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Original Article

The use of platelet count, mean platelet volume, platelet distribution width, and platecrit levels for predicting survival in respiratory intensive care unit

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Abstract

Aim: We aimed to investigate platelet and associated parameters' changes, such as mean platelet volume, platelet distribution width, and platecrit, in tertiary respiratory intensive care unit (ICU) patients.

Materials and Methods: This is a retrospective observational study. It's conducted between August 1, 2018 and February 1, 2019. Demographic variables, such as, age, gender, admission diagnosis, admission site, Acute Physiology and Chronic Health Evaluation Score-II (APACHE-II), Sequential Organ Failure Score (SOFA), mechanical ventilation (MV) need, multiple organ failure (MOF) status at admission, renal replacement therapy (RRT) need, and laboratory variables of platelet (PLT), mean platelet volume (MPV), platelet distribution width (PDW) and platecrit (PCT) were recorded. Patients under age 18, or had more than one intensive care unit admission, or lack of whole-records were excluded from the study.

Results: There were 132 patients included in the study. Mean age was 72±12.64 years and 50.4% of patients were male. Pneumonia was the most frequent admission diagnosis (32.6%) and patients admitted to ICU mostly from emergency department (86.4%). Mean APACHE-II and SOFA scores were 17(3-20) and 5(3-7), respectively. Invasive MV need, MOF status, vasoactive drug need and RRT need were found significant for increased mortality rate. Mean values of PLT, MPV, PDW and PCT levels were 225.02±94.85x103µL, 10.95±1.0 fL, 13.0±1.47 fL and 0.26±0.07 %, respectively. PLT and MPV levels were found related to increased mortality rate.

Conclusion: PLT and MPV levels could be helpful for physicians in need for early prognostication in the respiratory intensive care unit at admission.

Keywords: Mean platelet volume; mortality; thrombocytopenia

INTRODUCTION

Lungs have an important role of platelet (PLT) biogenesis as much as bone marrow. Mature and immature megakaryocyte cells in the extravascular space migrate out to where needed and ensure the continuity of PLT counts and functions (1).

Many studies showed that PLT and related parameters - Mean Platelet Volume (MPV), Platelet Distribution Width (PDW) and Platecrit (PCT), could be used as a biomarker to make prognostication of patients in the intensive care unit (ICU) (2-4).

According to our knowledge, there is no accurate consensus of using PLT, MPV, PDW and PCT in respiratory ICU's for prognostication of patients at admission. Therefore, in this study, we examined the effects of PLT, MPV, PDW and PCT levels on mortality prediction in a respiratory ICU.

MATERIALS and METHODS

This study is conducted in a tertiary respiratory ICU at a state hospital between August 1, 2018-February 1, 2019. The Ethical Approval was taken from the Erciyes University Clinical Research Ethic Committee with decision number of 2019/331.

Demographic information such as age, gender, admission diagnosis, Acute Physiology And Chronic Health Evaluation-II (APACHE-II) score, Sequential Organ Failure Assessment (SOFA) score, mechanical ventilation need-invasive mechanical ventilation (IMV), noninvasive mechanical ventilation (NIV) and spontaneous breathing with low flow oxygen (SB), multiple organ failure status (MOF; two or more organ systems failure), vasoactive drug need, renal replacement therapy need (RRT), glomerular filtration rate (GFR; according to Modified Cockroft and Gault equation corrected with weight), PLT count, MPV

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level, PDW level, and PCT level were recorded. Symex Hematology Analyser XN-1000i device were used for analysing and EDTA tubes were used for sampling.

Patients who were under 18 years, and had more than one hospitalization also whose records were incomplete, were excluded from the study.

Statistical Analysis

Statistical analysis was performed using TURCOSA software (TURCOSA Analytics, www.turcosa.com.tr) The variables were investigated using visual (histogram and Q-Q graphic) and analytic method (Shapiro Wilk test) to determine whether or not they were normally distributed. Descriptive analysis were presented using means and standard deviations for normally distributed and medians and interquartile range (IQR) for the non-normally distributed and ordinal variables.

The univariate analyses to identify variables associated with mortality were investigated using Chi-square, Fisher exact, Student's-t and Mann-Whitney-U tests where appropriate. For the multivariate analysis the possible factors identified with univariate analysis were further entered in the logistic regression analysis to determine independent predictors of patient outcome. Odds ratios were given in 95% confidential index (CI %95).

