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Original Research Article

# To Evaluate the Relationship between the Platelet Count and their Indices MPV, PCT, PDW, PLCC and P-LCR for Diagnosis and Prognosis in Patients with Sepsis. A Prospective Observational Study in Tertiary Care Center

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**Abstract**

**Background:** Platelets Count, Mean corpuscular volume (MCV), platelet crit (PCT), platelet distribution width (PDW), PLCC, and platelet-large cell ratio (P-LCR) are commonly used laboratory parameters to assess platelet function in sepsis, a life-threatening condition caused by an overwhelming immune response to infection.

**Materials and Methods:** The platelet count amongst non-survivors and survivors and the MPV, PDW, P-LCR, PLCC and PCT values were among non-survivals and survivals on admission day 1,2 and last day were compared with control group. The platelet indices were obtained from automated haematology analysers, and the results were compared with the reference ranges provided by the manufacturer and to compare platelet indices of cases of sepsis and non-septic patients, platelet indices of control group were also included in our study.

**Results:** A total of 90 patients were included in the study, with a mean age of 44 years (range: 18 to >65 years). The majority of the patients were males (60%) and female is (30%). The platelet count(*$10^9$/L) amongst non-survivors and survivors and the MPV (Fl), PDW (%), P-LCR (%), PCT (%), PLCC(*$10^9$/L) values were among non-survivals and survivals on day 1,2-4rth and final sample platelets count (231.23±115,254±141.9), (202±114,250.89±185.26), (104±51.9, 197±97.9). MPV (10.75±1.33, 10.54±1.46), (11.20±1.22,10.78±1.20), (11.84±1.17,10.88±1.20), PDW (16.60±0.82, 16.22±0.49), (16.52±0.74, 16.31±0.75), (16.62±0.89,16.30±0.87), P-LCR (41.4±12.47, 40.52±12.17), (47.32±12.79, 43.17±10.06), (53.22±13.77,42.72±9.72), PCT (2.09±1.2, 2.55±1.5), (2.17±1.25,2.66±1.91), (1.50±1.25, 2.46±1.71), PLCC (98±56.9, 83.15±41.7), (89.88±47,101.19±69.62), (71.58±40,101.72±79.62) respectively .

**Conclusion:** Thrombocytopenia is common in sepsis and associated with higher risk of mortality in sepsis. Higher MPV and PDW are associated with poor prognosis. Higher PLCR correlates with increased risk of mortality in sepsis. Lower PCT in sepsis is associated with poor prognosis. Platelet count inversely related to MPV and directly related to plateletcrit. MPV has a strong

positive correlation with PLCR as larger platelets contribute to increase in mean platelet volume. MPV has a strong positive correlation with PDW, when MPV increases the PDW tends to be higher. Platelets and its indices are helpful in diagnosis and prognosis of sepsis.

**Keywords:** Platelets Indices, PDW, MPV, PLCC, P-LCR.



## Introduction

Platelets are small, anuclear cell fragments that play a crucial role in hemostasis and thrombosis. Changes in platelet count and size, as reflected by mean platelet volume (MPV), platelet distribution width (PDW), platelet-large cell ratio (P-LCR), and plateletcrit (PCT), and PLCC have been associated with various pathological conditions.

Elevated MPV has been observed in numerous inflammatory and thrombotic disorders, while reduced MPV is seen in bone marrow disorders and bleeding disorders. PDW has been implicated in platelet activation and aggregation, and it is commonly elevated in cardiovascular disease and stroke. PCT, which measures the volume fraction of platelets in whole blood, is used to diagnose and monitor thrombocytosis and thrombocytopenia. P-LCR (> 12 Fl) is a useful marker for platelet activation and aggregation, and elevated levels are associated with a higher risk of thrombotic events.

Thus, platelet indices have proven to be valuable biomarkers in various clinical settings, providing insights into the underlying pathophysiology and aiding in the diagnosis, prognosis, and management of patients with hematological and cardiovascular diseases.

## Material and Method

The role of platelet count, mean platelet volume (MPV), platelet distribution width (PDW), platelet-large cell ratio (P-LCR), PLCC and plateletcrit (PCT) in sepsis was investigated. A Prospective observational study was conducted using patient data regarding age, sex, clinical diagnosis, present and past medical history or co-morbidity was recorded on the first day of admission in N.S.C.B. Medical College and Hospital, Jabalpur. Patient fulfilling clinical criteria for the diagnosis of sepsis that is microbiologically (blood culture) confirmed or strongly suspected infection and presence of two or more of the SIRS criteria [1]and Patients above 18 years admitted with fulfilling clinical criteria for sepsis. Were included in our study. diagnosis of sepsis between March 2017 to August 2018.Patients with Patient with a history of thromboembolic disease, Patient absconded or discharged against medical advice, Patient with concomitant hematological disease, Autoimmune thrombocytopenic purpura, Pregnant and breast-feeding women. Were excluded from the study.

