ORIGINAL ARTICLE

Factors Affecting the Survival Rate of Patients with Pulmonary Thromboembolism

Pulmoner Tromboembolili Hastalarda Sağkalımı Etkileyen Faktörlerin Belirlenmesi

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ABSTRACT

Aim: It is aimed to investigate the factors affecting the survival rate and complications that may arise throughout the treatment process from admission to the end of the 6-month period after discharge, the inpatient treatment of individuals with pulmonary thromboembolism, by monitoring these patients.

Materials and Methods: The study included adult patients who were followed up in the pulmonology clinic between 01.01.2017 and 01.12.2019 and who had at least segmental thrombus on computed tomography pulmonary angiography.

Results: The mean age of 210 patients enrolled into the study was 71.27±13.26 years and 55 (26%) of these patients were male and 155 (74%) of them were female. Pulse rate, Modified Geneva and Wells scores, pulmonary embolism severity index (PESI) and simplified PESI scores of the non-survivors were higher than in the patients who survived. In non-survivors, both red cell distribution width (RDW) and mean corpuscular volume on day 1 and 5, as well as the level of hematocrits were lower. Non-survivors had higher number of platelets but lower levels of total protein and albumin in blood on days 1 and 5. High alkaline phosphatase (ALP), total bilirubin and C-reactive protein (CRP) values on the 1st day were found to be associated with the mortality rate on the 5th day.

Conclusion: In our study, high PESI scores; low levels of hemoglobin, total protein, albumin as checked on day 1 and day 5; high RDW levels, high ALP; WBC, CRP and total bilirubin checked on day 5 remaining high were determined to be associated with mortality.

Keywords: Modified Geneva score, mortality, pulmonary thromboembolism, Wells score

ÖZ

Amaç: Bu çalışmada pulmoner tromboembolizmi olan bireylerin yatarak tedavisi, taburcu olduktan sonraki 6 aylık dönemin sonuna kadar olan tedavi süreci boyunca ortaya çıkabilecek komplikasyonlar ve sağkalım oranını etkileyen faktörlerin araştırılması amaçlanmaktadır.

Gereç ve Yöntem: Çalışmaya 01.01.2017-01.12.2019 tarihleri arasında göğüs hastalıkları kliniğinde izlenen ve bilgisayarlı tomografi pulmoner anjiyografisinde en az segmental seviyede trombüs saptanan yetişkin hastalar dahil edildi.

Bulgular: Çalışmaya alınan 210 hastanın yaş ortalaması 71,27±13,26 yıldı ve bu hastaların 55'i (%26) erkek, 155'i (%74) kadındı. Eksitus olan hastaların nabız hızı, Modifiye Cenevre ve Wells skorları, pulmoner emboli şiddet indeksi (PESI) ve basitleştirilmiş PESI skorları hayatta kalan hastalarınkinden daha yüksekti. Hayatını kaybeden hastalarda 1. ve 5. günlerde hem kırmızı hücre dağılım genişliği (RDW) hem de ortalama korpüsküler hacim ve hematokrit seviyeleri daha düşüktü. Hayatını kaybeden hastalar, 1. ve 5. günlerde daha yüksek sayıda trombosit ancak kanda daha düşük total protein ve albümin seviyelerine sahiplerdi. Birinci günde yüksek olan alkalen fosfataz (ALP), total bilirubin ve C-reaktif protein (CRP) değerlerinin, 5. günde olan ölüm oranı ile ilişkili olduğu saptandı.

Sonuç: Çalışmamızda yüksek PESI skorları 1. gün ve 5. günde düşük seviyelerde izlenen hemoglobin, total protein ve albüminle ilişkiliyken, yüksek seviyelerde izlenen RDW ve ALP ile ilişkiliydi. Beşinci günde yüksek olan beyaz kan hücresi, CRP ve total bilirubinin mortalite ile ilişkili olduğu belirlendi.

