ORIGINAL RESEARCH

DOI: 10.4274/globecc.galenos.2023.00719
Glob Emerg Crit Care 2023;2(1):1-7

Relationship Between Hematological Parameters and Mortality in Patients with Acute PTE

Adem Melekoğlu[1], Seda Özkan[2], Derya Öztürk[1]

[1]University of Health Sciences Turkey, Şişli Hamidiye Etfal Training and Research Hospital, Clinic of Emergency Medicine, İstanbul, Turkey
[2]İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, Department of Emergency Medicine, İstanbul, Turkey

Abstract

Objective: Acute pulmonary thromboembolism (APE) is one of the cardiopulmonary diseases that are frequently seen in emergency departments and have a high mortality rate. In this study, we investigated the relationship between hematological parameters, risk scores, clinical-radiological findings, and mortality with a definite diagnosis of APE in our emergency department.

Materials and Methods: Patients who were diagnosed with definitive PE by computed tomography pulmonary angiography in the emergency department of our hospital between May 2016 and May 2021 were analyzed retrospectively. The relationship between hematological parameters and mortality in these patients was investigated. SPSS 22.0 for the Windows program was used for statistical analysis.

Results: Two hundred and fifty nine patients were included in the study. Thirty-day mortality occurred in 20% of 259 patients. The mean age of the patients was 66.8. Female patients (54%) were more than the number of males. The most common risk factor was venous thromboembolism in the lower extremities, which was detected in 38.6% of the patients. Neutrophil-to-lymphocyte ratio (NLR) and red blood cell distribution width levels, which are among the hematological parameters of the patients, were associated with mortality (p=0.001). Receiver operating characteristic analysis of NLR for mortality revealed a cut-off value of >4.

Conclusion: NLR is associated with mortality in APE. We also determined that NLR, which is an inexpensive and easy test, is a predictive parameter for mortality. It may be useful to use hematological parameters together with other scorings in determining the prognosis in APE.

Keywords: Acute pulmonary thromboembolism, neutrophil to lymphocyte ratio, pulmonary embolism severity index

Introduction

Acute pulmonary embolism (APE) is a serious cardiovascular disease with high morbidity and mortality rates. It has been reported that APE is one of the most common causes of sudden death in hospital, and the annual incidence rates of PE are 39-115 cases per 100,000 people [1].

The prognostic importance of several clinical and laboratory variables has been established in patients with APE [2,3]. Additionally, elevated levels of biochemical markers such as troponin, brain natriuretic peptide (BNP), N-terminal pro-B type BNP (NT-proBNP), heart type fatty acid binding protein (H-FABP), myoglobin, and white blood cell (WBC) count predict adverse events in APE [4]. Immediate initiation of anticoagulation and/or thrombolytic therapy is vital to decreasing patient mortality and morbidity rates. Laboratory parameters may be used to guide the therapy, particularly in relatively stable patients [5].

Inflammation plays an important role in venous thromboembolism, and in a meta-analysis, it was observed that monocyte chemotactic proteins were involved in the disease's pathogenesis. Recently, neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) have been proposed as better inflammatory indicators than WBC count [6]. NLR and PLR are inflammatory and immunologic-based ratios identified as prognostic indicators of cancer or cardiac -related mortality

Address for Correspondence: Derya Öztürk, University of Health Sciences Turkey, Şişli Hamidiye Etfal Training and Research Hospital, Clinic of Emergency Medicine, İstanbul, Turkey
Phone: +90 212 373 50 00 **E-mail:** drderyaozturk@yahoo.com **ORCID-ID:** orcid.org/0000-0001-7318-0725
Received: 28.01.2023 **Accepted:** 29.03.2023

[6]. Recent studies have shown the potential prognostic role of NLR and PLR in patients with APE [6]. However, the current view on the prognostic role of NLR and PLR in PE is still controversial due to the different results between studies [6].

