RESEARCH ARTICLE

Role of mean platelet volume in diagnosis of neonatal sepsis

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Abstract

Objective: To assess the role of mean platelet volume in the detection of neonatal sepsis, and to work out its cut-off value.

Method: The comparative, cross-sectional study was conducted from December 2020 to June 2022 at the Neonatal Department of the Fauji Foundation Hospital, Rawalpindi, Pakistan, and comprised neonates in group A who were confirmed cases of sepsis diagnosed on the basis of blood culture test, and those in control group B who were healthy neonates with respect to sepsis. Blood samples were taken for the assessment of complete blood count, including mean platelet volume, total leucocyte count, neutrophil count, haemoglobin level and blood culture. Receiver operating characteristic curve was used to determine the optimum cut-off value of mean platelet volume. Data was analysed using SPSS 22.

Results: Of the 100 subjects, 50(50%) were in group A; 30(60%) boys and 20(40%) girls with mean age 1.78±1.50 days. There were 50(50%) subjects in group B; 34(68%) boys and 16(32%) girls with mean age 1.24±0.56 days. Age was significantly different between the groups (p=0.01). Mean neutrophil count was significantly different between the groups (p<0.05). Mean platelet volume in group A was 11.29±1.37fL compared to 9.69±1.11fL in group B (p<0.05). The cut-off value of the mean platelet volume was 10fL.

Conclusion: The mean platelet volume was found to be a reliable marker for the diagnosis of neonatal sepsis with a cut-off value of 10.0fL.

Keywords: Early onset neonatal sepsis, Mean platelet volume, Neutrophil count, Platelet count, Total leucocyte count.

(JPMA 75: 1049; 2025) **DOI: https://doi.org/10.47391/JPMA.9612**

Introduction

Neonatal sepsis is potentially a life-threatening condition, and is one of the major causes of mortality and morbidity throughout the world.[1] Sepsis is recognised as among the severe pathologies in infants and young children, accounting for nearly 1.5 million deaths worldwide each year. Infections affect up to 10% of infants in their first month of life, accounting for 30% to 50% of neonatal deaths in developing countries.[2,3]

Due to serious infection, approximately 40,000 annual neonatal deaths have been recorded, showing that the neonatal age group is at a high risk of serious infection.[4] In this regard, early diagnosis and treatment of suspected neonatal sepsis cases is crucial.[5] Neonatal sepsis has two categories; sepsis at neonatal age 0-3 days is called early neonatal sepsis, whereas late onset neonatal sepsis occurs after 3 days of age. Among early neonatal sepsis cases in a study, 85% occurred on the first day with a median age of 6 hours and it was associated with premature neonates, too.[6] The platelet volume is expressed through mean platelet volume (MPV), which reveals the presence of inflammatory burden and disease activity in many diseases.[7] It is a crucial marker for inflammatory and infection diseases as well as for severe pneumonia in patients with coronavirus disease-219 (COVID-19).[8]

To diagnose mortality in septic shock, MPV is already used frequently. After admission to neonatal intensive care unit (NICU), the increase in MPV in the first 15 days of non-survivors compared to survivors was significantly different in a study, and the cut-off value of 11.6fL was found significant. MPV >11.6fL at day 10 of NICU admission was an independent risk factor for predicting 90-day mortality.[9]

MPV's role and cut-off value in neonatal sepsis cases has remained unclear. The current study was planned to assess the role of MPV in the detection of neonatal sepsis, and to work out its cut-off value.

Patients and Methods

The prospective, comparative, cross-sectional study was conducted from December 24, 2020, to June 24, 2022, at the Neonatal Department of the Fauji Foundation Hospital, Rawalpindi, Pakistan, and comprised neonates in group A who were confirmed cases of sepsis diagnosed on the basis of blood culture test, and those in control group B who were healthy neonates with respect to sepsis. After approval from the institutional ethics review board, the sample size was calculated while keeping mean MPV in the control group 9.2±1.2fL and in neonates having clinical symptoms of sepsis 10.6±1.1fL.[10] The confidence level was kept at 95% and power of test at 99%. WHO sample size

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Submission complete: 16-04-2023 **1st Revision received:** 25-07-2023

Acceptance: 03-05-2025 **Last Revision received:** 02-05-2025

calculator 7.4(b)[11] was used to calculate the required sample size. The required sample size to complete this study was 23 in each group.