Anahtar Kelimeler: Modifiye Cenevre skoru, mortalite, pulmoner tromboembolizm, Wells skoru

INTRODUCTION

Pulmonary thromboembolism (PTE) is a treatable disease with high mortality and morbidity rates, whose diagnosis can sometimes be difficult. Annual incidence is 1/1000 and it increases with age[1,2]. It should be known that common symptoms and physical examination findings such as dyspnea, tachypnea, tachycardia and chest pain in patients with pulmonary embolism are not unique to this disease. Clinical findings can range from an asymptomatic picture to sudden death as a result of a massive attack. Clinical diagnosis is much more difficult and unreliable in trauma or intensive care patients. Sudden onset of dyspnea and tachypnea are the most common symptoms and signs in patients with no previous cardiopulmonary problem in pulmonary embolism. Pleuritic pain with dyspnea and tachypnea is present in more than half of the cases. Hemoptysis is seen in less than 10% of cases. Clinical symptoms and findings may vary depending on the size, number (single/multiple) of the embolism, its location, the development of an infarction, the resolution rate, whether it is recurrent, the age of the patient and the reserve of cardiopulmonary functions[2,3]. Approximately 10% of patients undergoing deep vein thrombosis (DVT) develop PTE afterwards and nearly 10% of these patients lose their lives. Death rates within the first 3 months following the acute incident were determined as 15% in the prospective study on PTE diagnosis (Prospective Investigation of Pulmonary Embolism Diagnosis) and 17.5% in the study on international collection of PTE records (International Cooperative Pulmonary Embolism Registry)[3,4]. PTE is responsible for 5-15% of all hospital deaths. Approximately 2/3 of the patients undergoing or experiencing PTE are not accurately diagnosed and the mortality rates of these patients reach 30%. When PTE is accurately diagnosed and the proper treatment is administered, this rate can decrease to as low as 3%[3]. While hospital mortality increases up to 30% due to undiagnosed PTE, hospital mortality decreases to around 8% in diagnosed cases[4].

In this study, it is aimed to investigate the factors affecting the survival rate and complications that may arise throughout the treatment process from admission to the end of the 6-month period after discharge, the inpatient treatment of individuals with PTE.

MATERIALS AND METHODS

The study was carried out with adult patients being followed up with a diagnosis of pulmonary embolism in two separate pulmonology clinics. A total of 210 patients, including 55 males and 155 females, who had at least segmental thrombus in the pulmonary artery on computed tomography (CT) pulmonary angiography between 01.01.2017 and 01.12.2019 were included in the study.

The study was planned as a retrospective study and the inclusion criteria were the confirmation of the diagnosis with CT angiography, being hospitalized for at least 7 days and surviving this period, having undergone echocardiography (ECHO) and venous Doppler ultrasonography (USG) for DVT, having been reached by phone on the 6-month follow-up and completing outpatient clinic visits. Patients who died within the first 7 days of admission, pregnant women, patients whose follow-ups/analyses in the database were not complete, patients who did not visit the clinic after discharge, and patients on whom CT angiography was not performed due to high levels of creatinine were excluded.

In this period, a total of 290 patients were admitted to the service with PTE diagnosis. Fifteen patients on whom CT angiography was not performed for various reasons, 15 patients, whose ECHO data on admission were inaccessible, 10 patients who died within the first 7 days of admission, 25 patients whose day 1 and 7 laboratory findings were incomplete, and 15 patients who did not attend the follow-up visits and were unavailable when called by phone were not included in the study. The study was conducted with 210 patients who fulfilled all of the criteria (Figure 1).