In the latest European Respiratory Society APE Guideline (2019), high laboratory values (such as lactate, urea, creatinine) have been reported to be associated with mortality [7]. Recent studies have shown that red cell distribution width (RDW) is associated with the prediction, severity, and prognosis of pulmonary embolism [8]. RDW is an indicator of variability in red blood cell size and is routinely reported as part of a patient's completea blood count. The biomolecular mechanism underlying the association between RDW and APE is largely unknown, but is thought to result from the association of RDW with acute inflammatory markers and variations in blood viscosity [8].

In this study, we investigated the relationship between hematological parameters (NLR, PLR, and RDW), risk scores, clinical-radiological findings, right ventricular (RV) failure, and mortality in 259 patients with a definite diagnosis of APE in our emergency department.

Materials and Methods

This study was planned in accordance the Declaration of Helsinki and the recommendations of our hospital Ethics Committee. After obtaining approval from the Ethics Committee of Dışkapı Yıldırım Beyazıt Training and Research Hospital (date: 26.10.2015, decision no: 26/04), our patients began to be recruited retrospectively. Patient data were obtained from the electronic files of the patients. Patients with missing data were excluded from the study.

Our hospital is a busy hospital that provides tertiary healthcare services and has approximately 270,000 admissions to the emergency department annually. A total of 259 patients who were diagnosed with PE by only computed tomography (CT) pulmonary angiography were included in the study to create a homogeneous universe among the patients who were admitted to the emergency department of our hospital between May 2016 and May 2021.

Patients with suspected APE are classified in the emergency department using the Wells' and Geneva risk classification [9]. Pulmonary CT angiography screening is promptly performed in patients with low clinical risk, patients with D-dimer levels >500 µg/L, and patients with high-risk scores. The original pulmonary embolism severity index (PESI) is calculated (age, male gender, cancer, chronic heart failure, chronic lung disease, pulse rate, systolic blood pressure, respiratory rate, temperature, altered mental status, arterial oxyhemoglobin saturation), as well as the risk classification of patients diagnosed with PTE, and classified as class I-V [10]. Electrocardiograms (ECG) of the patients were evaluated by an emergency specialist and cardiologist. The data obtained were recorded by us in the electronic file of the patients.

Venous blood was collected from the antecubital region of the patients and transferred to the laboratory for evaluation of hematological parameters. WBC, hemoglobin (Hgb), hematocrit, Plt, mean platelet volume, RDW, NLR, PLR, D-dimer, troponin-I, CK-MB, and lactate levels were determined and recorded.

The patients were evaluated with echocardiogram (ECHO) measurements by an experienced cardiologist. In ECHO, RV dimensions were measured at diastole from the apical four -chamber view at diastole at the level of the middle of the ventricle. RV enlargement was defined as a RV size bigger than 3.3 cm. Systolic pulmonary artery pressure was calculated by adding the trans tricuspid pressure gradient to the mean right atrial pressure calculated from the diameter of the inferior vena cava and movement during breathing [11].

In the radiology clinic, we performed multislice spiral pulmonary tomography using the pulmonary embolism protocol (field of view: 35 cm, section thickness: 4 mm, contrast material volume: 100 mL with contrast medium (injection rate: 4 mL/sec) using Siemens brand tomography device. APE was diagnosed in case of complete or partial lumen filling defect in the main pulmonary artery or its distal branches. The diagnosis of deep vein thrombosis was made by an experienced radiologist after performing lower extremity venous Doppler ultrasonography.

Patients diagnosed with APE were administered with 1 mg/kg enoxaparin, and 47 patients (19%) who were at clinically high risk were administered with 100 mg/2 h infusion of alteplase (recombinant tissue-type plasminogen activator) treatment. Patients who were admitted to the service or intensive care unit (ICU) according to their clinical status were scanned 30 days later in terms of early mortality from the hospital electronic data registry system and their data were recorded.

