Section: General Medicine

Original Research Article

STUDY OF EFFECT OF SEPSIS ON PLATELET COUNT AND THEIR INDICES – MEAN PLATELET VOLUME AND PLATELET DISTRIBUTION WIDTH AND THEIR PROGNOSTIC SIGNIFICANCE AND CORRELATION WITH C-REACTIVE PROTEIN

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Abstract

Background: Sepsis is a major disease affecting millions of people worldwide, affecting the haemostatic system, leading to thrombus formation and increased thrombocytopenia. The aim was to study the effect of sepsis on platelet count and its indices, namely Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW), and their significance as prognostic markers in sepsis and correlation with C-reactive protein (CRP). **Materials and Methods:** An observational study was conducted on 100 patients at the Institute of Internal Medicine, Madras Medical College, and Rajiv Gandhi Government General Hospital, Chennai, for six months. Complete Blood count, including platelet count and platelet indices, namely, Mean Platelet Volume, Platelet Distribution width, prothrombin time, C Reactive protein, culture/sensitivity depending on foci of infection, electrocardiogram, echocardiogram, chest X-ray, and ultrasonography, were performed. **Result:** Of the 100 patients, males were 55%, and females were 45%. Most patients were aged 51-60 (57%) and 41-50 (21%). The relationship between the mean platelet volume and C Reactive protein level had a p-value of 0.028, which was significant. The relationship between Platelet Distribution Width (PDW) and C Reactive protein level was 0.034, which was significant. Patients with a higher mean platelet volume (MPV), Platelet Distribution Width (PDW), and C-reactive protein (CRP) levels had higher mortality rates. The total percentage of patients with positive culture results was 36%. The percentage of patients who improved, worsened, and died with treatment was 86%, 6%, and 8%, respectively. **Conclusion:** Platelet indices such as Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) are crucial for diagnosing sepsis and predicting clinical outcomes.

INTRODUCTION

Sepsis is a major disease that affects millions of people worldwide. All organs and systems of the body are affected by sepsis.[1] The haemostatic system is adversely affected. There is a dysfunction of the clotting cascade, and the mononuclear and endothelial cells release cytokines, which leads to thrombus formation and, in later stages, stimulates plasminogen and activation of antithrombin III.[2,3] There is also a depletion of fibrinolytic and fibrinogen substances, which leads to the formation of clots and bleeding, ultimately leading to Disseminated Intravascular Coagulation (DIC), which leads to increased immunological destruction of platelets, which ultimately leads to thrombocytopenia.[4]

The decreased platelet counts paralleled the severity of the infection. Easily accessible and inexpensive laboratory tests show the severity of sepsis. The Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) are widely used platelet indices. Higher MPV and PDW values were observed in patients with sepsis. These MPV and PDW values were positively correlated with C-reactive protein (CRP) levels in the same direction. The role of these parameters in sepsis and severe sepsis and their prognostic significance holds great promise.[5,6] The Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) can be used in addition to C Reactive protein (CRP) for both diagnosis and follow-up of sepsis. It also helps assess the prognosis in severely septic patients, and it helps assess the response to antimicrobial treatment.[5-7]

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AIM

The aim was to study the effect of sepsis on platelet count and its indices, namely Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW), and their significance as prognostic markers in sepsis and correlation with C-reactive protein (CRP).

MATERIALS AND METHODS

This observational study was conducted on 100 patients at the Institute of Internal Medicine, Madras Medical College, and Rajiv Gandhi Government General Hospital, Chennai, for six months.

Inclusion Criteria

Age ranged from 15 to 60 years, all platelet indices proposed available, and patients diagnosed with sepsis based on criteria such as Systemic Inflammatory Response Syndrome (SIRS), quick Sequential Organ Failure Assessment (qSOFA), and Sequential Organ Failure Assessment (SOFA) score > 2, with clinical and laboratory features of evidence of foci of infection, including complications, were included.