The capacity of APACHE-II, SOFA scores, PLT and MPV levels in predicting mortality were analyzed using Receiver Operating Curve (ROC) analysis. A 5% type-I error level was used to infer statistical significance.

RESULTS

Out of 204 respiratory ICU patients, 132 eligible patients were enrolled in this study. Mean age was 72±12.64 years and 50.4% of patients were male. Frequencies of admission diagnosis in descending order were, pneumonia 32.6%, chronic obstructive pulmonary disease 25.8%, pulmonary thromboembolism 9.1%, sepsis/septic shock 7.6%, and others 25%. Frequencies depending on admission places were emergency department 86.4%, in-hospital ward 9.8%, 3% outer hospital and other 0.8%.

Table 1. Demographic variables and laboratory findings of the two groups of patients (survivors and non-survivors)

	Survivors (n=115)	Non-survivors (n=17)	p value
Gender			
Female	57 (49.6%)	7 (41.2%)	0.069
Male	58 (50.4%)	10 (58.8)	
Age (year)	72.53 ±13.07	70.24 ± 9.34	0.487
Admission diagnosis			
Pneumonia	40 (34.8%)	3 (17.6%)	0.067
COPD	31(27%)	3 (17.6%)	
Sepsis/Septic shock	6 (5.2%)	4 (23.5%)	
PTE	10 (8.7%)	2 (11.8%)	
Other	28 (24.3%)	5 (29.4%)	
Admission site			
ED	99 (86.1%)	15 (88.2%)	0.756
In-hospital Ward	12 (10.4%)	1(5.9%)	
Outer hospital	3 (2.6%)	1(5.9%)	
Other	1(0.9%)	0	
APACHE II score	16 (13-20)	26 (18-38)	<0.001
SOFA score	4 (3-6)	10 (6-12)	<0.001
MV need			
IMV	21(18.3%)	16 (94.1%)	<0.001
NIV	65 (56.5)	1 (5.9%)	
SB	29 (25.2%)	0	
MOF			
Yes	44 (38.3%)	16(94.1%)	<0.001
No	71(61.7%)	1(5.9%)	
Vasoactive drug need			<0.001
Yes	16 (13.9%)	15 (88.2%)	
No	99 (86.1%)	2 (11.8%)	
RRT need			
Yes	13 (11.3%)	8 (47.1%)	<0.001
No	102 (88.7%)	9 (52.9%)	
GFR-CKD-EPI (ml/dk/1.73 m²)	54 (38-86)	89 (55-101)	0.001
PLT (103/µL)	234.5 ± 91.83	168.59 ± 97.73	0.007
MPV (fL)	110.84 ± 0.94	11.7 ± 1.12	0.001
PDW (fL)	13.84 ± 1.38	14.1 ± 1.68	0.057
PCT (%)	0.27 ± 0.07	0.28 ± 0.06	0.062

COPD:Chronic obstructive pulmonary disease, PTE:Pulmonary thrombo-emboli, ED:Emergency department, APACHE:Acute phsiology and chronic health evaluation, SOFA:Sequental organ failure assessment, MV:Mechanical ventilation, IMV:Invasive mechanical ventilation, NIV:Non-invasive mechanical ventilation, SB:Spontaneous breathing, MOF:Multi-organ failure, RRT: Renal replacement therapy, GFR (CKD-EPI):Glomerular filtration rate (Chronic Kidney Disease Epidemiology Collaboration), PLT:Platelet, MPV:Mean platelet volume, PDW:Platelet distribution width, PCT:Platecrit

APACHE-II and SOFA scores with mean (Q1-Q3) levels were 17 (3-20) and 5 (3-7) respectively. IMV was applied to 28% of patients and this changed to 50% of patients for NIV and 2% of patients for SB. At the day of ICU admission, MOF was seen 45.5% and vasoactive drug need was 23.5%. The mean value of GFR was 58.5(33-88.8) ml/min/1.73 m2 and 2.3% of patients had a GFR level under 15 ml/min/1.73 m2. RRT need was 15.9% of all patients.

The average levels of PLT, MPV, PDW and PCT were 225.02±94.85x103µL, 10.95±1.0 fL, 13.0±1.47 fL and 0.26±0.07 %, respectively. The incidence of thrombocytopenia-PLT<150000x103µL- was 20.5%. Referring to power of mortality prediction of each factors, APACHE-II score, SOFA score, the presence of MOF status, vasoactive drug need, GFR levels, PLT and MPV levels were found significant and listed in Table 1.

