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Evaluation of Platelet Count and Indices for Diagnosing Neonatal Sepsis: A Cross-Sectional Analysis

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ABSTRACT

Introduction
Neonatal sepsis remains a leading cause of morbidity and mortality in neonates worldwide. Early and accurate diagnosis is crucial for timely intervention. Platelet parameters, such as platelet count, Mean Platelet Volume (MPV), and Platelet Distribution Width (PDW), have emerged as potential biomarkers for the early identification of neonatal sepsis. This study aims to evaluate the role of platelet indices in diagnosing neonatal sepsis.

Materials & Methods
A cross-sectional observational study was conducted in a tertiary care Neonatal Intensive Care Unit (NICU) from June 2023 to December 2024. A total of 100 neonates suspected of sepsis were enrolled. Neonates were categorized into two groups: confirmed sepsis (culture-positive) and probable sepsis (culture-negative). Platelet count, MPV, and PDW were measured on admission, day 3, and day 7. Blood cultures were processed using the BACTEC automated system. Statistical analysis was performed using SPSS version 23.0.

Results
Among the 100 neonates, 28 had culture-positive sepsis, and 72 had culture-negative sepsis. Platelet counts were significantly lower in culture-positive neonates at all time points ($p < 0.05$). MPV was significantly higher in culture-positive neonates compared to culture-negative ones ($p < 0.05$). However, PDW showed no statistically significant differences between the two groups. Escherichia coli was the most common organism isolated in blood cultures (64.3%).

Conclusion
This study highlights the potential of platelet count and MPV as early, cost-effective biomarkers for diagnosing neonatal sepsis. While PDW did not show significant diagnostic value, platelet count and MPV could serve as useful adjuncts to clinical assessment, particularly in resource-limited settings. Further multicenter studies are needed to validate these findings.

Keywords: Neonatal sepsis, Platelet count, Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), Biomarkers, Blood culture, Early diagnosis

1. INTRODUCTION

Neonatal sepsis continues to be a major cause of neonatal mortality across both developed and developing regions of the world. It is defined as a systemic infection caused by bacterial, viral, or fungal pathogens, often accompanied by hemodynamic instability and clinical symptoms that result in significant morbidity and mortality in neonates [1]. The Global Burden of Disease (GBD) Study 2016–2017 estimated around 1.3 million (95% CI: 0.8–2.3 million) new neonatal sepsis cases each year, contributing to approximately 203,000 sepsis-related deaths globally [2]. In India, reported case fatality rates for neonatal sepsis range between 25% and 65% [3].

Sepsis is characterized as a non-specific systemic inflammatory response that can affect virtually all organ systems, including the hemostatic system, which is frequently disrupted during infection [4]. Early and accurate diagnosis is critical for effective intervention and improved survival. However, the nonspecific nature of early clinical signs and the prolonged turnaround time of current diagnostic techniques like blood cultures pose challenges in timely diagnosis and treatment [5]. As a result, there is increasing interest in identifying fast, cost-effective, and reliable biomarkers for early detection of neonatal sepsis.

Among emerging candidates, platelet parameters such as platelet count, Mean Platelet Volume (MPV), and Platelet Distribution Width (PDW) have garnered attention. While traditionally known for their role in coagulation, platelets are now recognized for their function in immune responses, particularly in septic conditions [6]. Thrombocytopenia is a common finding in neonatal sepsis and has been linked to higher risks of poor outcomes [7,8].

Recent studies suggest that variations in platelet indices may serve as early indicators of sepsis and could correlate with disease severity. Elevated MPV has been associated with bacterial infections and may reflect increased platelet turnover triggered by inflammation [6]. Likewise, an increase in PDW, which reflects platelet size variability, has been observed in infectious and inflammatory conditions [9]. Despite these promising associations, there remains a need for broader and more context-specific studies to validate the diagnostic relevance of platelet indices in neonatal sepsis.
Although platelet markers like MPV and PDW have been extensively evaluated in adult populations as indicators of infection and inflammation, their utility in neonates remains under-explored [9,10]. Therefore, this study was conducted to examine thrombocytopenia and the role of platelet indices as diagnostic markers in neonatal sepsis.

2. MATERIALS AND METHODS

Study Design and Setting
This cross-sectional observational study was conducted in a tertiary care hospital's Neonatal Intensive Care Unit (NICU) from June 2023 to December 2024. Written informed consent was obtained from the parents or legal guardians of all enrolled neonates.

Sample Size
The sample size was calculated using the formula $4PQ/L^2$, where P is the estimated prevalence of neonatal sepsis, $Q = 100 - P$, and L is the allowable error. Based on this, the estimated sample size was approximately 100 neonates. Neonates admitted to the NICU with clinical signs of sepsis and/or born to mothers with risk factors for neonatal sepsis were included in the study.