**Diagnosis of sepsis [2]**

| | |
|---|---|
| **SIRS(Systemic inflammatory response syndrome)** | Systemic activation of innate immune response regardless of cause.<br>**SIRS criteria**<br>Presence of 2 or more than 2 of SIRS criteria<br>1.Temperature- >$38^0$C or < $36^0$C<br>2. Heart rate >90 beats/ min<br>3.Respiratory rate >20 / min |

| | |
|---|---|
| | 4. $PaCO_2$ < 32 mmHg<br>5.WBC > 12000 cells /mm3 or <4000 cells/ mm3<br>>10 % band form |
| **Sepsis** | Microbiologically confirmed or strongly suspected infection and presence of two or more of the SIRS criteria [1] |

The platelet indices were obtained from automated hematology analyzers, and the results were compared with the reference ranges provided by the manufacturer and to compare platelet indices of cases of sepsis and non-septic patients, platelet indices of control group were also included in our study. 40 controls were taken from outpatient department with equal sex distribution 20 females and 20 males.

All were above 18 years of age. Selection criteria for the control group was No infectious disease, absence of SIRS criteria and Leukocyte count within normal range. Data was entered in Microsoft Excel 2007 worksheet. Categorical variables were numerically coded and distributed in frequency and percentage. The difference of frequency distribution in outcome variable was analyzed using Chi square statistics. Fisher's exact was also applied if frequency was less than five. The student t test was applied to compare statistical differences between two independent means. Shapiro-Wilk test to determine normality was used and if variable significantly deviate from a normal distribution, log transformed data was used for statistical comparison and all statistical analysis was performed using R 3.5.0 for Windows and SPSS 20.0 for Windows. And these all parameters applied to assess the association between the platelet indices and sepsis.

## Result

A total of 90 patients were included in the study, with a mean age of 44 years (range: 18 to >65 years). The majority of the patients were males (60%) and female is (30%). The platelet count (*$10^9$/L) amongst non-survivor and survivor and the MPV (fl), PDW (%), P-LCR(%), PCT (%), PLCC(*$10^9$/L) values were among non-survivors and survivors on day admission (day 1),2-4rth day and Final sample before outcome were observed and result shown in Table 1.

**Table 1**

| **Patient outcome** | | **Non -survivals** | **Survivals** |
|---|---|---|---|
| Admission day sample (day 1) | PLT.COUNT | 231.23±115 | 254±141.9 |
| | MPV | 10.75±1.33 | 10.54±1.46 |
| | PDW | 16.60±0.82 | 16.22±0.49 |
| | PLCR | 41.4±12.47 | 40.52±12.17 |
| | PCT | 2.09±1.2 | 2.55±1.53 |
| | PLCC | 98±56.9 | 83.15±41.7 |
| After treatment (2-4rth day) sample | PLT.COUNT | 202±114 | 250.89±185.26 |
| | MPV | 11.20±1.22 | 10.78±1.20 |
| | PDW | 16.52±0.74 | 16.31±0.75 |
| | PLCR | 47.32±12.79 | 43.17±10.06 |
| | PCT | 2.17±1.25 | 2.66±1.91 |
| | PLCC | 89.88±47 | 101.19±69.62 |
| | PLT.COUNT | 104±51.94 | 197±97.9 |

| | | | |
|---|---|---|---|
| Final Sample Before outcome | MPV | 11.84±1.17 | 10.88±1.20 |
| | PDW | 16.62±0.89 | 16.30±0.87 |
| | PLCR | 53.22±13.77 | 42.72±9.72 |
| | PCT | 1.50±1.25 | 2.46±1.71 |
| | PLCC | 71.58±40 | 101.72±79.62 |