The demographic characteristics of the cases (age, sex, body mass index, smoking history), comorbidities (chronic obstructive pulmonary disease, bronchiectasis, immunosuppression, diabetes mellitus, hypertension, coronary arterial disease, congestive heart failure, cerebrovascular accident, chronic renal failure, malignancy), risk factors (recent surgical, travel history, obesity, use of oral contraceptives, immobility), duration of admission, costs and mortalities were recorded. Respiratory rate (RR), arterial blood pressure, body temperature, heart rate, consciousness, and % saturation O_2 values obtained from the


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┌─────────────────────────────────────────────┐
│ Patients admitted to the clinic with the     │
│ diagnosis of pulmonary embolism (n=290)      │
└─────────────────────────────────────────────┘
                     ↓
┌─────────────────────────────────────────────┐
│ Exclusion criteria from the study;           │
│ • Patients who cannot undergo computed       │
│   tomography angiography for various         │
│   reasons (n=15)                             │
│ • Patients whose echocardiography data are   │
│   not available (n=15)                       │
│ • Patients who died within the first 7 days  │
│   (n=10)                                      │
│ • Day 1 and day 7 Those who lack laboratory  │
│   data (n=25)                                 │
│ • Those who do not come for control and      │
│   cannot be reached by phone (n=15)           │
│ (n=80)                                        │
└─────────────────────────────────────────────┘
                     ↓
┌─────────────────────────────────────────────┐
│ Patients who meet the inclusion criteria     │
│ (n=210)                                       │
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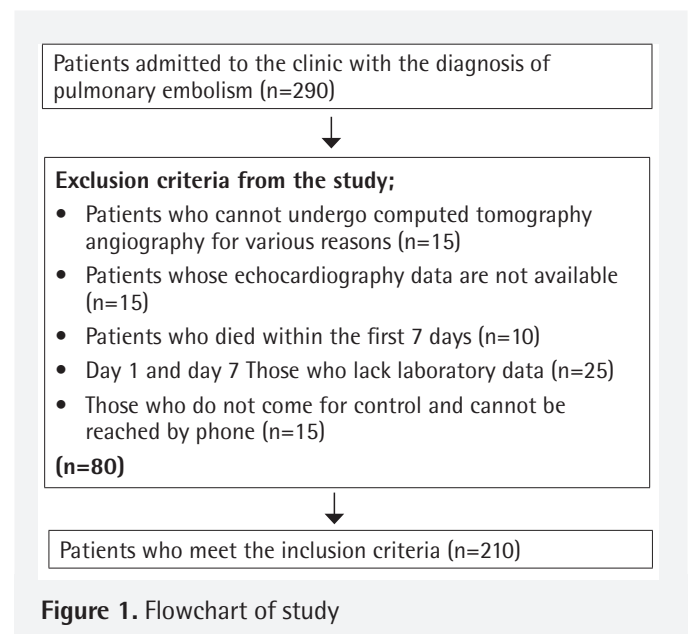
Figure 1. Flowchart of study

findings of the physical examination carried out at admission were included in the data. For cases, on whom ABG analyses were performed, PO_2, pCO_2, % saturation O_2 value and pH results were noted. The findings of the ECHO performed at the emergency unit and on day 7, as well as the results of bilateral lower extremity venous Doppler USG, were noted. % Saturation O_2 levels measured on days 1-6 in room atmosphere with pulse oximetry were recorded. Hemogram, coagulation, troponin, T, D-dimer, C-reactive protein (CRP), sedimentation, fibrinogen and overall biochemistry parameters at the time of arrival to emergency unit and outpatient clinic and on day 1 and 5 of admission were noted. Posteroanterior chest radiography and thorax computerized tomography findings at the time of arrival were noted. Wells and Geneva clinical probability scores and Wells bleeding risk scores, pulmonary embolism severity index (PESI) and simplified PESI (sPESI) scores measured within the first 24 hours of admission were recorded. The patients were called on the phone at Month 6 for obtaining information and were monitored with outpatient clinic follow up visits. The study was approved by the Bezmialem Vakıf University Non-Invasive Ethics Committee with the decision number: 03/20, date: 05.02.2020, and all patients participating in the study filled the informed consent form. Moreover, academic study permission was obtained. The work described was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Statistical Analysis

Statistical Package for the Social Sciences 22 statistics software was used for statistical analysis. For the assessment of data, continuous variables were indicated as mean±standard deviation and categorical variables were indicated in %. For comparing the two groups, Student's t-test or Mann-Whitney U tests were used. The correlations between the variables were studied using the Pearson or Spearman's correlation analysis. For the comparison of categorical variables, the chi-square testing was utilized. $P<0.05$ value was regarded as statistically significant.