Exclusion criteria:

- Patients with active malignancy, history of use of immunosuppressive agents, and anemia (Hgb <10.5),
- Patients were diagnosed with acute coronary artery disease in the last month,
- Patients with septic disease at the time of diagnosis of embolism and other inflammatory diseases that may cause inflammation,
- Patients under the age of 18 and pregnant patients,
- Patients were referred to other hospitals for different reasons,

Statistical analysis was performed by including 259 patients who did not meet the exclusion criteria and had filling defects observed in CT pulmonary angiography.

Statistical Analysis

The SPSS 22.0 for Windows (IBM, USA) program was used for statistical analysis. Descriptive statistics of the results were indicated as numbers and ratio for categorical variables, and mean, standard deviation, and minimum, and maximum for numerical variables. Comparisons of numerical variables between the two independent groups were compared with the Student's t-test in case the data were normally distributed, or using the Mann-Whitney U test. The relationships between numerical variables in the groups were examined by Pearson's correlation coefficient when the parametric test condition was met, or else, by Spearman's correlation coefficient. The comparison of the ratios in the groups was evaluated by chi-square test. In the comparison of three or more independent groups, the One-Way ANOVA test in the cases of parametric test conditions were met, or else, Kruskal-Wallis test was used. Variables that were statistically significant were evaluated with multivariate logistic regression analysis. MedCalc (version 20.009) was used in the receiver operating characteristic (ROC) analysis of the variables related to mortality. A p value lower than 0.05 was considered as statistically significant.

Results

Patients who were admitted to the emergency department between May 2016 and May 2021 and were diagnosed with APE on pulmonary CT angiography were included in the study. The data of 259 (female: 54%-male: 46%) patients who were followed-up after hospitalization in the ward or ICU were analyzed in terms of mortality within 30 days (20%) and survival (80%).

The mean age of all patients was 66.8 years, and in the patients with mortality, the mean age was 75.8 years (p=0.001; Table 1). The most common complaints of patients presenting to the emergency department were dyspnea and chest pain, followed by the unilateral increase in diameter in the lower extremity, pain, and tachycardia. Among the vital signs of the patients, systolic and diastolic blood pressures were lower in the patients with mortality, whereas heart rate and respiratory rate were higher (Table 2).

When the risk factors for APE were examined, venous thromboembolism in the lower extremities was detected in 38.6% of the patients. This risk factor was followed by immobilization, which was present in 73 patients. Among the risk factors, only malignancy (18.9%) was significantly associated with mortality (p=0.008). The most common chronic disease detected in both groups was hypertension, which was significantly associated with mortality (p=0.036). The history of coronary artery disease (21.6%) was the second most common chronic disease in all the groups (Table 1).

When the ECGs of the patients were analyzed, sinus tachycardia was the most common pattern (40.9%) in all patients. Sinus tachycardia was followed by T-wave inversion and atrial fibrillation in V1-3, respectively, were other common rhythms and they were not significantly associated with mortality.

ECHO findings showed enlargement of the right atrium and ventricle in 152 (58.7%) patients. Findings of RV failure in ECHO were associated with mortality (p=0.042). The mean pulmonary artery systolic pressure of all patients was measured as 50.3 mmHg and was higher in patients with mortality (56.73 mm/hg) (p=0.001). Considering the indications and contraindications of the patients, thrombolytic therapy was given to 47 of them. Early mortality developed in eight patients who received thrombolytic therapy.

When the laboratory findings of the patients were examined, NLR was higher in patients with mortality and those who survived (p=0.001). Similarly, blood urea, WBC, and RDW were higher in patients with mortality (p=0.001). High lactate level was associated with mortality (p=0.001).

Patients were grouped according to the PESI classification. In the analysis performed with Kruskal-Wallis test, more mortality was seen in the group with a high PESI class (p=0.001). While no mortality was observed in the class I patient group, 39 died patients (75%) were in class V (Table 3).

NLR and other risk factors, which differed significantly for mortality in univariate analysis, were also analyzed by multivariate logistic regression analysis. Among all variables, we found that only NLR was significantly associated with mortality [p=0.023, odds ratio: 0.245, 95% confidence interval (CI): 1.034-1.577] (Table 4).

