

Prognostic Role of Platelet Indices in Sepsis Patients

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Abstract

Sepsis is a major health problem, that significantly increases the mortality and morbidity of patients. The prognostic value of Platelet indices in septic shock has not been established. Our study aims to know the importance of platelet indices in sepsis and their value in prognosis. Details of sepsis patients from September 2018 to August 2019 were taken from case sheets and Hospital Information Management System (HIMS) in GEMS medical college and hospital, Srikakulam. Platelet (PLT) indices were recorded on the day of admission and the fifth day in hospital. The data were compared between revived and succumbed patients. A total of 100 septic shock patients were studied, of them, 55 were revived and 45 succumbed. Mean Platelet Volume (MPV) in the succumbed group was significantly higher than that of the revived group. Platelet Distribution Width (PDW) and Platelet Large Cell Ratio (PLCR) were increased, while Plateletcrit (PCT) and PLT count decreased in the succumbed group. A statistically significant difference was seen between revived and succumbed patients for PLT count and MPV which make them useful prognostic markers for patients in septic shock.

Keywords: Platelet indices, Platelet count, MPV, PDW, PLCR, PCT, Sepsis, Prognosis.

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INTRODUCTION

Platelet, an essential constituent of blood, has an important role in hematological diseases [1]. In the recent past, the morphology and proliferation kinetics of platelets are measured [2]. Platelet indices include platelet count, Mean platelet volume (MPV), Platelet volume distribution width (PDW), plateletcrit (PCT), and platelet large cell ratio (PLCR). These indices are well studied in diagnosing hematological diseases but recently these were found to be related to patient's prognosis in infective conditions. The role of reducing platelet count in predicting prognosis of critically ill patients is already proven [3, 4], but the importance of other indices is still not well established.

Sepsis, a major healthcare problem, affects millions of people worldwide [5]. Sepsis affects almost all organs and systems including haemostatic system. Several changes in the coagulation system are involved during its pathogenesis, which is manifested mainly by the prolongation of the activated partial thromboplastin time (aPTT), prothrombin time (PT), and decreased platelet (PLT) count [6, 7]. It also causes variations in platelet indices and all these can be measured by a hematology autoanalyser; But their prognostic use in

septic shock is not known.

Of these platelet indices, MPV is found to be increased in some infective conditions like acute appendicitis, pancreatitis, infective endocarditis, and malaria, but its role in sepsis is not proven [8]. Whenever platelet turnover is increased, the PDW increases during platelet depletion and has similar behavior to MPV during severe infections. PLCR is another marker for the platelet volume, which recognizes the largest-sized fraction of platelets. An increase in PLCR usually signifies that there is an increase in new platelets (which are larger). PCT is influenced by the number and the size of platelets and has a positive relationship with the platelet count.

Given the important role of platelets in infective conditions, we analyzed changes in platelet indices in sepsis patients and compared them between revived and succumbed patients. We aimed to know the importance of platelet indices in the prognosis of sepsis patients.

MATERIALS AND METHODS

This retrospective study was conducted in GEMS medical college and hospital, Srikakulam, from September 2018 to August 2019. Patients diagnosed as sepsis clinically (defined by at least two of four defined parameters namely body temperature of $>38^{\circ}\text{C}$ or leucocyte count of $>12,000$ cells/cumm or <4000 cells/cumm, heart rate $>90/\text{min}$, and respiratory rate of $>24/\text{min}$) and/or culture-proven were included, While those patients with hematological diseases like hematological malignancies, autoimmune thrombocytopenic purpura, and hypersplenism; patients receiving blood components and pregnant or breastfeeding women; patients whose stay in hospital is less than five days were excluded from the study.

Complete blood counts (CBCs) were performed daily during treatment using Sysmex coulter XP-100, a 3 part hematology auto analyzer. But only the average values of day 1 on admission and day 5 in hospital were reviewed. The normal range of PLT, MPV, PDW, PLCR, and PCT were $150\text{--}400 \times 10^9/\text{L}$, 7–13 fl, 9–17%, 13–43%, and 0.11–0.28% respectively.

STATISTICAL ANALYSIS

The patients were divided into 2 groups - revived and succumbed based on their outcome. Continuous variables were expressed as means with standard deviations and categorical variables as numbers with percentages. Quantitative variables were compared between the two groups. Cut-off values were taken for all parameters. The proportion of cases above and below these cut-off values were compared between revived and succumbed patients using chi-square test. All p-values less than 0.05 were considered statistically significant.

RESULTS

A total of 142 patients with sepsis were evaluated from which only 100 were studied based on exclusion criteria. Among them, 62 were men and 38 were women with a sex ratio (M: F) = 1.63:1. The age of the patients ranged from 15 to 80 years. The majority of them were in 6th decade (32%) followed by 5th decade (27%).

