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Can Mean Platelet Volume and Platelet Distribution Width Predict Readmissions Within 24 Hours to Emergency Department?

Ortalama Trombosit Hacmi ve Trombosit Dağılım Genişliği Acil Servise Son 24 Saat İçinde Başvuruyu Öngörebilir mi?

Ismail Tayfur[1*], Ramazan Güven[2]

[1]Sağlık Bilimleri Üniversitesi, Haydarpaşa Numune Suam, Acil Tıp Kliniği, İstanbul.
[2]Sağlık Bilimleri Üniversitesi, Kanuni Sultan Süleyman Suam, Acil Tıp Kliniği, İstanbul

ABSTRACT

Objective: In this study; we aimed to investigate the relationship between Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) values obtained from the initial hemogram of the patients admitted to the emergency department with the re-admission rate to the emergency department within the first 24 hours after discharge.
Materials and Methods: This retrospective case-control study was conducted with patients who presented to the emergency service over one-year period. The patients were divided into two groups: The first group consisted of patients who, after presenting to the emergency department and being discharged, were readmitted to the same service within the first 24 hours, the second group comprised of those who were not re-admitted to the emergency department within this period. Statistical analysis was performed between the groups and the ability of these parameters to predict re-admission. A p value of <0.05 was considered statistically significant.
Results: The study was carried out with 614 patients: 216 patients in the readmission group and 398 patients in the control group. When the differences between the groups in terms of hemogram parameters were examined, it was determined that MPV and PDW were higher in the readmission group compared to the control group. The multivariate regression analysis revealed that MPV and PDW were significant predictors of readmission cases. According to the ROC curve analysis, MPV had 90.2% sensitivity and 22.5% specificity while for PDW, these values were 20% and 77.0%.
Conclusion: It was concluded that MPV and PDW could be guiding parameters in predicting cases of emergency department readmission within 24 hours of discharge.

Key Words: Patient readmission, mean platelet volume, platelet distribution width, platelets

ÖZET

Giriş: Çalışmamızda; acil servise başvuran hastaların ilk başvuruda alınan hemogramından elde edilen Ortalama Trombosit Hacmi (MPV) ve Trombosit Dağılım Genişliği (PDW) değerlerinin, hasta taburcu olduktan sonraki ilk 24 saat içerisinde acil servise tekrar başvuru oranı ile ilişkisini incelemeyi amaçladık.
Gereç ve Yöntem: Retrospektif, vaka-kontrol çalışması olarak dizayn edilen bu çalışma, 1 yıllık süre içerisinde acil servise başvuran hastalarla yapıldı. Hastalar iki gruba ayrıldı. Birinci grupta acil servise başvurup taburcu edildikten sonra 24 saat içerisinde acil servise tekrar başvuranlar (readmission grubu), ikinci grupta ise acil servise başvurup taburcu edildikten sonra 24 saat içerisinde tekrar başvurusu olmayan (kontrol grubu) hastalar değerlendirildi. Hemogram parametrelerinin gruplar arası farklılık düzeylerine ve bu parametrelerin readmissionu öngörme düzeyine göre istatistiksel analiz yapıldı. P<0.05 istatistiksel olarak anlamlı kabul edildi.
Bulgular: Çalışma, readmission grubunda 216 hasta ve kontrol grubunda 398 hastadan oluşan 614 vaka ile yapıldı. Hemogram parametrelerinin grupları arası farklılık düzeyleri incelendiğinde; MPV ve PDW'nin, readmission grubunda kontrol grubuna göre yüksek anlamlılık düzeyinde daha yüksek değerlerde olduğu görüldü (sırasıyla 9.00 fL versus 8.60 fL; p<0.001, 16.3 % versus 15.00 %; p<0.001). Yapılan çok değişkenli regresyon analizi sonucunda readmission hastalarını öngörmede MPV ve PDW'nin anlamlı prediktörler olduğu bulundu (Sırasıyla; OR:2.836; 95% CI 1.898-4.239; p<0.001, OR:0.824; 95% CI 0.708-0.960; p=0.013). ROC curve analizinde MPV için cut-off 8.05 fL alındığında sensitivitenin % 90.2, spesifitenin %22.5 olduğu, PDW için cut-off 16.95 fL alındığında sensitivitenin %20, spesifitenin % 77.0 olduğu görüldü.
Sonuç: Acil servisten taburcu olan hastalardan, 24 saat içerisinde acil servise tekrar başvuranları öngörmede MPV ve PDW'nin yol gösterici olabileceği sonucuna varıldı.