Those included neonates were aged 1-28 days of both genders, while those on antibiotics, having surgery since birth or having a chromosomal abnormality were excluded.

All newborn babies were assessed for clinical findings by two clinicians. Neonates who had symptoms like fever (body temperature >99ºF), hypoglycaemia (sugar level <50g/dl), lethargy, diminished suck and Moro reflexes, heart rate <60bpm or >150bpm, difficulty in breathing, decreased perfusion or having any other suspicion of sepsis were further assessed through blood culture. Venous blood samples were sent for the assessment of complete blood count (CBC), including MPV, total leucocyte count (TLC), neutrophil count, haemoglobin (Hb) level and blood culture. Based on the results of the first sample and blood culture verification through aseptic technique, the diagnosed cases of sepsis were included through purposive sampling in group A, and an equal number of neonates who were not diagnosed as sepsis cases, were enrolled, through simple random sampling, in group B. CBC was performed of the cases selected in group B.

Data was analysed using SPSS 22. Descriptive data computed for both qualitative and quantitative variables. Independent sample t-test was used to identify the related parameters of neonatal sepsis. Receiver operating characteristic (ROC) curve was used to determine the cut-off value of the parameters. Neutrophil standard count was taken as 10,000-20,000 cells/µL. Platelets <100,000 cells/µL was considered suspicion of neonatal sepsis. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) and diagnostic accuracy were calculated. P<0.05 was considered significant.

Results

Of the 100 subjects, 50(50%) were in group A; 30(60%) boys and 20(40%) girls with mean age 1.78±1.50 days. There were 50(50%) subjects in group B; 34(68%) boys and 16(32%) girls with mean age 1.24±0.56 days. Age was significantly different between the groups (p=0.01) (Table 1).

The mean TLC count in groups A and B was 12.07±6.49 and 12.65±5.98 (p=0.642), whereas mean Hb level was 14.02±3.71 and 16.28±3.16 (p=0.001). The mean platelet count in the two groups was 187.3±114.43 and 251.58±125.30 (p=0.009), and mean neutrophil count was 51.21±19.89 and 31.93±11.08 (p=0.001), while mean MPV of group A and group B was 11.29±1.37fL and 9.69±1.11fL, respectively (p=0.001).

Table-1: Demographic data of the groups.

	Groups		*p*-value
	Sepsis Mean±SD n (%)	Control Mean±SD n (%)	
Age (days)	1.78±1.50	1.24±0.56	0.019
Gestational age (weeks)	35.5±3.69	36.00±4.46	0.543
Birth weight	2008.78±378.40	2018.57±412.49	0.902
Gender of neonate			
Male	30 (60)	34 (68.0)	0.405
Female	20 (42.5)	16 (32.0)	
Gestational age at birth			
Preterm delivery	36 (72)	22 (44)	0.017
Term delivery	10 (20)	21 (42)	
Post-term delivery	4 (8)	7 (14)	
Birth weight (categories)			
Low birth weight	32 (64)	35 (70)	0.523
Normal birth weight	18 (36)	15 (30)	

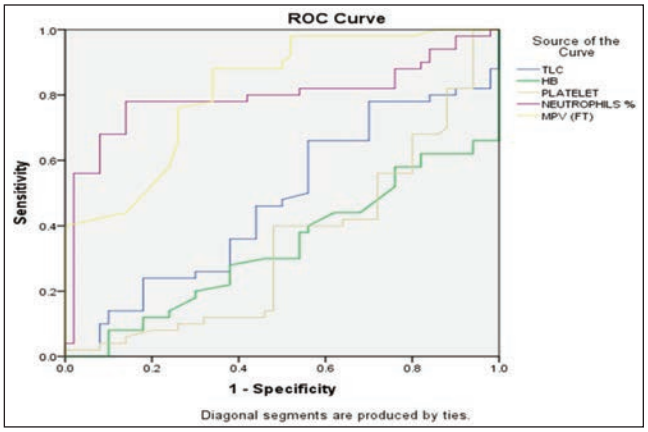

Figure: Receiver operating characteristic (ROC) curve of different parameters related to sepsis.