Overall, 45 patients succumbed during their

hospitalization, while 55 were revived. When comparing the platelet indices (Table-1), the mean PLT counts of Revived and Succumbed was $323.62 \times 10^9/\text{cells/L}$ and $118.56 \times 10^9/\text{cells/L}$ respectively. Among them, 44 patients in revived and 16 patients in succumbed had PLT count more than $200 \times 10^9/\text{cells/L}$, while 11 patients in revived and 29 patients in succumbed had PLT count less than $200 \times 10^9/\text{cells/L}$. This indicates PLT counts were significantly reduced in succumbed ($P=0.0001$).

The mean MPV of Revived and Succumbed was 8.1 fl and 9.8 fl respectively. Among them, 22 patients in revived and 29 patients in succumbed had MPV more than 8.5 fl, while 33 patients in revived and 16 patients in succumbed had MPV less than 8.5 fl. These results show that MPV was significantly increased in succumbed ($P=0.017$).

The mean PDW of Revived and Succumbed was 14.2% and 15.5% respectively. Among them, 26 patients in revived and 24 patients in succumbed had PDW more than 13.5%, while 29 patients in revived and 21 patients in succumbed had PDW less than 13.5%. These results show that PDW increased in succumbed but not significant ($P=0.69$).

The mean PCT of Revived and Succumbed was 0.25% and 0.17% respectively. Among them, 29 patients in revived and 20 patients in succumbed had PCT more than 0.20%, while 26 patients in revived and 25 patients in succumbed had PCT less than 0.20%. These results show that PCT decreased in succumbed but not significant ($P=0.43$).

The mean PLCR of Revived and Succumbed was 27.67% and 38.12% respectively. Among them, 24 patients in revived and 26 patients in succumbed had PLCR more than 25%, while 31 patients in revived and 19 patients in succumbed had PLCR less than 25%. These results show that PLCR increased in succumbed but not significant ($P=0.23$).

Overall, PLT counts & MPV were statistically significant. In the succumbed group PCT decreased, while PDW and PLCR increased but not significant.

Table-1: Comparison of Platelet indices between Revived and Succumbed patients

Parameter		Revived (N=55)	Succumbed (N=45)	P-value
PLT ($\times 10^9$ cells/L)	Mean \pm SD	323.62 \pm 154.32	118.56 \pm 178.56	0.0001
	>200	44	16	
	<200	11	29	
MPV(fl)	Mean \pm SD	8.1 \pm 1.81	9.8 \pm 1.58	0.017
	>8.5	22	29	
	<8.5	33	16	
PDW(%)	Mean \pm SD	14.2 \pm 0.66	15.5 \pm 0.78	0.69
	>13.5	26	24	
	<13.5	29	21	
PCT(%)	Mean \pm SD	0.25 \pm 0.11	0.17 \pm 0.18	0.43
	>0.20	29	20	
	<0.20	26	25	
PLCR(%)	Mean \pm SD	27.67 \pm 0.89	38.12 \pm 1.12	0.23
	>25	24	26	
	<25	31	19	

DISCUSSION

In this retrospective study of 100 patients with septic shock, there were several important findings. First, in the succumbed group, we observed that MPV, PLCR, and PDW were increased, while PLT and PCT were decreased. Most importantly, MPV over 10.5 on the day of admission was a good predictor of mortality in patients with septic shock.

The PLT count was significantly lower in succumbed, a finding that has already been described previously [7]. This drop is due to depletion of coagulation factors and platelet destruction during the septic process and hence is a significantly alters the prognosis of the patients.

The platelet indices are useful for narrowing the differential diagnosis of thrombocytopenia conditions. An increased MPV indicates a larger PLT size, produced from compensated bone marrow following any stress-induced platelet destruction, as seen in septic shock patients [9]; in fact, the more is the MPV, the less is the PLT maturity. In decompensated bone marrows, where platelet production is decreased, MPV will be low. In a study by Van der Lelie *et al.*, MPV was elevated in 13 of the 25 septicemia patients but returned to normal values when the disease was under control [9]. In local infection or sepsis with negative blood culture, MPV is not increased. Elevated MPV, therefore, suggests a systemic, uncontrolled, invasive infection and is related to the severity of the disease and hence may be useful for assessing the prognosis of septic shock [10].

The different methods and instruments in different laboratories are responsible for discrepancies found in the literature. The normal range of MPV should be established and calibrated within each specific laboratory because of the different laboratory analysis techniques [11]. MPV changes are complex

and are not only related to the PLT count but also related to the method of laboratory analysis used [12]. In a study by Akarsu *et al.*, an MPV >9.5 fl was considered above normal range [13], and in another study, MPV elevation was defined >10.4 fl [14] and the normal range of MPV from our laboratory was 7–13 fl. Most patients in the present study had an MPV within the normal range. Nevertheless, despite the absence of critical abnormalities in the MPV, discreet changes in MPV conferred prognostic value, as previous studies have suggested [13, 14].

Platelet distribution width (PDW) is an indicator of the heterogeneity in platelet size. Swelling, destruction, and immaturity of platelets cause a large range of platelet size, which increases the value of PDW. In our study, PDW was more elevated in succumbed. Our finding is similar to that of Akarsu's research in neonates with sepsis [13].