Anahtar Kelimeler: Acil servise tekrar başvuru, Ortalama Trombosit Hacmi, Trombosit Dağılım Genişliği

***Sorumlu Yazar:** İsmail Tayfur, University of Health Sciences, Haydarpaşa Numune Training and Research Hospital, Department of Emergency Medicine. Tıbbiye Street, Üsküdar/İstanbul
E-mail: ismail.tayfur@sbu.edu.tr, ismailtayfur@yahoo.com, Phone: +90 (532) 711 87 56
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Introduction

Today, one of the most important problems of the health system in the world is unplanned readmissions. Almost all of these readmissions are to emergency department, and the majority of patients present with a serious clinical picture. Emergency readmissions causes loss of workforce, time, money, and resources, but even more importantly, they involve mortality and morbidity due to an overlooked diagnosis at the initial presentation. It is known that unplanned readmission cases generally consist of elderly patients and those with underlying diseases (1,2). Having a low socioeconomic status and a history of readmission are considered as risk factors (3,4). In addition to the investigation of these risk factors, researchers have also explored whether hemogram parameters, such as platelet, MPV and PDW can predict readmission. However, these studies have been mostly performed with certain patient groups by areas of specialization other than the emergency department; e.g., cardiology, chest diseases, and surgery.

MPV is a measure of the mean platelet size and is considered to be an indicator of platelets and platelet activation. PDW is a measure of platelet anisocytosis calculated based on the distribution of the platelet volume (5). In addition to its important roles in hemostasis and thrombosis, platelets contribute to the inflammatory process (6); therefore, PDW can be used as a marker of activated thrombocytes released in some inflammatory diseases. The level of PDW varies under certain medical conditions compared to healthy individuals (7).

Unplanned emergency department readmissions can reduce both the mortality and morbidity of patients and play an important role in preventing waste of resources. To date, studies on emergency department readmission focused on analyzing patient behavior, diseases, and risk factors that caused the readmission, and reducing the rate of readmissions by eliminating these risk factors. In the current study, we investigated the MPV and PDW values obtained from the patients at the time of the initial presentation to the emergency department, to evaluate the relationship between these parameters and the patients' rate of emergency department readmission within the first 24 hours after discharge.

Materials and Methods

The study had a single-center, retrospective, case-control design. The study was performed in compliance with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects and because it is retrospective nature, we did not receive approval from the ethics committee.

The state hospital where the study was conducted is the only hospital in the province with a daily emergency presentation of over 700 patients. We conducted the study with patients who presented to the emergency service of this hospital in a one-year period. The patients were examined in two groups: the first group (readmission group) consisted of patients who, after presenting to the emergency department and being discharged, were readmitted to the same service within 24 hours, and the second group (control group) comprised of those who were not readmitted to the emergency department within this period. Other inclusion criteria were being over 18 years of age and having undergone hemogram analysis.

Excluded from the study were patients that were hospitalized, those that were not discharged within 24 hours at initial presentation, those with missing medical data, those referred to the emergency service from another health center, and those that left the hospital without being officially discharged.

The sample size calculation was based on our pilot study. The emergency department of our hospital had an average of 200 emergency department readmissions within 24 hours of discharge annually and 217 such cases in the previous year. One of the 217 cases was excluded from the study since the patient had been referred from another health center.