Table-2: Diagnostic analysis of neonatal sepsis with respect to gestational age at Delivery.

Parameters	Pre-term	Term	Post-term	Overall
Neutrophil				
Area under the curve	0.86	0.67	0.86	0.796
Sensitivity	80.6	70	75	78
Specificity	100	66.7	100	86
Positive Predictive Value	100	50	100	84.8
Negative Predictive value	75.9	82.4	87.5	79.6
Mean Platelet Volume				
Area under the curve	0.92	0.77	0.84	0.817
Sensitivity	86.1	90	100	88
Specificity	77.3	57.1	57.1	66
Positive Predictive Value	86.1	50	57.1	72.1
Negative Predictive value	77.3	92.3	100	84.6

ROC analysis showed that Hb level and platelet count were not reliable markers to predict neonatal sepsis correctly as the area under the curve (AUC) of the two parameters was 0.334 and 0.345, respectively. The AUC of neutrophil count and MPV was 0.796 and 0.817, respectively (p=0.001). The

optimal pair of sensitivity-specificity was associated with neutrophil count cut-off 36 or higher and MPV count >10 (Figure).

The diagnostic accuracy of neutrophil count was 82%; 39(78%) in group A and 43(86%) in group B. MPV count had diagnostic accuracy of 77%; 44(88%) in group A and 33(66%) in group B (Table 2).

Discussion

The mortality rate in neonates with sepsis can be controlled by early diagnosis. An Indian study divided the sample into three groups; those with culture-proven sepsis, those who were culture-negative but had clinically-proven sepsis, and healthy subjects. The mean MPV, C-reactive protein (CRP), platelet count and immature-to-total neutrophil ratio (I/T ratio) was significantly different among the groups at 5% level of significance.[12] A similar study showed that among the three groups, white blood cells (WBC) count, Hb level, absolute neutrophil count (ANC), I/T ratio, platelets, MPV, uric acid and CRP were significantly different at 5% level of significance. MPV and uric acid were further examined. The cut-off value, sensitivity, specificity, PPV, NPV and diagnostic accuracy were 10.2fL, 71%, 63%, 74%, 59% and 68% for MPV, respectively, and for uric acid they were 3.7mg/dl, 13%, 19%, 19%, 13% and 15%.[7] Mohankumar et al. conducted a similar study and found that the mean MPV level was 10.95fL in neonates with culture-proven sepsis, which was almost similar to the MPV level in neonates with clinical sepsis i.e. 10.40fL, while in the control group, the mean MPV level was 9.36fL. The AUC was 0.871 with cut-off of ≥10fL, which meant sensitivity 74.30%, specificity 85.20%, PPV 83.31% and NPV 76.90%.[13] Similarly, in the current study, the mean values of Hb, platelets, neutrophil count and MPV were significantly different between sepsis patients and healthy controls.

The prevalence of neonatal sepsis can be controlled with early diagnosis by focussing on MPV. In a study exploring factors of sepsis mortality included 149 sepsis patients diagnosed. The severity of the disease was assessed using standardised tools. The results showed that neutrophil-to-lymphocyte ratio (NLR) and Platelet-to-lymphocyte ratio (PLR) were not good predictors with cut-off value, AUC, sensitivity and specificity >13.2, 0.53, 47.1%, 48.4% and >221.8, 0.56, 47.1% and 48.4%, respectively.[14] Similarly in the current study, Hb and platelets were the two markers having significant different mean values between the groups, but were not a good predictor for sepsis diagnosis having a very low AUC of 0.334 and 0.345, respectively. Karabulut et al. investigated the level of MPV for the prediction of neonatal sepsis and found that at cut-off level of ≥9.32fL, MPV had the sensitivity of 84.1%, and specificity of 32.2% for the detection of neonatal sepsis. Another study found that with a cut-off value ≥7.44fL, MPV had 80% sensitivity, 84.2% specificity, 69% PPV and 90.6% NPV for sepsis diagnosis.[15,16] Shaaban et al. assessed the correlation between serial MPV measurements and early onset sepsis occurrence in preterm infants. They found that MPV of 8.6fL was identified as a cut-off value in patients probably resulting in sepsis with a sensitivity of 97.14% and a specificity of 100%. MPV of 10.4fL was determined as the cut-off value in patients possibly resulting in death with a sensitivity of 70% and a specificity of 82.5%.[17]