Platelet large cell ratio (PLCR) is similar to MPV but is more sensitive to platelet size changes. In a study by Babu *et al.*, PLCR level is found to be inversely related to the platelet counts and directly proportional to MPV and PDW and helps for the differentiation of thrombocytopenia conditions [15]. This value was also more elevated in the succumbed group. However, the studies comparing the changes of PLCR to MPV and PDW in sepsis conditions are limited. So the further investigation is needed. The PCT is similar to the platelet count and has a similar clinical implication. The PCT was also decreased in the patients who expired. Previously Aydemir *et al.*, studied only the kinetics of platelets and MPV [14], whereas our study analyzes all five platelet indices.

Limitations of our study and future work

Patients who received any blood components were excluded from the study as these directly affect the concentration of platelet indices. As these patients

may have more severe features, they also should be investigated before a conclusion is drawn about these platelet indices changes in septic shock. Some drugs like antibiotics, etc may have an impact on the platelet indices and could have affected our results [16]. Thus prospective studies having a larger sample of septic shock patients, with criteria such as the infection sites, various therapeutic agents, and causative pathogens are needed to compare their impact on prognosis.

CONCLUSION

In this retrospective study, apart from platelet count, a statistical difference in MPV was seen between the succumbed and the revived of septic shock. The decreased platelet count and a rise in MPV are indicative of a worse prognosis in patients with septic shock.

REFERENCES

- Gardiner, E. E., & Andrews, R. K. (2014). Structure and function of platelet receptors initiating blood clotting. *Adv Exp Med Biol*, 844:263-275.
- Guclu, E., Durmaz, Y., & Karabay, O. (2013). Effect of severe sepsis on platelet count and their indices. *African Health Sciences*, 13(2), 333-338.
- Zakynthinos, S. G., Papanikolaou, S., Theodoridis, T., Zakynthinos, E. G., Christopoulou-Kokkinou, V., Katsaris, G., & Mavrommatis, A. C. (2004). Sepsis severity is the major determinant of circulating thrombopoietin levels in septic patients. *Critical care medicine*, 32(4), 1004-1010.
- Levi, M., & Opal, S. M. (2006). Coagulation abnormalities in critically ill patients. *Critical care*, 10(4), 222.
- Dellinger, R. P., Levy, M. M., & Carlet, J. M. (2008). Surviving Sepsis Campaign: international guidelines for management of severe sepsis and septic shock. *Crit Care Med*, 36(1):296-327.
- Mavrommatis, A. C., Theodoridis, T., Orfanidou, A., Roussos, C., Christopoulou-Kokkinou, V., & Zakynthinos, S. (2000). Coagulation system and platelets are fully activated in uncomplicated sepsis. *Critical care medicine*, 28(2), 451-457.
- Irmak, K., Sen, I., Cöl, R., Birdane, F. M., Güzelbektes, H., Civelek, T., ... & Turgut, K. (2006). The evaluation of coagulation profiles in calves with suspected septic shock. *Veterinary research communications*, 30(5), 497-503.
- Gao, Y., Li, Y., Yu, X., Guo, S., Ji, X., Sun, T., ... & Li, L. (2014). The impact of various platelet indices as prognostic markers of septic shock. *PLoS One*, 9(8), e103761.
- Van der Lelie, J., & Von dem Borne, A. K. (1983). Increased mean platelet volume in septicaemia. *Journal of clinical pathology*, 36(6), 693-696.
- Guclu, E., Durmaz, Y., & Karabay, O. (2013). Effect of severe sepsis on platelet count and their indices. *African Health Sciences*, 13(2), 333-338.
- Farias, M. G., Schunck, E. G., Dal Bó, S., & de Castro, S. M. (2010). Definition of reference ranges for the platelet distribution width (PDW): a local need. *Clinical chemistry and laboratory medicine*, 48(2), 255-257.
- Giovanetti, T. V., Nascimento, A. J. D., & Paula, J. P. D. (2011). Platelet indices: laboratory and clinical applications. *Revista brasileira de hematologia e hemoterapia*, 33(2), 164-165.
- Akarsu, S., Taskin, E., Kilic, M., Ozdiller, S., Gurgoze, M. K., Yilmaz, E., & Aygun, A. D. (2005). The effects of different infectious organisms on platelet counts and platelet indices in neonates with sepsis: is there an organism-specific response?. *Journal of tropical pediatrics*, 51(6), 388-391.
- Aydemir, H., Piskin, N., Akduman, D., Kokturk, F., & Aktas, E. (2015). Platelet and mean platelet volume kinetics in adult patients with sepsis. *Platelets*, 26(4), 331-335.
- Babu, E., & Basu, D. (2004). Platelet large cell ratio in the differential diagnosis of abnormal platelet counts. *Indian journal of pathology & microbiology*, 47(2), 202-205.
- Giovanetti, T. V., Nascimento, A. J. D., & Paula, J. P. D. (2011). Platelet indices: laboratory and clinical applications. *Revista brasileira de hematologia e hemoterapia*, 33(2), 164-165.