RESULTS

A total of 210 patients were enrolled into the study. The mean age of the patients was 71.27±13.26 years. The demographical characteristics, comorbidities and risk factors of patients are shown in Table 1. When the correlation of vital signs with mortality at the time of admission was evaluated, only a significant correlation was found between high average heart rate and mortality (p=0.041). No statistically significant correlation was observed between the symptoms of the patients at the time of admission and mortality. Although the cost of admission was significantly higher for non-survivors than for the survivors, it was observed that this difference was not statistically significant (p=0.270).

The average modified Geneva scores and Wells PTE clinical prediction scores were higher in non-survivors; however, this difference was not statistically significant. The correlation of PESI and SPESI scores of patients, as calculated in the emergency unit, and mortality were studied. PESI score was 109.90±34.93 on average for non-survivors and 96.59±29.78 for survivors, and it was observed to be higher in non-survivors. However, the difference between non-survivors and survivors in terms of PESI scores was not statistically significant (p=0.139).

Table 1. Demographic characteristics, comorbidities and risk factors of patients	
Sex patients	**(n) %**
Male	55 (26.19)
Female	155 (73.80)
Comorbidities	
Diabetes mellitus	36 (17.14)
Cerebrovascular accident	24 (11.42)
Hypertension	144 (68.57)
Coronary arterial disease	43 (20.47)
Congestive heart failure	24 (11.42)
Malignancy	34 (16.19)
Liver diseases	17 (8.09)
Immune suppression	19 (09.04)
Risk factors	
Recent surgery	43 (20.47)
Travel history	19 (9.04)
Obesity	60 (28.57)
Oral contraceptive use	48 (22.87)
Major surgery	43 (20.47)
Immobility	84 (40.00)
Other	108 (51.42)

Table 2. Correlation of mortality with PESI and sPESI scores			
Non-survivors (n=42) (mean±SD)		**Survivors (n=168) (mean±SD)**	**p**
PESI	1109.90±34.93	96.59±29.78	0.139
sPESI	2.20±1.17	1.20±1.12	**0.013**
Geneva	6.1±1.7	4.7±1.6	0.07
Wells	4.8±1.8	4.2±2.1	0.09
PESI: Pulmonary Embolism Severity Index, sPESI: Simplified Pulmonary Embolism Severity Index, SD: Standard deviation			

sPESI score was 2.20±1.17 on average for non-survivors and 1.20±1.12 for survivors, and this difference was found to be statistically significant (p=0.013) (Table 2).

When the correlation of the arterial blood gas (ABG) parameters at admission and mortality were studied, no statistically significant difference was observed between non-survivors and survivors.

Average WBC on day 1 was lower in non-survivors, and average WBC on day 5 was significantly higher in non-survivors and was found to be correlated with mortality (p=0.602 and

p=0.039, respectively). Average platelet count on days 1 and 5 were higher in non-survivors; however, this difference was not found to be statistically significant (p=0.449 and p=0.729, respectively). Average levels of hemoglobin on days 1 and 5 were lower in non-survivors and this was determined to be correlated with mortality (p=0.002 and p=0.008, respectively). Average MCV on days 1 and 5 and hematocrit levels on days 1 and 5 were found to be lower in non-survivors; however, this was not significantly correlated with mortality (p=0.289, p=0.071, p=0.060 and p=0.141, respectively). Average levels of red cell distribution width (RDW) on days 1 and 5 were higher