A meta-analysis of 11 studies having 932 sepsis cases and 1,088 controls showed that a higher MPV was observed in neonatal sepsis patients compared to the controls ($p<0.0001$). The diagnostic criteria of sepsis and the method to measure MPV were crucial risk factors which affected the decision.[18] Another meta-analysis with 9 studies showed that MPV and Acute Physiology and Chronic Health II (APACHE-II) were the only two variables associated with mortality in sepsis patients at day 3 after admission ($p<0.0001$).[19] Another study showed that MPV and Mean Platelet Volume to Platelet Count ratio (MPV/P) were used as predictors of clinical severity and mortality. The results showed that the cut-off value was decreasing in trend >9.45, >8.95 and >8.85 at days 1, 2 and 3 of admission in NICU, respectively.[20]

A study in Ecuador applied multivariate logistic regression to find the risk factors for predicting mortality. MPV with a cut-off value 8.45fL showed sensitivity 67.5% and specificity 65.5% at baseline, 78.3% and 57.1% at day 1, and 72.2% and 59.2% at day 2 after NICU admission, respectively. They also concluded that at >8.45fL, the probability of not surviving increased 5.28 times.[21]

A study in Egypt showed that MPV was significantly different between sepsis and healthy patients along with other markers serum CRP, salivary CRP and NLR at 5% level of significance. The study also showed that salivary CRP was the best marker for sepsis diagnosis with cut-off value 3.48ng/L having AUC 0.886, sensitivity 94.3%, specificity 80% whereas MPV with a cut-off value of 10.2fL showed AUC 0.873 with 80% sensitivity and specificity.[22]

In the study, the results showed that MPV and neutrophil count were the two markers that could be used for diagnosis of sepsis at an early stage. Physicians can choose one of these markers as per their choice and requirement. Post-stratified results showed that the two markers were equally efficient in neonates of different gestational ages.

Conclusion

MPV in the serum of a neonate could be a reliable diagnostic blood marker for the diagnosis of early neonatal sepsis. The MPV cut-off value was found to be 10fL.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