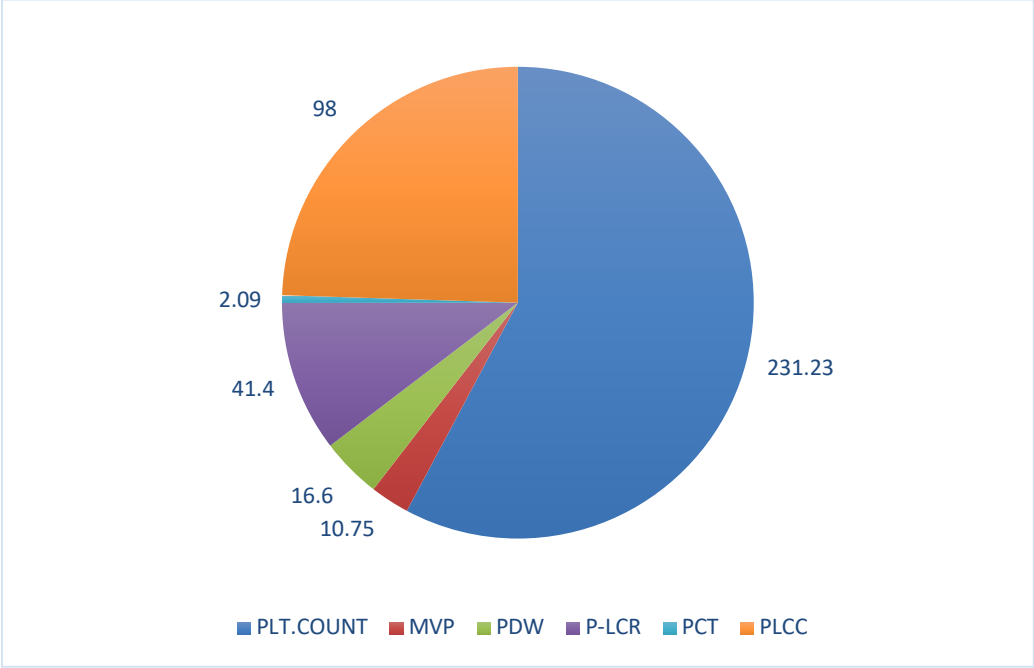


**Figure 1: Platelets Indices In Non-Survivors**

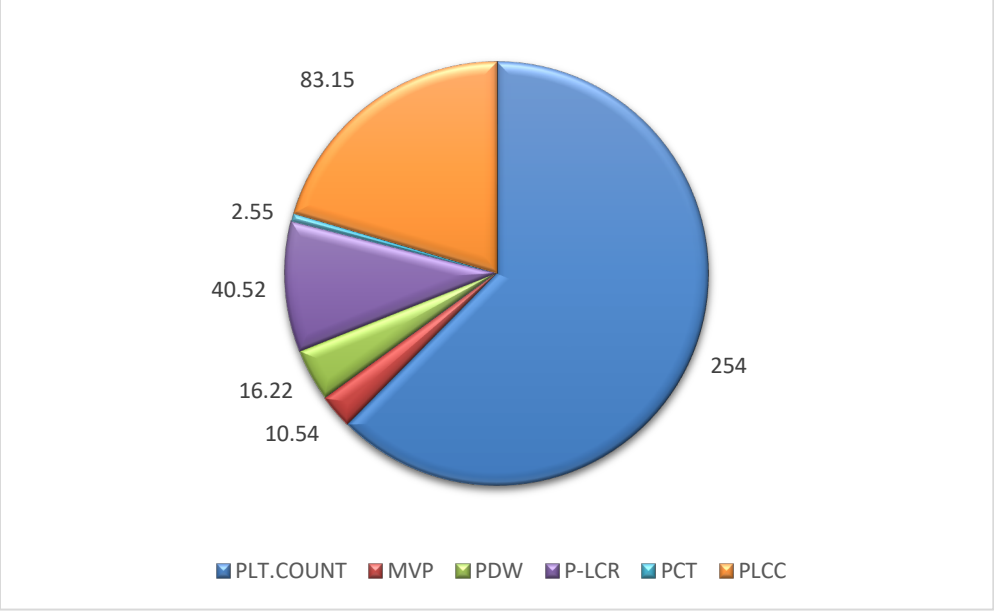


**Figure 2: Platelets Indices In Survivors**

## Discussion

### PDW

In the present study, on the first day of admission only PDW and Procalcitonin had significant difference (p =0.008). Mean PDW among non-survivors was 16.60±0.82 and mean PDW among survivor was 16.22±0.499. In the present study PDW was associated with higher risk of mortality due to sepsis (OR =2.68). PDW on the first day is associated with increased risk of mortality by 2.6-fold. Our finding is similar with that of Gao *et al* [3], M orak [19], Guclu E [4,] *et al* and kaito *et al* [5,].