Exclusion Criteria

Pregnant women, patients with active haemorrhage, patients with prior abnormal haematological parameters and serious comorbid illnesses, patients who had been transfused blood or platelets before admission – 8 days prior, patients using antiplatelet drugs, and patients who received chemotherapy/radiotherapy were excluded.

Patients meeting the inclusion and exclusion criteria were selected, and blood samples were collected. Complete Blood count, including platelet count and platelet indices, namely, Mean Platelet Volume, Platelet Distribution width, renal function tests, liver function test, prothrombin time, international normalised ratio, C Reactive protein, culture/sensitivity depending on foci of infection, electrocardiogram, echocardiogram, chest X-ray, and abdomen/pelvis ultrasonography, were performed on admission. Treatment was started, and CbC with platelet count and indices, including MPV and PDW, was performed again after 24 h and 72 h of admission.

Statistical Analysis

The results were analysed using SPSS software version 20. The association between variables was analysed using a paired sample t-test. The primary efficacy measures were the mean change in Total White Blood Cell count, platelet count, Mean Platelet Volume, and Platelet Distribution Width from admission to 72 h after admission. Statistical significance was set at a p-value of 0.05.

RESULTS

Among the 100 patients, males were 55%, and females were 45%. Most patients were aged 51-60 (57%) and 41-50 (21%) [Table 1].

The Total White Blood Cell Count of patients on admission (TC1), 24 h after admission (TC2), and 72 h after admission (TC3) had p-values of 0.562, 0.208, and 0.394, respectively, which were statistically insignificant.

The platelet counts in different age groups on admission (PLT1), 24 h after admission (PLT2), and 72 h after admission (PLT3) had p-values of 0.89. 0.856 and 0.884 were not statistically significant [Table 2].

The platelet distribution width in different age groups on admission (PDW1), 24 h after admission (PDW2), and 72 h after admission (PDW3) had p-values of 0.939. 0.860 and 0.974, respectively, which were statistically insignificant.

The mean platelet volume in different age groups on admission (MPV1), 24 h after admission (MPV2), and 72 h after admission (MPV3) had p-values of 0.516. 0.898 and 0.752, respectively, which were statistically insignificant. There was no significant difference in C-reactive protein levels between the age groups (p=0.704) [Table 3].

The Total White Blood Cell Count in sex on admission (MPV1), 24 h after admission (MPV2), and 72 h after admission (MPV3) had p-values of 0.975. 0.298 and 0.335, respectively, were statistically insignificant [Table 4]. There was no significant difference in platelet counts between the outcomes (p=0.620).

The p values of patients' platelet counts on admission, 24 h after admission, and 72 h after admission were 0.620. 0.698 and 0.393, respectively, which were not significant.

The Platelet Distribution Width (PDW) of patients on admission, 24 h after admission, and 72 h after admission were 0.610, 0.765, and 0.055, respectively. 11.5 fl was taken as the mean, and when PDW was more than 14 fl, there were higher mortality rates among patients.

The Mean Platelet Volume (MPV) was 10 fl. The p-values of the Mean Platelet Volume on admission (MPV1), 24 h after admission (MPV2), and 72 h after admission (MPV3) were 0.245, 0.41, and <0.001, respectively. When the MPV increased to > 12, it showed significant worsening, and treatment was initiated. Platelet counts improved, and MPV decreased.

The relationship between MPV1 and PDW1, MPV2 and PDW2, and MPV3 and PDW3 was linear, with a p-value <0.001, which was highly significant. The relationship between MPV1 and PLT1 had a p-value of <0.001, which was significant. The p-value of the relationship between MPV2 and PLT 2 was 0.680, and that between MPV3 and PLT3 was 0.995, which was insignificant.

The relationship between the mean platelet volume and C Reactive protein level had a p-value of 0.028, which was significant. The relationship between Platelet Distribution Width (PDW) and C Reactive protein level was 0.034, which was significant. This showed that the Mean Platelet Volume (MPV), Platelet Distribution Width (PDW), and C Reactive

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protein (CRP) were positively correlated (Table 5). There was a correlation between platelet Volumes (MPV1/MPV2/MPV3) and mean platelet counts (PLT1). However, there was no correlation between platelet volume (MPV1/MPV2/MPV3) and platelet count (PLT2/PLT3) [Table 6].