References

1. Chauhan N, Tiwari S, Jain U. Potential biomarkers for effective screening of neonatal sepsis infections: An overview. Microb Pathog 2017;107:234-42. doi: 10.1016/j.micpath.2017.03.042.
2. Smertka M, Wroblewska J, Suchojad A, Majcherczyk M, Jadamus-Niebroj D, Owsianka-Podlesny T, et al. Serum and urinary NGAL in septic newborns. Biomed Res Int 2014;2014:717318. doi: 10.1155/2014/717318.
3. Naher HS, Khamael AB. Neonatal sepsis; the bacterial causes and the risk factors. Int J Res Med Sci 2013;1:19–22.
4. Vergnano S, Menson E, Smith Z, Kennea N, Embleton N, Clarke P, et al. Characteristics of Invasive Staphylococcus aureus in United Kingdom Neonatal Units. Pediatr Infect Dis J 2011;30:850-4. doi: 10.1097/INF.0b013e318224546d.
5. Aliefendioglu D, Gürsoy T, Çağlayan O, Aktaş A, Ovalı F. Can resistin be a new indicator of neonatal sepsis? Pediatr Neonatol 2014;55:53-7. doi: 10.1016/j.pedneo.2013.04.012.
6. Gollehon NS, Anderson-Berry AL. Neonatal sepsis. [Online] 2019 [Cited 2023 January 18]. Available from URL: https://emedicine.medscape.com/article/978352-overview?form= fpf
7. Shalaby MM, Sobeih AA, Abdulghany WE, Behiry EG, Ismail YM, Abd-El-Aziz MA. Mean platelet volume and serum uric acid in neonatal sepsis: A case-control study. Ann Med Surg (Lond) 2017;20:97-102. doi: 10.1016/j.amsu.2017.06.015.
8. Zhong Q, Peng J. Mean platelet volume/platelet count ratio predicts severe pneumonia of COVID-19. J Clin Lab Anal 2021;35:e23607. doi: 10.1002/jcla.23607.
9. Vardon-Bounes F, Gratacap MP, Groyer S, Ruiz S, Georges B, Seguin T, et al. Kinetics of mean platelet volume predicts mortality in patients with septic shock. PLoS One 2019;14:e0223553. doi: 10.1371/journal.pone.0223553.
10. Aydın B, Dilli D, Zenciroğlu A, Karadağ N, Beken S, Okumuş N. Mean platelet volume and uric acid levels in neonatal sepsis. Indian J Pediatr 2014;81:1342-6. doi: 10.1007/s12098-014-1417-4.
11. Lwanga SK, Lemeshow S. Sample size determination in health studies: a practical manual. Geneva, Switzerland: World Health Organization; 1991. [Online] 1991 [Cited 2025 April 30]. Available from URL: https://apps.who.int/iris/handle/10665/40062
12. Hanaganahalli SB, Sreeram S, Bompada M, Kuppannagari SK, Suresh PK, Philipose CS. Is MPV a Predictive Marker for Neonatal Sepsis? A Pilot Study. J Pediatr Hematol Oncol 2018;40:548-52. doi: 10.1097/MPH.0000000000001272.
13. Mohankumar M, Paulose S. Mean platelet volume in neonatal sepsis-a case control study. J Evolution Med Dent Sci 2019;8:1808-12. doi: 10.14260/jemds/2019/397.
14. Vélez Páez JL, Calderón Hidalgo AP, Vélez Páez PA, Aguayo Moscoso SX. Neutrophil to lymphocyte and platelets to lymphocyte ratios as predictive factors of sepsis mortality. Rev Fac Cien Med 2019;44:57-67. doi: 10.29166/ciencias_medicas.v44i1.1970.
15. Karabulut B, Alatas SO. Diagnostic Value of Neutrophil to Lymphocyte Ratio and Mean Platelet Volume on Early Onset Neonatal Sepsis on Term Neonate. J Pediatr Intensive Care 2021;10:143-7. doi: 10.1055/s-0040-1715104.
16. Pamudji KM, Kardana IM. Diagnostic value of mean platelet volume in neonatal sepsis. Paediatr Indones 2019;59:289-93. doi: 10.14238/pi59.6.2019.289-93.
17. Shaaban HA, Safwat N. Mean platelet volume in preterm: a predictor of early onset neonatal sepsis. J Matern Fetal Neonatal Med 2020;33:206211. doi: 10.1080/14767058.2018.1488161.
18. Wang J, Wang Z, Zhang M, Lou Z, Deng J, Li Q. Diagnostic value of mean platelet volume for neonatal sepsis: A systematic review and meta-analysis. Medicine (Baltimore) 2020;99:e21649. doi: 10.1097/MD.0000000000021649.
19. Vélez-Paez JL, Velarde-Montero C, Irigoyen-Mogro E, Vélez-Páez P, Cifuentes-López P, Vélez JW, et al. Mean platelet volume as a predictor of mortality in patients with sepsis: systematic review and meta-analysis. Infectio 2020;24:162-8. doi: 10.22354/in.v24i3.861.
20. Vélez-Páez JL, Legua P, Vélez-Páez P, Irigoyen E, Andrade H, Jara A, et al. Mean platelet volume and mean platelet volume to platelet count ratio as predictors of severity and mortality in sepsis. PLoS One 2022;17:e0262356. doi: 10.1371/journal.pone.0262356.
21. Vélez-Páez JL, Armendáriz-Carvajal AC, Rueda-Barragán FE, Castro-Reyes EE, Escola-Brito AC, Chambergo-Michilot D, et al. Utility of cytometric parameters and indices as predictors of mortality in patients with sepsis. Infectio 2021;25:153-8. doi: 10.22354/in.v25i3.939.
22. Omran A, Maaroof A, Mohammad MHS, Abdelwahab A. Salivary C-reactive protein, mean platelet volume and neutrophil lymphocyte ratio as diagnostic markers for neonatal sepsis. J Pediatr (Rio J) 2018;94:82-7. doi: 10.1016/j.jped.2017.03.006.

Author Contribution:
AT: Design and drafting.
RA: Supervision and final approval.
RT: Laboratory analysis.
FH: Drafting, statistical work and drafted the results.
MAH & SIH: Drafting, acquired and completed clinical data.