Inclusion Criteria
- Neonates admitted to the NICU with clinical features suggestive of sepsis.
- Neonates born to mothers with known risk factors for sepsis (e.g., maternal fever, prolonged rupture of membranes, or urinary tract infections).
- Parental consent provided.

Exclusion Criteria
- Neonates with congenital or acquired causes of thrombocytopenia unrelated to sepsis, such as autoimmune or alloimmune platelet disorders.
- Neonates with congenital anomalies, hyaline membrane disease, congenital heart defects, metabolic disorders, chromosomal abnormalities, intrauterine growth restriction, or birth asphyxia.
- Neonates born to mothers who received antibiotics within 48 hours prior to delivery.

Methodology
All eligible neonates were assessed for sepsis based on maternal history, clinical examination, and risk factors. A structured proforma was used to collect data on history, clinical signs, and laboratory parameters (Figure 1). Blood samples were collected via peripheral venipuncture using aseptic techniques.
For platelet indices (platelet count, Mean Platelet Volume [MPV], and Platelet Distribution Width [PDW]), 1 mL of blood was drawn into a K_3 EDTA (tripotassium ethylenediaminetetraacetic acid) vial. These parameters were assessed at three time points: on admission, day 3, and day 7 of suspected sepsis. All analyses were performed within one hour of sample collection using a 6-part Sysmex XN-350 fully automated hematology analyzer.
For blood culture, 2 mL of blood was collected in culture bottles under strict aseptic precautions and processed using the BACTEC automated system.

Classification of Study Groups
Participants were categorized into two groups:
- **Confirmed Sepsis**: Clinical signs and symptoms of sepsis with a positive blood culture.
- **Probable Sepsis**: Clinical and laboratory evidence of sepsis without a positive culture result.

Clinical diagnosis of neonatal sepsis was considered in the presence of one or more of the following signs: hypothermia or hyperthermia, seizures, bulging anterior fontanelle, lethargy, altered consciousness, poor activity, apnea or tachypnea, respiratory distress, bradycardia or tachycardia, hypotension, poor feeding, abdominal distension, and necrotizing enterocolitis.

Statistical Analysis
Data were entered in Microsoft Excel and analyzed using SPSS version 23.0 (licensed software). Descriptive statistics were presented as mean ± standard deviation for continuous variables and as proportions for categorical variables. The *t*-test was used to compare quantitative variables, and the Chi-square test was applied for categorical data. A p-value <0.05 was considered statistically significant.

3. RESULTS

Table 1: Demographic Profile of Neonates (n = 100)

Variables	Culture Positive (n = 28)	Culture Negative (n = 72)
Mean age (days)	9.96 ± 7.41	8.64 ± 6.45
Male	17	43
Female	11	29
Preterm	11	28
Term	17	44
Early-onset sepsis (EOS)	20	52
Late-onset sepsis (LOS)	8	20

Table 1 presents the demographic characteristics of 100 neonates enrolled in the study. Among the 28 neonates with culture-positive sepsis, the mean age was 9.96 ± 7.41 days, slightly higher than the 8.64 ± 6.45 days observed in the 72 culture-negative neonates. Males predominated in both groups, accounting for 60.7% in the culture-positive and 59.7% in the culture-negative group. Preterm neonates comprised 39.3% of the culture-positive and 38.9% of the culture-negative group. A higher number of early-onset sepsis (EOS) cases were observed in both groups—71.4% among culture-positive and 72.2% among culture-negative neonates—compared to late-onset sepsis (LOS). Overall, the groups were demographically comparable, with no significant variation in sex, gestational age, or sepsis onset.

Table 2: Comparison of Mean Platelet Count at Different Time Intervals

Time	Group	N	Mean	SD	p-value
1st Day	Culture Positive	28	2.17	1.18	0.0436*
	Culture Negative	72	2.75	1.11	
3rd Day	Culture Positive	28	2.10	1.16	0.0431*
	Culture Negative	72	2.66	1.06	
7th Day	Culture Positive	28	2.24	1.16	0.0417*
	Culture Negative	72	2.72	1.02	

Table 2 compares the mean platelet counts between culture-positive and culture-negative neonates at three time intervals. On all observed days—1st, 3rd, and 7th—the mean platelet count was consistently lower in the culture-positive group compared to the culture-negative group. Specifically, on the 1st day, the mean platelet count in culture-positive neonates was 2.17 ± 1.18 lakh/µL, significantly lower than 2.75 ± 1.11 lakh/µL in the culture-negative group ($p = 0.0436$). Similar statistically significant differences were observed on the 3rd day (2.10 vs. 2.66; $p = 0.0431$) and the 7th day (2.24 vs. 2.72; $p = 0.0417$). These findings indicate that thrombocytopenia is more prominent and persistent in neonates with culture-confirmed sepsis.