Patients with a higher mean platelet volume (MPV), Platelet Distribution Width (PDW), and C-reactive protein (CRP) levels had higher mortality rates. When the values increased from baseline, the patients worsened, warranting more intensive supervision and aggressive treatment to prevent further exacerbations of the condition.

The total percentage of patients with positive culture results was 36%. The percentage of patients who improved, worsened, and died with treatment was 86%, 6%, and 8%, respectively [Table 7].

The percentage of patients with thrombocytopenia was 62%, of whom 53% improved, 3% worsened, and 6% died. Hence, of the total patients with thrombocytopenia, 85.5% improved, 4.8% worsened, and 9.7% died.

The percentage of patients with a normal platelet count was 31%, of whom 28% improved, 2% worsened, and 1% died. Of the patients with normal platelet counts, 90.3% improved, 6.5% worsened, and 3.2% died.

The percentage of patients with thrombocytosis was 7%, of whom 5% improved, 1% worsened, and 1% died. Hence, of the total patients with thrombocytosis, 71.4% improved, 14.3% worsened, and 14.3% died.

Table 1: Distribution of sex and age groups

		Frequency	Percentage
Sex	Male	55	55
	Female	45	45
Age in years	Below 30	11	11
	31-40	11	11
	41-50	21	21
	51-60	57	57

Table 2: Mean total white blood cell count and platelet counts in age group

		Mean	SD	P value
TC1	Below 30	19427.27	6421.385	0.562
	31-40	21336.36	7706.007	
	41-50	18833.33	4397.082	
	51-60	20192.98	4452.522	
TC2	Below	14970	4503.098	0.208
	31-40	19930	8614.852	
	41-50	17752.38	3968.579	
	51-60	17559.92	4878.827	
TC3	Below	13310	4142.316	0.394
	31-40	13890	5006.984	
	41-50	15614.29	3439.373	
	51-60	15194.12	4131.364	
PLT1	Below 30	89090.91	60475.54	0.89
	31-40	154727.27	158059.54	
	41-50	203238.1	121412.069	
	51-60	176622.81	123512.661	
PLT2	Below 30	114500	68812.547	0.856
	31-40	182700	127214.648	
	41-50	206190.48	134267.129	
	51-60	440557.69	1920672	
PLT3	Below 30	154300	76610.197	0.884
	31-40	252800	181579.979	
	41-50	222952.38	104418.138	
	51-60	416450.98	1629270.97	

Table 3: Mean platelet distribution width, mean platelet volume, and CRP in age group

		Mean	SD	P value
PDW 1	Below 30	14.391	3.4608	0.939
	31-40	15.018	3.2357	
	41-50	14.771	1.6447	
	51-60	14.788	2.1552	
PDW 2	Below 30	13.57	2.8975	0.86
	31-40	13.69	2.4365	
	41-50	14.133	1.6963	
	51-60	14.079	2.1082	
PDW 3	Below 30	13.03	2.9322	0.974
	31-40	12.92	2.7414	
	41-50	13.219	1.575	
	51-60	13.232	2.1557	

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MPV 1	Below 30	10.955	1.6446	0.516
	31-40	11.6	1.4826	
	41-50	11.295	1.0632	
	51-60	11.07	1.1334	
MPV 2	Below 30	10.626	1.6454	0.898
	31-40	11.03	1.2517	
	41-50	10.848	1.1643	
	51-60	10.775	1.182	
MPV 3	Below 30	9.999	1.5369	0.752
	31-40	10.24	1.2483	
	41-50	10.486	1.0753	
	51-60	10.388	1.2167	
CRP	Below 30	115.055	109.6837	0.704
	31-40	73.673	73.8344	
	41-50	148.552	90.9547	
	51-60	161.747	306.2419	