ROC curve analysis revealed that NLR is a moderate-to-high predictor of mortality [area under the curve (AUC): 0.718; 95% CI:0.659-0.772; p=0.001; Figure 1]. Cut-off value in ROC analysis of NLR for mortality >4.

Discussion

In addition to aggravating conditions, comorbidities, clinical, and imaging, laboratory findings must assess the overall risk of mortality and early outcomes of a patient directly related to the severity of APE and premature death associated with APE. RV overload due to the APE is associated with increased myocardial tension releasing BNP, NT-pro BNP, and cardiac troponins and premature death [12].

In addition to these laboratory parameters, the measurement of NLR is an inexpensive and simple test, and NLR has been reported to be an independent variable associated with mortality in inflammatory diseases [13]. In the recent studies,

NLR, whose relationship with mortality has been investigated in many inflammatory diseases recently, has been suggested to be associated with mortality in APE [6]. Our primary finding in this study was that in the patients with or without comorbidity, inflammation markers such as NLR, PLR, RDW, impaired vital signs, and high PESI score were associated with mortality. We also determined that NLR, which is an inexpensive and easy test, is a predictive parameter for mortality.

In the study by Celik et al. [14], they determined that NLR, PLR, and RDW could be diagnostic markers in APE. In our study, NLR, PLR, and RDW values, which are associated with increased inflammation from hematological parameters, were associated with mortality in univariate analysis, similar to the results obtained in a study involving 203 patients [15]. These studies showed the prognostic importance of inflammatory markers in terms of diagnosis and mortality. APE is already a life-threatening cardiopulmonary disease. Additionally, if inflammatory markers are high, even in stable patients, treatment may be more aggressive.

Among these hematological parameters that increased due to inflammation, which were significantly associated with mortality in univariate analysis, only NLR showed a significant difference in mortality in multivariate regression analysis. This makes NLR more prominent than other inflammation markers in APE.

ROC analysis revealed that NLR is a moderate-to-high predictor of mortality with a cut-off value of >4. We found the sensitivity

Table 1. Comparison of demographic characteristics and risk factors in study groups

	Dead (52) n (%)	**Survive (207) n (%)**	**Total (259) n (%)**	**p**
Age (mean ± SD)	75.85±11.66	64.54±16.3	66.8±16.1	**0.001***
Sex (female)	24 (46.2)	117 (56.5)	141 (54.4)	0.180$^{\chi 2}$
Complaints**				
Dyspnea	47 (90.4)	176 (85)	223 (86.1)	0.438$^{\chi 2}$
Chest pain	18 (34.6)	94 (45.4)	112 (43.2)	0.212$^{\chi 2}$
Syncope	8 (15.4)	27 (13)	35 (13.5)	0.830$^{\chi 2}$
Palpitation	13 (25)	28 (13.5)	41 (15.8)	0.070$^{\chi 2}$
Pain-swelling in the leg	6 (11.5)	39 (18.8)	45 (17.4)	0.299$^{\chi 2}$
Risk factors**				
Active DVT	14 (26.9)	86 (41.5)	100 (38.6)	0.076$^{\chi 2}$
Prior surgery	4 (7.7)	38 (18.4)	42 (16.2)	0.09$^{\chi 2}$
Malignancy	17 (32.7)	32 (15.5)	49 (18.9)	**0.008$^{\chi 2}$**
Immobilization	16 (30.8)	57 (27.5)	73 (27.2)	0.771$^{\chi 2}$
Comorbidity**				
CVD	5 (9.6)	9 (4.3)	14 (5.4)	0.247$^{\chi 2}$
HT	30 (57.7)	86 (41.5)	116 (44.8)	**0.036$^{\chi 2}$**
DM	9 (17.3)	39 (18.8)	48 (18.5)	0.956$^{\chi 2}$
CAD	15 (28.8)	41 (19.8)	56 (21.6)	0.220$^{\chi 2}$
ECG**				
Sinus tachycardia	24 (46.2)	82 (39.6)	106 (40.9)	0.391$^{\chi 2}$
S1Q3T3	0	10 (4.8)	10 (3.9)	0.102$^{\chi 2}$
T wave inversion in V1-V3	10 (19.2)	42 (20.3)	52 (20.1)	0.865$^{\chi 2}$
Right bundle branch block	10 (19.2)	32 (15.5)	42 (16.2)	0.653$^{\chi 2}$
Atrial fibrillation	14 (26.9)	30 (14.5)	44 (17)	0.054$^{\chi 2}$
Thrombolytic areas	8 (15.4)	39 (18.8)	47 (18.1)	0.706$^{\chi 2}$
Right insufficiency	37 (71.2)	115 (55.6)	152 (58.7)	**0.042$^{\chi 2}$**
sPAP (mean ± SD)	56.73±16.4	48.72±17.83	50.33±17.81	**0.001***
Wells score (mean ± SD)	4.19±2.12	4.44±4.87	4.39±2.19	0.442*
Genova points (mean ± SD)	7.35±3.34	7.05±3.78	7.11±3.69	0.322*