Hoffman J [6] reported that reticulated platelets are immature platelets circulating in blood. They reflect the activity of megakaryopoiesis in the bone marrow. We hypothesize that the presence of platelets of different sizes either fragmented or younger as well as activated platelets contribute in maximum heterogenicity result in higher PDW. Platelets also involved in inflammation result in activation and acquire larger size.

On admission PDW can be used as predictor for mortality in sepsis. Higher PDW correlates with higher risk of mortality.

PDW was not significant on the last day among survivors and non survivors (p = 0.119). However higher PDW was observed in non-survivors' group. The mean PDW was 16.62 ±0.89 and in non survivors was 16.30±0.87.

Similar study done by Guclu E *et al* [4**]** reported that PDW was significantly different between sepsis patients and control group (P<0.05). Platelet count in sepsis patients was lower than control group, but the difference was not significant. PDW was the unique significantly different parameter between survivors and non-survivors (p=0.001). They reported that platelet indices are important laboratory findings in the diagnosis of sepsis and severe sepsis. Severe sepsis patients who have greater than 18 % PDW have a higher risk of mortality.

Kaito *et al* [5] reported that PDW had the largest AUCs, which indicated that these values were very reliable sign for hyper destructive immune thrombocytopenia. These indices provide clinical information about the underlying conditions of thrombocytopenia. Similarly in our study PDW was also the best predictor at the time of application with AUC 0.64.

On the day of admission PDW can be served as strongest predictor of mortality among all other platelet indices. So, PDW can be routinely performed for almost all patients admitted to health facilities and it may be used to assess severity.

Vegdatil *et al* [7] suggested that PDW was more specific marker of platelet activation. PDW do not increase in simple platelet swelling. Combination of MPV and PDW can be used to assess activation of platelet.

### Platelet count

In the present study, overall, 23.33% cases in our study had thrombocytopenia at the time of admission. On the day of admission platelet count was not significantly different among survivors and non survivors (p =0.74). However, the mean platelet count on the day of admission was higher in survivor group (254±141.9) and it was lower in no survivor group (231.23±115). Our finding of final sample is correlate with similar strauss *et al* [8], Aissaoui *et al*[9] and Francois *et al* [10] study on sepsis.

In the present study mortality in ICU was 28%. Similar to our study by Faviere *et al* in[11], reported that thrombocytopenia was associated with mortality. Overall mortality in ICU was 32%.

A similar study done by Aissaoui *et al*[9] on "Thrombocytopenia in a surgical intensive care unit: incidence, risk factors and effect on outcome" reported that thrombocytopenia is common in surgical ICUs. This study included 112 patients with a mean age of 50±18 years. Bleeding and sepsis are the major risk factors. In this study, thrombocytopenia was not an independent factor of poor vital outcome in these critically ill patients. Out of 112, 41 developed thrombocytopenia (incidence=36.6%). Although mortality was higher in patients with than without thrombocytopenia, this difference was not statistically significant (p=0.26).

Similar to the above study the first day platelet count does not have any significance in determining prognosis (P=0.74) and it has lowest (AUC 0.53) among all platelet indices.

The platelet count drop can be due to consumption during inflammatory process. There is immune and nonimmune mediated destruction along with increased sequestration resulting in thrombocytopenia [12].

Francois B *et al* [13], reported that thrombocytopenia can be due to hemophagocytosis, and it is associated with severe sepsis syndrome.

In the present study, we have observed that normalization of platelet count was associated with increased survival while failure of normalization or persistent abnormal platelet count was associated with increased Mortality. On day of admission, 73.10% of no survivors had adequate platelet count but prior to death 84.61% developed thrombocytopenia. 93% of survivors had adequate platelet count at the time of discharge. There was significant difference seen between survivors and non-survivors' group ($p < 0.0001$). Although Gao *et al* [3] showed similar results but statistically not significant among survivors and non survivors.

In our study, last platelet count prior to death or on day of discharge, was statistically significant among survivors and non survivors ($p < 0.0001$) along with all other platelet indices i.e. MPV3 ($p = 0.001$), PCT 3($p = 0.008$), PLCC3 ($p = 0.045$) and PLCR3 ($p < 0.0001$).

Overall decreasing trend of platelet count was more significant between day 1 today last ($p = 0.0001$).