Table 3: Comparison of Mean MPV at Different Time Intervals

Time	Group	N	Mean	SD	p-value
1st Day	Culture Positive	28	10.22	1.18	0.0214*
	Culture Negative	72	9.63	0.93	
3rd Day	Culture Positive	28	10.13	1.07	0.0402*
	Culture Negative	72	9.53	1.15	
7th Day	Culture Positive	28	9.91	1.12	0.0450*
	Culture Negative	72	9.32	1.17	

Table 3 highlights the comparison of Mean Platelet Volume (MPV) between culture-positive and culture-negative neonates across three time points. MPV was significantly higher in the culture-positive group at all intervals. On the 1st day, the mean MPV in culture-positive neonates was 10.22 ± 1.18 fL, compared to 9.63 ± 0.93 fL in the culture-negative group ($p = 0.0214$). This trend continued on the 3rd day (10.13 vs. 9.53; $p = 0.0402$) and 7th day (9.91 vs. 9.32; $p =$

0.0450). These results suggest that elevated MPV may be a useful marker for early detection and monitoring of neonatal sepsis, reflecting increased platelet production and turnover in response to infection.

Table 4: Comparison of Mean PDW at Different Time Intervals

Time	Group	N	Mean	SD	p-value
1st Day	Culture Positive	28	11.61	2.34	0.844#
	Culture Negative	72	11.49	2.54	
3rd Day	Culture Positive	28	11.47	2.45	0.707#
	Culture Negative	72	11.24	2.51	
7th Day	Culture Positive	28	11.31	2.68	0.801#
	Culture Negative	72	11.15	2.10	

Table 4 presents the comparison of Platelet Distribution Width (PDW) between culture-positive and culture-negative neonates over three time intervals. Although the mean PDW values were slightly higher in the culture-positive group across all days, the differences were not statistically significant. On the 1st day, the PDW was 11.61 ± 2.34 in the culture-positive group versus 11.49 ± 2.54 in the culture-negative group ($p = 0.844$). Similar non-significant differences were observed on the 3rd day (11.47 vs. 11.24; $p = 0.707$) and the 7th day (11.31 vs. 11.15; $p = 0.801$). These findings suggest that while PDW levels may rise during sepsis, they do not significantly differentiate between culture-positive and culture-negative neonates.

Table 5: Platelet Count Distribution (n = 100)

Platelet Count (in lakhs)	N	Percentage (%)
<1.5	22	22.0
1.5–4.5	71	71.0
>4.5	7	7.0
Total	100	100.0

Table 5 shows the distribution of platelet counts among 100 neonates. A majority (71%) had platelet counts within the normal range of 1.5–4.5 lakh/µL. Thrombocytopenia, defined as a platelet count below 1.5 lakh/µL, was observed in 22% of neonates, indicating a considerable burden. Only 7% had elevated platelet counts above 4.5 lakh/µL. This distribution highlights that while most neonates maintained normal platelet levels, a significant portion exhibited thrombocytopenia, which may serve as an early indicator of sepsis in neonatal populations.

Table 6: Organisms Isolated in Culture (n = 28)

Organism	N	Percentage (%)
Escherichia coli	18	64.3
Klebsiella pneumoniae	6	21.4
Staphylococcus aureus	4	14.3
Total	28	100.0

Table 6 outlines the distribution of organisms isolated from blood cultures in 28 neonates with confirmed sepsis. *Escherichia coli* was the most commonly identified pathogen, accounting for 64.3% of cases, followed by *Klebsiella pneumoniae* at 21.4% and *Staphylococcus aureus* at 14.3%. These findings indicate that Gram-negative organisms, particularly *E. coli*, are the predominant causative agents in neonatal sepsis in this cohort, underlining the importance of targeting empirical antibiotic therapy toward these pathogens.

4. DISCUSSION

Neonatal sepsis remains a major contributor to morbidity and mortality among neonates, especially in low- and middle-income countries. Early diagnosis and prompt management are critical to reducing adverse outcomes. Traditional diagnostic methods, such as blood cultures, remain the gold standard but are time-consuming and may delay treatment decisions. In this context, platelet indices—including platelet count, mean platelet volume (MPV), and platelet distribution width (PDW)—have emerged as potentially useful, rapid, and cost-effective biomarkers for the early identification of sepsis.