Univariate and multivariate analyses showed that APACHE-II score, SOFA score, PLT and MPV levels might be used to predict the mortality rate (Table 2). The cut-off values of these parameters were listed in Table 3, in response to ROC analyses.

Table 2. Logistic regression analysis results of mortality effecting variables

	Univariate Binary Logistic Regression		Multiple Binary Logistic Regression (Forward LR) Modal 1		Multiple Binary Logistic Regression (Forward LR) Modal 2	
	OR (%95 CI)	p	Modal 1	p	OR (%95 CI)	p
PLT	0.99 (0.99-1.00)	0.010	-	-		
MPV	2.54 (1.41-4.59)	0.002	-	-	6.41 (1.68-24.38)	0.006
APACHE-II	1.16 (1.09-1.24)	<0.001	-	-		
SOFA	1.94 (1.49-2.54)	<0.001	1.93 (1.36-2.74)	<0.001	3.25 (1.59-6.62)	0.001
GFR	1.03 (1.01-1.05)	0.008	-	-	1.06 (1.00-1.11)	0.037
RRT need		-		-		
Yes	1.00	0.001	-	-		
No	6.97 (2.29-21.24)		-			

CI:Confidential interval, OR:Odds ratio, LR:Likelihoodratio, PLT:Platelet, MPV:Mean Platelet Volum, APACHE-II:Acute Physiology and Chronic Health Evaluation-II, SOFA:Sequential Organ Failure Assessment, GFR:Glomerular Filtration Rate, RRT:Renal Replacement Therapy.

Table 3. ROC curve analysis (AUC, Cutoff point, sensitivity, specifity) to determine mortality in ICU patients

Variables	AUC (%95 CI)	Cutoff point	Sensitivity	Specifity	p value
APACHE-II	0.81 (0.73-0.87)	>24	0.59	0.91	<0.001
SOFA	0.93 (0.87-0.97)	>6	0.88	0.83	<0.001
PLT (10^3/µL)	0.68 (0.59-0.76)	≤98	0.47	0.93	0.020
MPV	0.71 (0.63-0.79)	>11.23	0.71	0.69	0.002

AUC (%95 CI): Area under curve (%95 Confidence Interval); APACHE-II; Acute physiology and chronic health evaluation-II , SOFA; Sequential organ failure assessment, PLT; Platelet, MPV;Mean platelet volume

DISCUSSION

In respiratory ICU, PLT and MPV levels may help physicians to discover the severity of illness and determine the mortality rate at ICU admission.

Thrombocytopenia is seen commonly in medical and surgical ICU's. Many studies focus on its effect to mortality (5-7).

Strauss et al., searched its prevalance in medical ICU and reported that it's seen 44% of patients who had a PLT level under 150000 x103µL (5). Mortality rate was found higher in thrombocytopenia patients. They also investigated the other risk factor for mortality and found that APACHE-II score was significant, but it's opposite for SOFA score. Thrombocytopenia was less common in our study than the study mentioned above (20.5% vs 44%). Also for scoring systems, we both found significant results for APACHE-II and SOFA scores. Yet, SOFA score was even had a higher capability to predict mortality than APACHE-II scores through our analyses.

Shalansky et al., determined the risk factors of mortality in medical and coronary care units and conducted that sepsis, APACHE-II score, elder patients and thrombocytopenia could be associated (6). They found 18.8% of patients had thrombocytopenia and particularly, respiratory failure patients had a higher prevalence for both thrombocytopenia and mortality. Shortening in thrombocytes' lifetime and increasing of sequestration in lungs were found related to thrombocytopenia.

In another study, Coskun et al., thrombocytopenia prevalence was found 45% of all ICU patients, and

APACHE-II and SOFA scores were significantly higher in thrombocytopenia group with increased rate of mortality (7). They also claimed that the more drugs got used in the ICU, the more thrombocytopenic patients were occurred in the ICU. Famotidine and heparin were the most common drugs accused for causing thrombocytopenia. Finally, they concluded that not only thrombocytopenia itself, but also the leading factors of thrombocytopenia were related to increased mortality rate. Detecting and treating the thrombocytopenia causing factors were important to decrease mortality rate. We agreed in this term and want to add that both the degree of thrombocytopenia and its trend should be taken into account in the ICU's.