*Mann-Whitney U test, **There may be more than one finding in the same patient, DVT: Deep vein thrombosis, CVD: Cerebrovascular disease, HT: Hypertension, DM: Diabetes mellitus, CAD: Coronary artery disease, sPAP: Systolic pulmonary artery pressure, SD: Standard deviation

Table 2. Comparison of laboratory parameters and vital signs of study groups

	Dead (mean ± SD)	Survive (mean ± SD)	Total (mean ± SD)	p
Vital signs				
Systolic BP	106±21.63	118.17±22.69	115.74±22.96	**0.001***
Diastolic BP	64.60±12.99	72.85±12.52	71.19±13.02	**0.001***
Pulse	111.54±20.86	102.72±19.89	104.5±21.23	**0.007***
Respiratory rate	23.94±5.99	19.94±3.93	20.7±4.81	**0.001***
Fire	36.82±0.47	36.82±0.49	36.82±0.49	0.872*
Hematological parameters				
NLR	8.09±5.28	5.46±5.47	5.99±5.52	**0.001***
PLR	216±169.7	183.2±275.23	189.8±257.59	**0.019***
Neutrophil	10.87±5.63	7.41±3.57	8.1±4.29	**0.001***
Lymphocyte	1.54±0.61	1.88±0.91	1.81±0.87	**0.011***
Platelet	274±169	250±110	255±124	0.750*
RDW	16.52±2.1	15.55±2.37	15.74±2.35	**0.001***
WBC	13591±4944	11059±3729	11567±41119	**0.001***
Troponin I	0.22±0.28	0.28±0.66	0.27±0.6	0.110*
Lactate	2.92±2.01	2.21±1.22	2.35±1.44	**0.005***
Urea	63.8±36.75	45.91±21.3	49.5±26.09	**0.001***
Creatinine	1.08±0.43 (0.39-2.3)	0.99±0.3 (0.43-2.2)	1.01±0.33 (0.39-2.3)	0.292*
pH	7.39±0.098	7.41±0.067	7.41±0.075	0.154*
SO_2	85.18±9.11	88.69±10.71	87.99±10.49	**0.001***
HCO	22.26±4.51	23.16±3.37	22.98±3.64	**0.031***
BE	-1.92±4.47	-0.89±3.3	-0.76±3.45	**0.011***
D-dimer	8650±10963	8146±7693	7438±8394	0.649*

*Mann-Whitney U test, NLR: Neutrophil lymphocyte ratio, PLR: Platelet lymphocyte ratio, RDW: Red cell distribution width, MPV: Mean platelet volume, WBC: White blood cell, SD: Standard deviation