For the control group, 400 patients were initially planned and 398 were included in the study. One of the two excluded patients had missing data in the medical file and the other had been referred to our emergency department from another center. To form the control group, the total number of emergency department presentations within the previous year was calculated (244.258). Then, starting from the first patient that presented to the emergency department on the first day of the data collection period, every 600^{th} patient was included in the control group. If one of these patients coincided with a readmission case, the first consecutive patient was included in the control group. The data were obtained anonymously from the hospital automation system in compliance with the rules of patient privacy.

Statistical Methods: Continuous and categorical variables were represented with standard derivations and percentages, respectively. Differences between continuous and categorical variables were analyzed using the t-test and x2 test, respectively.

Logistic regression analysis was undertaken using the enter method and including just statistically significant unrelated parameters in univariate analyses. We

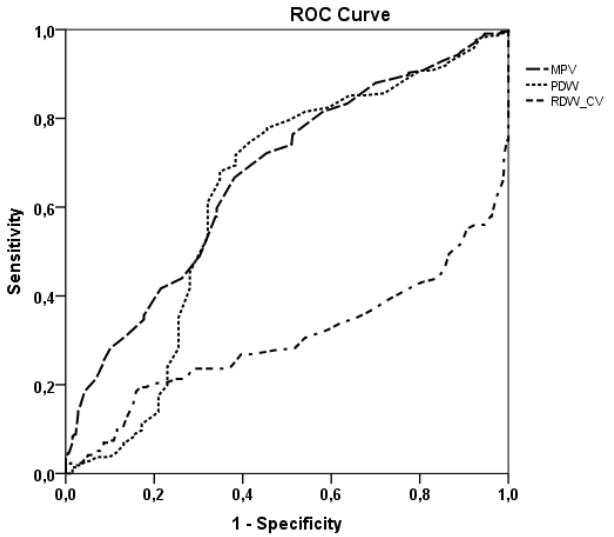

Fig. 1. The ROC curve analyses of hematologic variables for the prediction of emergency readmission within 24 hours

measured the prognostic performance of the hematologic inflammatory variables using receiver operating characteristic curves and calculated sensitivity, specificity, positive and negative likelihood ratios using different cut-off values. All statistical procedures were performed with SPSS 25.0 (SPSS Inc, Chicago, Illinois). P <0.05 was considered significant.

Results

Of the 614 patients enrolled in the study, 216 were in the readmission group and 398 were in the control group. In the readmission group, 54.6% of the patients (n = 118) were female and 45.4% (n = 98) were male, and the median (quartile) age was 39.0 (29.0-53.0) years. In the control group, % 54.8% of the cases (n = 218) were female and 45.2% (n = 180) were male with a median (quartile) age of 39.0 (25.0-58.2) years. The diagnoses causing readmission in order of frequency were determined as cardiovascular-respiratory system diseases in 27.8% (n = 60), surgical gastrointestinal problems in 24.0% (n = 52), internal gastrointestinal problems in 16.20% (n = 35), otorhinolaryngologic conditions in 8.33% (n = 18), neurological disorders in 6.5% (n = 14), psychiatric disorders in 5.6% (n = 12), genitourinary system diseases in 5.10% (n = 11), musculoskeletal system problems in 4.16% (n = 9), and other diagnoses in 2.31% (n = 5).

The differences in the hemogram parameters between the groups are shown in Table 1. According to the results, the readmission group had significantly higher levels of white blood cells (WBC) (9.55 x 103/µL versus 8.15 x 103/µL; p < 0.001), neutrophils (5.94 x103/µL vs 4.89 x103/µL; p < 0.001), monocytes (0.69 x103/µL vs 0.60 x103/µL; p = 0.001), basophils (0.9 x103/µL vs 0.5 x103/µL; p < 0.001), MPV (9.00 fL vs 8.60 fL; p < 0.001) and PDW (16.3% vs 15.00%; p < 0.001) and a significantly lower level of red cell distribution width (RDW) (13.60% vs 15.00%; p < 0.001) compared to the control group.

