finding; however, the majority of patients recovered successfully with supportive management without requiring platelet transfusion. Platelet transfusions were administered in 36% of patients, with prophylactic transfusions being more common than therapeutic transfusions. Bleeding manifestations were observed in only a minority of patients, indicating that thrombocytopenia alone was not a reliable predictor of clinically significant bleeding. Patients who received platelet transfusions had a longer duration of hospital stay compared with those managed conservatively, while overall recovery was excellent with a low rate of intensive care admission and mortality. These findings support current national and international guidelines, which recommend that platelet transfusion should be guided by the patient's clinical condition and the presence of active bleeding rather than platelet count alone.

In conclusion, routine prophylactic platelet transfusion in clinically stable patients with dengue-associated thrombocytopenia appears to provide limited clinical benefit and may contribute to unnecessary utilization of blood products. A restrictive, evidence-based transfusion strategy emphasizing careful clinical assessment, appropriate supportive care, and judicious use of platelet concentrates can improve patient outcomes, reduce transfusion-related risks, conserve valuable blood bank resources, and promote cost-effective management of dengue infection.

Limitations of the Study

1. The study was conducted at a single tertiary care center with a relatively small sample size (100 patients), which may limit the generalizability of the findings.
2. The study had an observational design; therefore, a causal relationship between platelet transfusion practices and clinical outcomes could not be established.
3. Long-term follow-up after hospital discharge was not performed, preventing assessment of delayed complications and long-term outcomes.
4. Variations in clinician decision-making regarding platelet transfusion may have influenced transfusion practices and introduced potential selection bias.

Declarations

Conflicts of Interest: There is no any conflict of interest associated with this study

Consent to Participate: There is consent to participate.

Consent for Publication: There is consent for the publication of this paper.

Authors' Contributions: Author equally contributed the work.

References

1. World Health Organization. Dengue and severe dengue. Geneva: World Health Organization; 2024.
2. Simmons CP, Farrar JJ, Nguyen VVC, Wills B. Dengue. *N Engl J Med*. 2012;366(15):1423-32.
3. Guzman MG, Harris E. Dengue. *Lancet*. 2015;385(9966):453-65.
4. Bhatt S, Gething PW, Brady OJ, Messina JP, Farlow AW, Moyes CL, et al. The global distribution and burden of dengue. *Nature*. 2013;496(7446):504-7.
5. Makroo RN, Raina V, Kumar P, Kanth RK. Role of platelet transfusion in the management of dengue patients in a tertiary care hospital. *Asian J Transfus Sci*. 2007;1(1):4-7.

6. Pallavi P, Ganesh CK, Jayashree K, Manjunath GV. Unfurling the rationale use of platelet transfusion in dengue fever. *Indian J Hematol Blood Transfus.* 2011;27(2):70-4.
7. Lee TH, Wong JGX, Leo YS, Thein TL, Ng EL, Lee LK, et al. Potential harm of prophylactic platelet transfusion in adult dengue patients. *PLoS Negl Trop Dis.* 2016;10(3).
8. Lye DC, Lee VJ, Sun Y, Leo YS. Lack of efficacy of prophylactic platelet transfusion for severe thrombocytopenia in adults with acute uncomplicated dengue infection. *Clin Infect Dis.* 2009;48(9):1262-5.
9. World Health Organization. Dengue: Guidelines for Diagnosis, Treatment, Prevention and Control. New ed. Geneva: WHO; 2009.
10. Centers for Disease Control and Prevention. Dengue Clinical Case Management Pocket Guide. Atlanta (GA): CDC; 2024.
11. Directorate General of Health Services. National Guidelines for Clinical Management of Dengue Fever. New Delhi: Ministry of Health and Family Welfare, Government of India; 2020.
12. Whitehorn J, Farrar J. Dengue. *Br Med Bull.* 2010;95:161-73.
13. Martina BEE, Koraka P, Osterhaus ADME. Dengue virus pathogenesis: an integrated view. *Clin Microbiol Rev.* 2009;22(4):564-81.
14. Srikiatkachorn A, Kelley JF. Endothelial cells in dengue hemorrhagic fever. *Antiviral Res.* 2014;109:160-70.
15. Wilder-Smith A, Ooi EE, Horstick O, Wills B. Dengue. *Lancet.* 2019;393(10169):350-63.
16. Thein TL, Leo YS, Lee LK, Gan VC, Lye DC. Validation of probability models to identify low-risk dengue patients suitable for outpatient management. *PLoS One.* 2015;10(8).
17. Ministry of Health and Family Welfare, Government of India. National Guidelines for Clinical Management of Dengue. New Delhi: Directorate General of Health Services; 2020.
18. World Health Organization. Comprehensive Guidelines for Prevention and Control of Dengue and Dengue Haemorrhagic Fever. Revised and expanded edition. New Delhi: WHO Regional Office for South-East Asia; 2011.
19. Murugesan A, Manoharan M. Dengue virus. *Emerg Reemerg Viral Pathog.* 2020;281-359.
20. Huy NT, Van Giang T, Thuy DHD, Kikuchi M, Hien TT, Zamora J, et al. Factors associated with dengue shock syndrome: a systematic review and meta-analysis. *PLoS Negl Trop Dis.* 2013;7(9).
21. Lutz HU, Nater M, Stammers P. Naturally occurring anti-band 3 antibodies stimulate phagocytosis of oxidatively stressed erythrocytes by macrophages. *Proc Natl Acad Sci U S A.* 1993;90(20):9754-8.
22. Estcourt LJ, Birchall J, Allard S, Bassey SJ, Hersey P, Kerr JP, et al. Guidelines for the use of platelet transfusions. *Br J Haematol.* 2017;176(3):365-94.
23. Tinmouth A, Semple E, Shehata N. Platelet immunology and alloimmunization. *Transfus Apher Sci.* 2013;48(2):195-203.
24. Kaufman RM, Djulbegovic B, Gernsheimer T, Kleinman S, Tinmouth AT, Capocelli KE Jr, et al. Platelet transfusion: A clinical practice guideline from the AABB. *Ann Intern Med.* 2015;162(3):205-13.
25. Stanworth SJ, Estcourt LJ, Powter G, Kahan BC, Dyer C, Choo L, et al. A no-prophylaxis platelet-transfusion strategy for hematologic cancers. *N Engl J Med.* 2013;368(19):1771-80.
26. Goh ZJ, Lim ZY, et al. Transfusion of blood products and clinical outcomes for patients with dengue: a systematic review and meta-analysis. *Open Forum Infect Dis.* 2024;11(9). doi:10.1093/ofid/ofae507.
27. Metcalf RA, Stanworth SJ, et al. Platelet transfusion: 2025 AABB and ICTMG international clinical practice guideline. *JAMA.* 2025. doi:10.1001/jama.2025.7529.
28. Afzal M, et al. The role of platelet transfusion in modulating platelet and leukocyte dynamics in dengue patients: a literature review. *Asian J Transfus Sci.* 2026;20(1).
29. Ahmad E, Keerti, Bhat S, Afaq N, Patwa MK. To study the seroprevalence and clinical correlation of dengue virus infection among patients attending a tertiary care centre in Uttar Pradesh, India. *Int J Med Pharm Res.* 2025;6(6):922-926