Table 3. Correlation of day 1 and 5 hemogram parameters with mortality

	Non-survivors (n=42) (mean±SD)	Survivors (n=168) (mean±SD)	p*
WBC-1 (hc/uL)	8520±3048	9188±3418	0.586
WBC-5 (hc/uL)	8105±3896	5874±2824	**0.041**
PLT-1 (hc/uL)	241030±121678	198385±71322	0.452
PLT-5 (hc/uL)	253900±107365	243300±81682	0.734
Hb-1 (g/dl)	10.89±1.91	12.85±1.51	**0.003**
Hb-5 (g/dl)	10.79±1.41	11.95±1.52	**0.009**
MCV-1 (fl)	83.95±6.61	87.63±4.96	0.302
MCV-5 (fl)	81.71±5.18	85.87±5.64	0.071
HCT-1	35.12±5.94	39.04±4.28	0.059
HCT-5	32.93±3.41	35.74±4.34	0.143
RDW-1 (%)	14.96±2.85	12.18±1.23	**0.021**
RDW-5 (%)	15.94±2.85	12.74±1.36	**0.003**

The numbers 1 and 5 next to the laboratory parameters indicate the values on day 1 and day 5. Bold characters indicate statistical significance.

*Student's t-test.

WBC: White blood cell, PLT: Platelet, Hb: Haemoglobin, MCV: Mean corpuscular volume, HCT: Hematocrit, RDW: Red cell distribution width, SD: Standard deviation

Table 4. The comparison of the parameters obtained in repeated tests in died and surviving patient groups

	Survivors (n=168)			Non-survivors (n=42)		
	Day 1	Day 5	p	Day 1	Day 5	p
D-dimer	15192±24	3286±48	<0.001	7643±88	3234±18	0.121
Troponin	0.41±0.49	0.05±0.12	**0.002**	0.61±1.11	0.10±0.11	0.171
Leukocyte	9188±3418	54968±32	<0.001	8520±30	8105±3896	0.536
Platelet	198385±713	243300±81	**0.004**	253900±10	253900±107	0.264
Hemoglobin	12.8±1.51	12.2±1.49	<0.001	10.8±1.9	10.8±1.4	0.106
RDW	12.21±1.17	12.68±1.24	<0.001	15.0±3	16.0±2.7	**0.016**
ALP	81±39	83±47	0.692	141±11	106±80	0.449
Total protein	7.0±0.6	6.4±0.6	**<0.001**	6.2±0.7	5.9±0.4	0.224
Albumin	3.8±0.4	3.4±0.4	**<0.001**	3.0±0.6	2.7±0.5	0.081
Total bilirubin	0.87±0.45	0.45±0.22	**<0.001**	0.93±0.61	0.77±0.39	0.249
Direct bilirubin	0.30±0.16	0.18±0.08	**<0.001**	0.44±0.38	0.34±0.25	0.174
CRP	4.78±6.21	3.63±6.37	0.186	6.97±4.72	9.14±6.40	0.085
Fibrinogen	391±16	447±188	**0.020**	472±16	535±157	**0.033**
Sedimentation	33±28	34±26	0.577	49±35	58±38	**0.014**
LDH	454±64	311±114	0.163	413±295	339±142	0.343

The numbers 1 and 5 next to the laboratory parameters indicate the values on day 1 and day 5. Bold characters indicate statistical significance.

RDW: Red cell distribution width, ALP: Alkaline phosphatase, CRP: C-reactive protein, LDH: Lactate dehydrogenase

in non-survivors and this was determined to be correlated with mortality (p=0.003 and p=0.008, respectively) (Table 3). The comparison of day 1 and day 5 laboratory parameters of non-survivors and survivors are shown in Table 4.

As measured on day 1 and day 5, average levels of total protein (p=0.001 and p=0.002, respectively) and albumin (p=0.041 and p=0.001, respectively) were found to be lower in non-survivors, pointing to a correlation with mortality. Average alkaline phosphatase levels on both day 1 and day 5 were higher in non-survivors; however, only the difference on day 1 was found to be correlated with mortality (p=0.008 and p=0.251, respectively). As measured on day 1 and day 5, average total bilirubin (p=0.761 and p=0.001, respectively) and direct bilirubin (p=0.259 and p=0.081, respectively) were higher in non-survivors; however, only the difference in average total bilirubin on day 5 was determined to be correlated with mortality. As measured at admission (day 1), average levels of glucose, urea, creatinine, sodium, chlorine and uric acid were higher in non-survivors, and average levels of potassium, phosphorus, magnesium, alanine aminotransferase (ALT), aspartate aminotransferase (AST) and lactate dehydrogenase were lower, but these were not found to be correlated with mortality (Table 5).