Table 2 presents the results of the univariate and multivariate logistic regression analyses for the determination of independent risk factors of the readmission group (age, gender, and complaints of patients according to the related systems, MPV, PDW, and RDW). The univariate regression analysis revealed that the MPV, PDW and RDW parameters were significant predictors of readmission (p < 0.001, p < 0.001 and p < 0.001, respectively). In the multivariate logistic regression analysis of these parameters, significant independent risk factors of readmission were determined as MPV (OR: 2.836; 95% CI 1.898-4.239; p < 0.001) and PDW (OR: 0.824; 95% CI 0.708-0.960; p = 0.013).

Table 3 shows the area under the curve (AUC) values and significance levels for MPV, PDW and RDW according to the ROC curve (Figure 1) for the differentiation of readmission and control group patients. MPV had a sensitivity of 90.2% and specificity of 22.5% at a cut-off value of 8.05 fL (AUC: 0.672, 95% CI: 0.63-0.72) and 67.0% and 61.9%, respectively at a cut-off value of 8.75 fL. For PDW, the sensitivity and specificity values were % 72.1% and 61.6%, respectively at a cut-off value of 15.55 fL (AUC: 0.629, 95% CI: 0.58-0.67), and 20% and 77.0%, respectively at a cut-off value of 16.95 fL (Table 4).

Discussion

In addition to the overcrowding of emergency departments being an important problem that needs to be resolved, the current study confirms that discharging patients who need to be hospitalized or those who need to be followed up for a longer period bring serious problems, such as unplanned readmissions and increased mortality and morbidity (8). In this study, readmissions within 24 hours constituted 0.8% of all emergency service presentations, and 31.48% of these patients were referred to other services for hospitalization after readmission. Considering that in Turkey, the rate of hospitalization after a referral from the emergency department is only 12% for initial presentations, there seems to be a more severe clinical picture and a much higher hospitalization rate for readmission cases (9).

Table 1. Comparison of the hematologic variables between the readmission and control groups

Characteristic	Control (n=398) Median (IQR)	Readmission (n=215) Median (IQR)	P value
White Blood Cell (x103/µL)	8.15 (3.4)	9.55 (4.8)	<0.001
Neutrophil (x103/µL)	4.89 (3.4)	5.94 (4.2)	<0.001
Lymphocyte (x103/µL)	1.72 (1.1)	1.80 (1.4)	0.091
Monocyte (x103/µL)	0.60 (0.3)	0.69 (0.4)	0.001
Basophil (x103/µL)	0.9 (0.8)	0.5 (0.6)	0.001
Eosinophil (x103/µL)	0.13 (0.1)	0.14 (0.1)	0.735
Red blood cell (x106/µL)	4.63 (0.7)	4.62 (0.5)	0.857
Hemoglobin (g/dl)	13.24 (2.2)	13.66 (2.2)	0.074
Hematocrit (%)	41.30 (6.3)	40.95 (6.0)	0.235
Mean Corpuscular Volume (fL)	91.00 (8.0)	89.95 (6.4)	0.181
Mean Corpuscular Hemoglobin (pg)	29.32 (2.9)	29.65 (3.2)	0.312
Platelet (x103/µL)	275.00 (96.0)	267.50 (102.5)	0.244
Mean Platelet Volume (fL)	8.60 (1.1)	9.00 (1.3)	<0.001
Red Cell Distribution Width (fL)	14.80 (1.9)	13.60 (2.7)	<0.001
Platelet Distribution Width	15.00 (3.3)	16.30 (1.5)	<0.001

Table 2. The results of logistic regression analysis comparing the readmission and control groups

Variables	Univariate analysis			Multivariate analysis		
Total(n = 110)	OR	95% CI	P	OR	95% CI	P
Gender (female vs male)	0.994	0.713-1.387	0.973			
Complaints*	0.988	0.936-1.044	0.674			
Age	1.000	0.992-1.009	0.943			
MPV	1.888	1.554-2.294	< 0.0001	2.836	1.898-4.239	< 0.0001
PDW	1.143	1.061-1.230	< 0.0001	0.824	0.708-0.960	0.013
RDW	0.787	0.718-0.864	< 0.0001	0.927	0.837-1.027	0.147