Table 4: Mean total white blood cell count in sex

	Sex	Mean	SD	P value
TC1	Male	19934.55	5405.56	0.975
	Female	19966.67	4716.605	
TC2	Male	17077.23	5081.055	0.298
	Female	18217.07	5378.006	
TC3	Male	14580.77	3390.242	0.335
	Female	15415	4853.154	

Table 5: Correlation of platelet distribution width and CRP between mean platelet volume

		MPV1	MPV2	MPV3	CRP
PDW1	Pearson Correlation	.771(**)	.742(**)	.625(**)	.233(*)
	P-value	<0.001	<0.001	<0.001	0.019
PDW2	Pearson Correlation	.677(**)	.768(**)	.751(**)	.214(*)
	P-value	<0.001	<0.001	<0.001	0.04
PDW3	Pearson Correlation	.571(**)	.699(**)	.748(**)	.221(*)
	P-value	<0.001	<0.001	<0.001	0.034
CRP	Pearson Correlation	.219(*)	.207(*)	0.178	-
	P-value	0.028	0.047	0.09	-

Table 6: Correlation of mean platelet volume between platelet counts

		PLT1	PLT2	PLT3
MPV1	Pearson Correlation	-.471(**)	0.107	0.106
	P-value	<0.001	0.309	0.315
MPV2	Pearson Correlation	-.468(**)	0.043	0.045
	P-value	<0.001	0.68	0.67
MPV3	Pearson Correlation	-.323(**)	0.007	0.001
	P-value	0.002	0.951	0.995

Table 7: Distribution of blood culture, urine culture, sputum culture, and outcome

		Frequency	Percentage
Blood culture	Positive	8	8
	Negative	92	92
Urine culture	Positive	26	26
	Negative	74	74
Sputum culture	Positive	5	5
	Negative	95	95
Outcome	Death	8	8
	Worsen	6	6
	Improved	86	86

DISCUSSION

Our study included 100 patients aged 51-60 (57%) and 41-50 (21%). Similarly, PDW and MPV did not exhibit significant differences across the age groups. This was similar to several study findings, where PDW and MPV did not report significant differences in age groups.8,9 The mortality rates were notably higher in patients with PDW values > 14 fl. Moreover, an MPV above 12 fl was associated with significant worsening, leading to initiation of treatment, subsequent improvement in platelet counts, and decreased MPV. Elevated MPV, PDW, and CRP levels were correlated with higher mortality rates, necessitating intensified monitoring and aggressive treatment. Guclu et al. reported similar findings, where MPV levels >8 fI were associated with sepsis and mortality. In addition, a high PPV (81.1%) was seen for MPV, and multivariate analysis revealed that MPV and PDW are the independent risk factors for sepsis.[8]

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A study conducted by Tajarernmuang et al. found that an increase in MPV over several days following hospital admission was linked to higher mortality rates.[10] Sezgi et al. conducted a study that demonstrated a significant difference in mean platelet volume (MPV) levels between non-survivors and survivors of sepsis.[11] Specifically, MPV levels were found to increase in non-survivors throughout the progression of the disease, while they decreased in the surviving group.[12]

Our study found a significant relationship between mean platelet volume and C-reactive protein level. Thrombocytopenia was observed in 62% of the patients, with the majority showing improvement, while patients with normal platelet counts and thrombocytosis also demonstrated positive outcomes. Thrombocytopenia is associated with a higher mortality rate, emphasising its potential as an indicator of disease severity. Sayed et al. also reported a similar finding, where thrombocytopenia and C-reactive protein levels were associated with poor clinical outcomes. The study also stated that thrombocytopenia is one of the essential factors that can lead to higher chances of infection and can be used to assess the severity of sepsis.[10]

Our study showed that MPV and PDW are essential to consider biomarkers for diagnosing sepsis and predicting clinical outcomes. In addition, a low MPV, prevalence of thrombocytopenia, and abnormalities in PDW can be associated with higher rates of infection and mortality. Several cross-sectional and retrospective studies also reported this conclusive finding.[8-10]

CONCLUSION

Platelet indices, namely Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW), are important and valuable parameters that help diagnose sepsis and are inexpensive for predicting clinical outcomes. Increased Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) are associated with higher death rates in patients with sepsis than those with normal platelets. An abnormally low platelet count, high Mean Platelet Volume (MPV), and high Platelet Distribution Width (PDW) values are associated with more severe illness.