Table 3. Statistical analysis of PESI for mortality

	Dead	Survive	Total	p
PESI	**n (%)**	**n (%)**	**n (%)**	
Class I	0	31 (15)	31 (12)	
Class II	1 (1.9)	36 (17.4)	37 (14.3)	
Class III	2 (3.8)	56 (27.1)	58 (22.4)	**0.001#**
Class IV	10 (19.2)	37 (17.9)	47 (18.1)	
Class V	39 (75)	47 (22.9)	86 (33.2)	

#Kruskal-Wallis test, PESI: Pulmonary embolism severity index

and specificity of the it to be 86.5% and 56%, respectively. In the study conducted to determine the normal NLR level in 413 normal healthy adults, the upper limit of NLR was found to be 3.53 [16]. In a study by Kasapoğlu et al. [17], they found NLR as a moderate predictor of mortality with an AUC value of 0.604. They found the sensitivity and specificity to be 69% and 48%, respectively (cut-off >7.3). In another study conducted on APE patients, the cut-off value was found as 5.99 and the AUC value was found to be 0.792. Studies showed that NLR

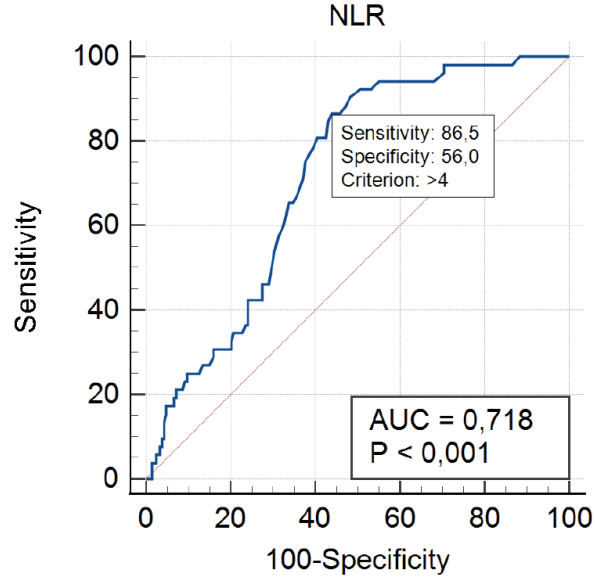

Figure 1. ROC analysis for NLR to detect mortality

ROC: Receiver operating characteristic, NLR: Neutrophil lymphocyte ratio, AUC: Area under the curve

Table 4. Multivariate regression analysis for mortality

	Odds ratio	95% confidence interval Lover-upper	p
sPAP	0.011	0.968-1.011	0.331
Pulse	0.012	0.971-1.006	0.195
Malignancy	2.201	0.919-5.268	0.077
NLR	0.245	1.034-1.577	**0.023**
PLR	0.0001	0.999-1.001	0.435
RDW	0.105	0.764-1.060	0.208
Lactate	0.100	0.683-1.199	0.487
WBC	0.001	1.000-1.000	0.722
Urea	0.015	0.971-1.000	0.044
SO_2	0.033	0.996-1.072	0.079
PCO_2	0.011	0.949-1.029	0.579
HCO_3	0.002	0.920-1.091	0.967
BE	0.064	0.938-1.212	0.329

sPAP: Systolic pulmonary artery pressure, NLR: Neutrophil lymphocyte ratio, PLR: Platelet-to-lymphocyte ratio, RDW: Red cell distribution width, WBC: White blood cell

is a moderate-to-high predictor of mortality with moderate-to-high AUC value [18]. When we compared the cut-off value of our study with these studies, we attributed the low cut-off value in our study was because the mean NLR value in the patient group with mortality and discharged groups was lower than the average the above studies.

Cardiac damage marker troponin I was higher in mortality and survivor groups, but we could not find any difference between them. One study found that mean troponin I levels in APE were higher in the deceased and surviving groups [15]. Troponin I level was higher in the group with RV failure in APE than in the normal group. We also found that RV failure is associated with mortality in APE.