(RDW: Red cell distribution width, PDW: Platelet distribution width, CI: confidence interval; OR: odds ratio)
*Complaints of patients according to the related systems

Studies related to readmission have investigated its relationship with age and underlying diseases. Hocagil et al. (10) examined the effects of factors related to the disease, patient, doctor and hospital management system on readmission within 72 hours and reported that readmissions were caused by these factors at the rates of 60.4%, 12.1%, 20%, and 7.5%, respectively. These factors were identified from retrospectively scanned patient files and phone surveys conducted with readmitted cases. In our study, we used laboratory parameters to obtain more objective data than Hocagil et al. (10).

To date, research on the predictive ability of laboratory parameters for readmission has mostly focused on pulmonary and cardiovascular cases. For example, Aksoy et al. (11) divided eosinophilic and non-eosinophilic Chronic Obstructive Pulmonary Disease (COPD) patients into two groups depending on whether or not they were readmitted to the hospital within 28 days and investigated the level of differences in the hemogram parameters between the groups. According to their results, leukocyte count, neutrophil/lymphocyte ratio, Platelet/MPV ratio and were C-Reactive Protein significantly higher in the readmission group while MPV did not significantly differ between the groups.

Unlike the current study, the authors only examined the patients with stable COPD presenting to the outpatient clinic. In contrast, in our study, a significant portion of the readmission group consisted of patients that presented to the emergency department with respiratory arrest. This may also be the reason why our MPV value was significantly higher in the readmission group compared to the control group, unlike the findings of Aksoy et al. (11) since MPV is known to increase and decrease rapidly.

Table 3. The ROC curve analysis of the hematologic variables for the prediction of emergency department readmission within 24 hours

Variable	AUC	95% CI	SE	P
MPV	0.672	0.63-0.72	0.023	<0.0001
PDW	0.629	0.58-0.67	0.023	<0.0001
RDW	0.301	0.25-0.35	0.025	<0.0001

(PDW: Platelet distribution width, RDW: Red cell distribution width, AUC: Area under the curve, CI: Confidence interval, SE: Standard error)

Table 4. The sensitivity and specificity of MPV and PDW at different cut-off values

Cut off	Sensitivity (%)	Specificity (%)	+LR	-LR
MPV (fL)				
8.05	90.2	22.5	1.16	0.43
8.75	67.0	61.9	1.76	0.53
PDW (fL)				
15.55	72.1	61.6	1.88	0.45
16.95	20.0	77.0	0.87	1.04

(MPV: Mean platelet volume, PDW: Platelet distribution width, +LR: Positive likely hood ratio, -LR: Negative likely hood ratio)

Varol et al. (12), who followed up 258 patients with coronary artery ectasia for one to 78 months, reported that 24% of these patients (n = 63) developed a major adverse cardiac event and this patient group had a significantly higher MPV value compared to the patients that did not develop a major adverse cardiac event. This finding indicated the prognostic value of MPV for major adverse cardiac events in patients with coronary artery ectasia. In the group that had a major adverse cardiac event, cardiac death was seen in four of the 63 patients, rehospitalization in 14 patients, and readmission in 45 patients. The authors concluded that the patients with an MPV of > 9 fL had a significantly higher rate of readmission due to a major adverse cardiac event. In the current study, in which we used MPV as one of the predictive laboratory parameters for readmission, we calculated the sensitivity of MPV as 90.2% at a cut-off value of 8.75 fL, which is very similar to the value reported in the study by Varol et al.

To the best of our knowledge, the current study that has examined emergency department early period readmissions is the first of its kind. Based on the results, we conclude that MPV and PDW can be evaluated before patient discharge from the emergency department to predict readmission. This will allow the early diagnosis and treatment of the patient and timely hospitalization, which will, in turn, increase patient satisfaction and reduce healthcare costs and overcrowding of the emergency department due to readmission.

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