Strauss *et al* [8] reported that mortality was higher in patients with a nadir platelet count ($p < .001$). In no survivors, decrease in platelet count was greater ($p < .001$) and the duration of thrombocytopenia longer ($p = 0.008$) than in survivors. They concluded that any drop in platelet count requires urgent clarification. Disseminated intravascular coagulation, signs of organ failure at admission, and cardiopulmonary resuscitation are predictors of intensive care unit-acquired thrombocytopenia.

Francois Stephan *et al* [13] reported that thrombocytopenic patients had comparable value for severity between day of admission and thrombocytopenia. So, thrombocytopenia less than 50 X $10^9$ platelets/L may be a useful marker for severity of illness and increased risk of death. The incidence of thrombocytopenia was 12% surgical ICU in their study. Immune mechanism and hemophagocytosis in bacterial infection resulting in thrombocytopenia.

**MPV**

In the present study, mean MPV among non survivors was 10.75±1.33 and in survivor group was 10.54±1.46 ($p = 0.52$) on admission. MPV of non survivors on first day observed to be higher than survivors but not statistically significant. However it can be used to assess severity of sepsis on day of

admission. It has the second highest odds ratio among all platelet indices (OR 1.11). Various studies suggest that MPV correlates with sepsis severity. Our finding is like Aydemir *et al* [14] that there is increase in MPV in response to infection. They also reported that increased MPV along with thrombocytopenia and higher PDW were associated with bad prognosis. Dastugue N *et al* [15] and Bechchi *et al*[16] also have similar findings in their studies.

Dastugue N *et al* [15], reported 80 % of the patients had an increase in MPV, and the increase persisted even after thrombocytopenia had regressed. In the present study there is increase in MPV seen in all septic patients with marked increase in MPV noted in nonsurvivors.

Bechchi *et al* [16] showed in their study that the MPV can be used as an indicator of platelet behavior and malfunction in measuring indirectly platelet production and activation during sepsis. Elevated MPV indicates endothelial damages and platelet activation under inflammation.

However, change in Δ MPV1-2 Was statistically significant (p = 0.009). Our study suggests that there is a higher rate of increase in MPV in non survivors than survivors.

In present study mean change in MPV (ΔMPV1-3 = -1.09) in nonsurvivors was higher than in survivors **(**ΔMPV1-3 = -0.34) and it is significant (p = 0.001).

Farid Sadaka *et al* 2014[17], studied on "Mean Platelet Volume is not a Useful Predictor of Mortality in Septic Shock". It was a retrospective cohort study that included all patients with septic shock. A total of 484 septic shock patients were included in the study. They reported that there was no relation between mean platelet volume on day of septic shock and mortality. Estimating the ROC, AUC showed that MPV has a no discriminative power for predicting mortality (ROC AUC=0.5). However, our study do not match with their study because we had AUC of MPV was 0.72 and we found that MPV is a good prognostic marker for mortality.

On the last day, the highest risk of mortality due to sepsis was determined by MPV (OR = 1.84). Hence increase in MPV is associated with higher risk of mortality and it shows that it should be monitored carefully on serial CBC.

**PLCR**

Mean PLCR on day of admission, among non survivors was 41.4±12.47 and survivor group was 40.52±12.17 (p =0.74), it was statistically not significant. However, with increase in PLCR there is increased risk of mortality (OR = 1.00).

PLCR1-2 was statistically significant (p = 0.002). It was observed that MPV and PLCR changed significantly over 24 – 72 hours. We hypothesized that these changes may be due to production of more reticulated platelets by bone marrow under challenge of sepsis. Our study is consistent with the study of Gao *et al* [3].

Gao *et al* in 2014[3] reported that an increase in PLCR usually signifies that there is an increase in new platelets (which are larger in size). PDW increases during platelet depletion when turnover is accelerated, and similar behavior shared by MPV during acute severe infections.

PLCR is another surrogate marker for the platelet volume. It identifies the largest-sized fraction of platelets.

**PLCC**

In the present study, no survivor group had higher PLCC on the day of admission (98±56.9) compared to survivor group (83.15±41.7). It was statistically insignificant on the day of admission( p=0.21).

However, PLCC was statistically significant in the last CBC among survivors and no survivors (0.045).

**PCT**

Mean PCT among non-survivor group was 2.09±1.2 and in survivors group it was 2.55±1.53 (p = 0.18), statistically not significant (p=0.18).

In the last sample, mean PCT among non-survivors was 1.50±1.2 and in survivors it was 2.46±1.53 (p = 0.008). PCT was statistically significant among the two groups.

Gao *et al* in 2014[3] reported that plateletcrit is influenced by the number and the size of platelets and has a positive relationship with the platelet count.