MPV can be used in addition to C-reactive protein (CRP) for diagnosing and following up sepsis and response to antimicrobials. There was a positive correlation between Mean Platelet Volume (MPV) and C Reactive protein (CRP). A uniformity of measurement should be used to make results comparable, and large multicentre prospective studies collecting data from different ethnicities and sexes are needed before they can be used in day-to-day clinical practice.

Limitations

The Inclusion and Exclusion criteria of the study resulted in a limited sample size. A multicentre study with a larger population is required to confirm its efficacy. There was no stratified analysis of whether there was a difference when platelet indices were applied as predictors in patients with different diseases. Several aetiologies may be observed, and it is difficult to evaluate the effect of each disease on platelet indices individually. It has been established that platelet volume depends on several laboratory variables, including the method of measurement employed, anticoagulant use, storage time, and temperature. Therefore, it is imperative to standardise the procedures for measuring platelet volumes.

REFERENCES

1. Hotchkiss RS, Moldawer LL, Opal SM, Reinhart K, Turnbull IR, Vincent J-L. Sepsis and septic shock. Nat Rev Dis Primers 2016;2:1–21. https://doi.org/10.1038/nrdp.2016.45.
2. Levi M, van der Poll T. Coagulation and sepsis. Thromb Res 2017;149:38–44. https://doi.org/10.1016/j.thromres.2016.11.007.
3. Vazquez-Garza E, Jerjes-Sanchez C, Navarrete A, Joya-Harrison J, Rodriguez D. Venous thromboembolism: thrombosis, inflammation, and immunothrombosis for clinicians. J Thromb Thrombolysis 2017;44:377–85. https://doi.org/10.1007/s11239-017-1528-7.
4. Boral BM, Williams DJ, Boral LI. Disseminated intravascular coagulation. Am J Clin Pathol 2016;146:670–80. https://doi.org/10.1093/ajcp/aqw195.
5. Guclu E, Durmaz Y, Karabay O. Effect of severe sepsis on platelet count and their indices. Afr Health Sci 2013;13:333–8. https://doi.org/10.4314/ahs.v13i2.19.
6. Gao Y, Li Y, Yu X, Guo S, Ji X, Sun T, et al. The impact of various platelet indices as prognostic markers of septic shock. PLoS One 2014;9:e103761. https://doi.org/10.1371/journal.pone.0103761.
7. Kim CH, Kim SJ, Lee MJ, Kwon YE, Kim YL, Park KS, et al. An increase in mean platelet volume from baseline is associated with mortality in patients with severe sepsis or septic shock. PLoS One 2015;10:e0119437. https://doi.org/10.1371/journal.pone.0119437.
8. Guclu E, Durmaz Y, Karabay O. Effect of severe sepsis on platelet count and their indices. Afr Health Sci. 2013;13:333-338. https://doi.org/10.4314/ahs.v13i2.19.
9. Sayed SZ, Mahmoud MM, Moness HM, Mousa SO. Admission platelet count and indices as predictors of outcome in children with severe sepsis: a prospective hospital-based study. BMC Pediatr 2020;20:387. https://doi.org/10.1186/s12887-020-02278-4.
10. Tajarernmuang P, Phrommintikul A, Limsukon A, Pothirat C, Chittawatanarat K. The role of mean platelet volume as a predictor of mortality in critically ill patients: A systematic review and meta-analysis. Crit Care Res Pract 2016;2016:1–8. https://doi.org/10.1155/2016/4370834.
11. Sezgi C, Taylan M, Kaya H, Selimoglu Sen H, Abakay O, Demir M, et al. Alterations in platelet count and mean platelet volume as predictors of patient outcome in the respiratory intensive care unit. Clin Respir J 2015;9:403–8. https://doi.org/10.1111/crj.12151.

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