In the present study, we evaluated the platelet parameters among 100 neonates admitted to a tertiary care NICU with suspected sepsis. Of these, 28 (28%) were culture-positive, and 72 (72%) were culture-negative. The mean age, gestational age, and sex distribution between the groups were comparable, suggesting that demographic factors did not significantly influence the outcome measures.

Platelet Count

Our study found significantly lower platelet counts in culture-positive neonates compared to culture-negative ones at all three time intervals (Day 1, Day 3, and Day 7), with p-values of 0.0436, 0.0431, and 0.0417 respectively. These findings are consistent with previous literature that has identified thrombocytopenia as a frequent hematological abnormality in neonatal sepsis.

Chavhan et al. reported thrombocytopenia in 75.5% of culture-confirmed septic neonates, supporting our finding that platelet count is often suppressed in the presence of active infection [11]. Goyal et al. also observed similar trends, with lower platelet counts significantly associated with culture-positive sepsis and *Escherichia coli* being the predominant pathogen [12]. The mechanism behind sepsis-induced thrombocytopenia includes increased platelet consumption due to disseminated intravascular coagulation (DIC), bone marrow suppression, and immune-mediated destruction.

Mean Platelet Volume (MPV)

MPV reflects the average size of platelets and is a surrogate marker of platelet production and activation. In our study, MPV was significantly higher in culture-positive neonates across all time intervals (Day 1: 10.22 ± 1.18 vs. 9.63 ± 0.93; Day 3: 10.13 ± 1.07 vs. 9.53 ± 1.15; Day 7: 9.91 ± 1.12 vs. 9.32 ± 1.17), with all differences showing statistical significance ($p < 0.05$).

These results are in line with studies by Bhakri et al. and Parmar et al., who also noted significantly elevated MPV in septic neonates compared to healthy controls [13,14]. Elevated MPV in sepsis is thought to result from increased megakaryocytic stimulation in response to systemic inflammation and cytokine release, leading to the production of larger, younger platelets.

Platelet Distribution Width (PDW)

Although PDW was consistently higher in culture-positive neonates in our study, the difference was not statistically significant at any of the three time intervals ($p > 0.7$). This indicates that while PDW may reflect variability in platelet morphology during infection, it may not serve as a reliable standalone diagnostic marker for neonatal sepsis.

Similar findings were reported by Mevundi and Harsha, who observed increased PDW in septic neonates but found no significant correlation between PDW levels and blood culture results [15]. Akarsu et al. also suggested that while PDW may rise in sepsis, it lacks specificity when used independently [16].

Microbiological Profile

In our study, *Escherichia coli* was the most commonly isolated organism (64.3%), followed by *Klebsiella pneumoniae* (21.4%) and *Staphylococcus aureus* (14.3%). This pattern reinforces previous findings by Goyal et al. and Chavhan et al., both of whom identified *E. coli* as a leading cause of neonatal sepsis in similar settings [11,12]. However, other studies such as that by Mevundi and Harsha have reported *Staphylococcus aureus* as the most frequent pathogen, suggesting regional variation in microbiological profiles [15].

Clinical Implications

Our findings suggest that thrombocytopenia and elevated MPV can serve as useful adjuncts for early detection of neonatal sepsis, particularly in resource-limited settings where immediate access to culture results is often unavailable. Incorporating these indices into initial sepsis evaluation may aid in early diagnosis and timely initiation of antibiotics.

However, PDW, while biologically plausible as a marker of platelet activation, did not show statistically significant differences in this study and may have limited standalone utility. Its role may be better evaluated as part of a composite scoring system or in combination with other biomarkers like C-reactive protein or procalcitonin.

Limitations

This study is limited by its single-center design and relatively small sample size. Moreover, platelet indices can be influenced by factors such as sample handling and timing of analysis. Future multicenter studies with larger populations and standardized methodology are warranted to validate these findings.

5. CONCLUSION

This study highlights the significant association between platelet indices—particularly platelet count and mean platelet volume (MPV)—and neonatal sepsis. Culture-positive neonates consistently exhibited lower platelet counts and higher MPV values across all measured time intervals, suggesting that these parameters can serve as early, accessible, and cost-effective indicators of sepsis. While platelet distribution width (PDW) was elevated in culture-positive cases, it did not show statistical significance, indicating limited diagnostic utility on its own.

The predominance of *Escherichia coli* among the isolated organisms underscores the need for vigilant perinatal infection control and targeted empirical antibiotic policies. Overall, platelet indices, especially when used in conjunction with clinical features and other laboratory markers, can enhance early diagnosis and timely management of neonatal sepsis, particularly in resource-constrained settings.

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