In studies, RDW was found to be high in patients with APE with mortality [19]. In our study, we found the RDW value to be significantly higher in the mortality group. The biomolecular mechanism underlying the association between RDW and APE is largely unknown, but is thought to result from the association of RDW with acute inflammation and changes in blood viscosity [8].

The PESI, consisting of 11 different clinical scorings combining clinical and comorbidity in determining severity in APE, is the most extensively validated classification system to date. The main strength of PESI lies in the reliable identification of patients at low risk for 30-day mortality (PESI classes I and II). In PESI class V, the risk of death rises up to 25% [20,21]. In our study, mortality was observed in one case in PESI classes I and II. In our study, we found that the mean age of the cases with mortality to be higher than the group who survived. The age factor used in PESI scoring explains the higher number of elderly patients and mortality rate in the class IV-V group compared to other studies.

High mortality due to the APE in emergency services led to the generation of different combinations of clinical, laboratory, and imaging in determining prognosis [22,23]. This is associated with increased cost, labor, and time loss. Because of these, cheap, simple, and easy tests are being researched in determining the prognosis in APE. Because it is cost -effective and easy, it may be beneficial to use hematological parameters with other scoring for the determination of prognosis in APE.

Study Limitations

We had some limitations in our study. First, our study was single-centered and the number of cases was limited. Because of the high bed occupancy rate of our hospital, patients diagnosed in the emergency department and referred to other centers were excluded from the study. Additionally, we had to exclude patients whose lower extremity venous Doppler ultrasound could not be performed since we did not have a radiologist in the evenings and on weekends. Moreover, since NT-proBNP and H-FABP were not routinely analyzed in our biochemistry laboratory, we did not have the opportunity to compare these biomarkers with other variables in RV failure.

Conclusion

NLR is a determined hematological parameter associated with mortality in inflammatory diseases. In our study, we found that NLR was a predictive of mortality in patients with APE patients. We believe that the use of NLR, which is easy and inexpensive to measure, by emergency clinicians for the prognosis determination of patients diagnosed with APE in the emergency department will be beneficial.