Williamson et al., investigated thrombocytopenia whether it was useful for prognostication in ICU. They found APACHE-II score, vasoactive drug need, RRT need and low PLT counts were related with increased mortality rate and helpful for physicians to predict prognosis (8).

Vanderschueren et al., examined PLT counts from the ICU admission day to the day of discharge. According to the results they found, both the admission thrombocytopenia and the discharge thrombocytopenia were significant. But, thrombocytopenia at discharge had a deeper association with mortality rate than thrombocytopenia at admission. So, following up PLT counts was found reliable and easy to see the treatment success, too (9).

Cohen et al., stated that thrombocytopenia was merited much more attention than it had now because of its being a leading biomarker of sepsis. In this context, PLT count was suggested to use as a biomarker to determine sepsis early whether at the admission or during the ICU staying. Also, they suggested for its being used to identify severity of illness and prediction of mortality rate (10).

With only a basic blood analysis, we get information about PLT counts, function and activation. PLT parameters -MPV, PDW and PCT, may help physician to diagnose or to observe closely many different diseases in a wide-spectrum way in medicine (11-13).

Tesfay et al., investigated PLT, MPV and PDW levels' effects for preeclampsia. Firstly, they found that they could be used to early detection of preeclampsia with normotensive pregnant women. Secondly, they were also helpful to grade the disease's severity in preeclamptic patients. Finally, they emphasized that using PLT, MPV and PDW levels created an economic, reliable and quick method in pregnant women (14).

Mese et al., researched MPV, PDW and PCT to diagnose pulmonary hypertension in children with congenital heart disease. All of them were seen higher in group with pulmonary hypertension than the healthy children group. Then, they separated the group of children with pulmonary hypertension due to congenital heart disease into another two groups to compare, survivors and non-survivors. MPV, PDW and PCT levels were significantly higher in non-survivors group. They finally suggested using MPV, PDW and PCT as a screening test for detecting pulmonary hypertension in children with congenital heart disease. They also emphasized that they were non-invasive, easy and reliable markers for following up the treatment success, too (15).

Orak et al., studied MPV and PDW parameters to find their relation with mortality rate in sepsis patients at emergency department (13). They stated the mortality rate were higher in patients whom had higher levels of MPV and PDW. Whenever thrombocytopenia existed together increased levels of MPV and PDW, mortality rate was found higher in septic patients at emergency department. They recommended adding MPV and PDW levels to scoring systems.

Similarly, Becchi et al., suggested that, MPV could be used as a surrogate of sepsis like thrombocytopenia, too (4).

MPV, PDW and PCT may have also significant roles in ICU's. Efe et al., investigated PLT, MPV, PDW and PCT parameters to find their effect on mortality rate in a mixed type ICU (2). They found negative correlations of PLT and PCT, positive correlations of MPV and PDW with mortality rate at the same time. We found no correlations between PDW and PCT levels with mortality rate. But, PLT and MPV showed similar results as in the aforementioned study. They made a recommendation for adding PLT, MPV, PDW and PCT to ICU scoring systems. We disagree of this context because of the lack of strong evidences. We need more studies focusing on these parameters and determine their exact cut-off levels to form a new ICU scoring system before making a recommendation.

Sezgi et al., in a respiratory ICU, observed PLT, MPV, PDW and PCT levels' changings (3). They compared laboratory results of two groups, survivors and non-survivors. They obtained lesser levels for PLT and PCT levels and in the opposite, higher levels of MPV and PDW levels in non-survivors. They concluded these parameters could help physician to make prognostication in respiratory ICUs. We similarly think that PLT and associated parameters could give an intensive instant look and help for planning management strategy.

There were several limitations in our study. First of all, this study was settled as a retrospective investigation. Second, the study group was relevantly small. And lastly, we didn't make a comparison between admission and discharge levels of these parameters. Following up the the trends of the PLT and associated parameters would be beneficial to select the accurate cut-off values for predicting mortality rate and adding them in scoring systems.

CONCLUSION

As lungs having an important role on thromboctye's lifetime, both PLT and MPV levels may be useful to predict mortality rate in respiratory ICU's. They may be not just numbers but, biomarkers of survival rate.

Competing interests: The authors declare that they have no competing interest.

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