Kavya *et al* [18] in a retrospective case control study conducted in an intensive care unit (ICU), including 65 non survivors (cases) and 130 survivors (controls) reported that only hemoglobin at time of admission was the only predicting factor concluded that there was no correlation between platelet count and other platelet indices on admission to ICU with mortality. Hemoglobin was found to be the only significant indicator in assessing mortality in ICU patients.

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**Conclusion**

Thrombocytopenia is common in sepsis and associated with higher risk of mortality in sepsis. Higher MPV and PDW are associated with poor prognosis. Higher PLCR correlates with increased risk of mortality in sepsis. Lower PCT in sepsis is associated with poor prognosis. Platelet count inversely related to MPV and directly related to plateletcrit. MPV has a strong positive correlation with PLCR as larger platelets contribute to increase in mean platelet volume. MPV has a strong positive correlation with PDW, when MPV increases the PDW tends to be higher. Platelets and its indices are helpful in diagnosis and prognosis of sepsis.

**Reference**

1. M Singer, CS Deutschman, CW Seymour, The third international consensus definitions for sepsis and septic shock (Sepsis-3), JAMA Author manuscript, 2016.
2. D. Banerjee, Mitchell M. Levy, Sepsis Definition, Springer International publishing, 2017.
3. Y Gao, Y Li, X Yu, S Guo, X Ji, T Sun, The impact of various platelet indices as prognostic markers of septic shock, Plos ONE, 2014;9(8).
4. Rana Isguder, GokhanCeylan, hasanAgin, increased mean platelet volume in children with sepsis as a predictor of mortality, the Turkish Journal of pediatrics, 2016; 503-511.
5. Kaitok, Platelet size deviation width, platelet large cell ratio, and mean platelet volume have sufficient sensitivity and specificity in the diagnosis of immune thrombocytopenia. Br J Haematol. 2005 Mar;128(5):698-702.
6. Hoffman JJ, Reticulated platelets: analytical aspects and clinical utility, 2014; Aug;52(8):1107-17.
7. Vagdatli E, Platelet distribution width: a simple, practical and specific marker of activation of coagulation Hippokratia, 2010;14(1): 28-32, 2010.
8. Strauss, Thrombocytopenia in patients in the medical intensive care unit: bleeding prevalence, transfusion requirements, and outcome. Crit Care Med. 2002 Aug; 30(8):1765-71.
9. Aissaoui, Thrombocytopenia in a surgical intensive care unit: incidence, risk factors

and effect on outcome. 2007 Jan;36(1 Pt 1):43-9. Epub Dec 11.2006.
10. Francois B, Thrombocytopenia in the sepsis syndrome: role of hemophagocytosis and macrophage colony-stimulating factor, https://www.ncbi.nlm.nih.gov/d/9274894, 1997
11. W. Faviere, Sepsis: thrombocytopenia is bad, not recovering thrombocytopenia is too bad. Crit Care; 2011; 15(Suppl 1): P440.
12. Antoine Dewitte, Sébastien Lepreux, Julien Villeneuve, Claire Rigothier, Christian Combe, Alexandre Ouattara, Jean Ripoche, Blood platelets and sepsis pathophysiology: A new therapeutic prospect in critical ill patients? Annuals of Intensive Care, 2017.
13. F. Stephan, Role of hemophagocytosis in the etiology of thrombocytopenia in patient with sepsis syndrome or septic shock. Clinical infectious disease, 1997.
14. Aydemir, Platelet and mean platelet volume kinetics in adult patients with sepsis. 2012; 26(4):331-5.
15. Dastugue N, Increase in mean platelet volume in shock related thrombocytopenia Nouv Presse Med. 1982, Oct 9;11(39):2899-901.
16. Bechchi, "Mean platelet volume trend in sepsis: is it a useful parameter?" Minerva Anestesiol. 2006 Sep;72(9):749-56.
17. Farid Sadaka, Mean Platelet Volume is not a Useful Predictor of Mortality in Septic Shock, J Blood Disorders Transf, 2014; 5:2.
18. Kavya I, Swaroop Raj B V, Utility of platelet indices in assessing risk of mortality in intensive care patients admitted at a tertiary hospital, international journal of scientific research, 2017; 6(9).
19. M Orak, An investigation of the effects of the mean platelet volume, platelet distribution width, platelet/lymphocyte ratio, and platelet counts on mortality in patients with sepsis who applied to the emergency department. Nigerian Journal of clinical practice. 2018; 21(5): 667-671.