Ethics

Ethics Committee Approval: Ethics Committee of Dışkapı Yıldırım Beyazıt Training and Research Hospital (date: 26.10.2015, decision no: 26/04).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.M., S.Ö., D.Ö., Concept: A.M., S.Ö., D.Ö., Design: A.M., S.Ö., Data Collection or Processing: S.Ö., D.Ö., Analysis or Interpretation: A.M., S.Ö., Literature Search: A.M., S.Ö., D.Ö., Writing: A.M., S.Ö., D.Ö.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Wendelboe AM, Raskob GE. Global burden of thrombosis: epidemiologic aspects. Circ Res. 2016;118:1340-7.
2. Kucher N, Goldhaber SZ. Cardiac biomarkers for risk stratification of patients with acute pulmonary embolism. Circulation. 2003;108:2191-4.
3. Agnelli G, Becattini C. Acute pulmonary embolism. N Engl J Med. 2010;363:266-74.
4. Konstantinides SV, Torbicki A, Agnelli G, Danchin N, Fitzmaurice D, Galiè N, et al. 2014 ESC guidelines on the diagnosis and management of acute pulmonary embolism. Eur Heart J. 2014;35:3033-69.
5. Donzé J, Le Gal G, Fine MJ, Roy PM, Sanchez O, Verschuren F, et al. Prospective validation of the Pulmonary Embolism Severity Index. A clinical prognostic model for pulmonary embolism. Thromb Haemost. 2008;100:943-8.
6. Wang Q, Ma J, Jiang Z, Ming L. Prognostic value of neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio in acute pulmonary embolism: a systematic review and meta-analysis. Int Angiol. 2018;37:4-11.
7. Kostrubiec M, Pływaczewska M, Jiménez D, Lankeit M, Ciurzynski M, Konstantinides S, et al. The prognostic value of renal function in acute pulmonary embolism-a multi-centre cohort study. Thromb Haemost. 2019;119:140-8.
8. Hammons L, Filopei J, Steiger D, Bondarsky E. A narrative review of red blood cell distribution width as a marker for pulmonary embolism. J Thromb Thrombolysis. 2019;48:638-47.
9. Shen JH, Chen HL, Chen JR, Xing JL, Gu P, Zhu BF. Comparison of the Wells score with the revised Geneva score for assessing suspected pulmonary embolism: a systematic review and meta-analysis. J Thromb Thrombolysis. 2016;41:482-92.
10. Jiménez D, Aujesky D, Moores L, Gómez V, Lobo JL, Uresandi F, et al. Simplification of the pulmonary embolism severity index for prognostication in patients with acute symptomatic pulmonary embolism. Arch Intern Med. 2010;170:1383-9.
11. Jae KOH, James BS, A. Jamil T. Appendix 6 In: The Echo Manual 2009; 3th ed.: 401-15.
12. Konstantinides SV, Meyer G, Becattini C, Bueno H, Geersing GJ, Harjola VP, et al. 2019 ESC Guidelines for the diagnosis and management of acute pulmonary embolism developed in collaboration with the European Respiratory Society (ERS). Eur Heart J. 2020;41:543-603.
13. Azab B, Chainani V, Shah N, McGinn JT. Neutrophil-lymphocyte ratio as a predictor of major adverse cardiac events among diabetic population: a 4-year follow-up study. Angiology. 2013;64:456-65.
14. Celik A, Ozcan IT, Gündes A, Topuz M, Pektas I, Yesil Eet al. Usefulness of admission hematologic parameters as diagnostic tools in acute pulmonary embolism. Kaohsiung J Med Sci. 2015;31:145-9.
15. Karataş MB, İpek G, Onuk T, Güngör B, Durmuş G, Çanga Y, et al. Assessment of prognostic value of neutrophil to lymphocyte ratio and platelet to lymphocyte ratio in patients with pulmonary embolism. Acta Cardiol Sin. 2016;32:313-20.
16. Forget P, Khalifa C, Defour JP, Latinne D, Van Pel MC, De Kock M. What is the normal value of the neutrophil-to-lymphocyte ratio? BMC Res Notes. 2017;10:12.
17. Kasapoğlu US, Olgun Yıldızeli Ş, Arıkan H, Erer A, Kabadayı F, Yalçınkaya E, et al. Comparison of neutrophil to lymphocyte ratio with other prognostic markers affecting 30 day mortality in acute pulmonary embolism. Tuberk Toraks. 2019;67:179-89.
18. Ma Y, Mao Y, He X, Sun Y, Huang S, Qiu J. The values of neutrophil to lymphocyte ratio and platelet to lymphocyte ratio in predicting 30 day mortality in patients with acute pulmonary embolism. BMC Cardiovasc Disord. 2016;16:123.
19. Cha MJ, Lee HS, Kim HM, Jung JH, Choi EK, Oh S. Association between red cell distribution width and thromboembolic events in patients with atrial fibrillation. Eur J Intern Med. 2017;46:41-6.
20. Donzé J, Le Gal G, Fine MJ, Roy PM, Sanchez O, Verschuren F, et al. Prospective validation of the Pulmonary Embolism Severity Index. A clinical prognostic model for pulmonary embolism. Thromb Haemost. 2008;100:943-8.
21. Elias A, Mallett S, Daoud-Elias M, Poggi JN, Clarke M. Prognostic models in acute pulmonary embolism: a systematic review and meta-analysis. BMJ Open. 2016;6:e010324.
22. Hobohm L, Hellenkamp K, Hasenfuß G, Münzel T, Konstantinides S, Lankeit M. Comparison of risk assessment strategies for not-high-risk pulmonary embolism. Eur Respir J. 2016;47:1170-8.
23. Dellas C, Tschepe M, Seeber V, Zwiener I, Kuhnert K, Schäfer K, et al. A novel H-FABP assay and a fast prognostic score for risk assessment of normotensive pulmonary embolism. Thromb Haemost. 2014;111:996-1003.