Average CRP levels of patients on both day 1 and day 5 were higher in non-survivors, and the difference on day 5 was found to be correlated with mortality (p=0.234 and p=0.018, respectively). Additionally, average sedimentation, fibrinogen and troponin 1 levels on days 1 and 5 were higher, and d-dimer levels were lower in non-survivors, but no significant correlation with mortality was detected (Table 6).

4 out of 21 patients (19%) with DVT in at least one extremity died and this was not found to be statistically correlated with mortality.

The correlation between certain ECHO parameters and mortality was examined. Two out of 4 patients (50%), whose ejection fraction was low, 2 out of 10 patients (20%) with large right spaces with no concomitant D-septum, and 2 out of 15 patients with D-septum died. No statistical correlation with mortality was observed in these results.

In our study, no complications such as bleeding due to the treatment used, medication side effects etc. were observed both during the inpatient treatment period and during the 6-month follow-up period.

Table 5. Correlation of mortality with biochemical parameters on day 1 and 5

	Non-survivors (n=42) (mean±SD)	Survivors (n=168) (mean±SD)	p*
Total protein-1 (g/dL)	6.21±0.72	7.11±0.59	0.001
Total protein-5 (g/dL)	5.89±0.41	6.39±0.71	**0.003**
Albumin-1 (g/dL)	3.23±0.61	3.83±0.42	**0.038**
Albumin-5 (g/dL)	2.69±0.49	3.39±0.38	**<0.001**
ALP-1 (U/L)	139.25±121.13	79.63±40.24	**0.009**
ALP-5 (U/L)	105.75±79.32	84.73±51.54	0.248
Total bilirubin-1 (mg/dL)	0.94±0.59	0.86±0.51	0.805
Total bilirubin-5 (mg/dL)	0.81±0.41	0.51±0.18	**0.003**
Direct bilirubin-1 (mg/dL)	0.39±0.42	0.31±0.21	0.261
Direct bilirubin-5 (mg/dL)	0.36±0.19	0.19±0.11	0.076
Urea (mg/dL)	61.18±29.83	51.87±19.84	0.468
Creatinine (mg/dL)	0.96±0.28	0.79±0.38	0.644
Na (mEq/L)	138.23±3.78	135.89±3.01	0.886
K (mEq/L)	3.87±0.58	4.31±0.48	0.204
CL (mg/dL)	105.10±6.44	104.64±16.47	0.876
P (mg/dL)	3.29±0.81	3.51±0.79	0.704
Mg (mg/dL)	1.89±0.32	1.94±0.28	0.889
ALT (U/L)	28.30±28.60	49.20±158.50	0.643
AST (U/L)	40.70±41.30	92.50±374.40	0.701
Uric acid (mg/dL)	7.4±4.12	6.12±3.11	0.204
CK (U/L)	78.00±89.76	106.32±172.68	0.654
LDH (U/L)	422±301	461±638	0.914

The numbers 1 and 5 next to the laboratory parameters indicate the values on day 1. and day 5. Bold characters indicate statistical significance. *Student's t-test.

ALP: Alkaline phosphatase, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, CK: Creatine kinase, LDH: Lactate dehydrogenase, SD: Standard deviation

Table 6. Correlation of mortality with certain parameters on day 1 and day 5

	Non-survivors (n=42) (mean±SD)	Survivors (n=168) (mean±SD)	p
CRP-1 (mg/dL)	7.14±5.13	5.06±7.04	0.306
CRP-5 (mg/dL)	10.21±7.56	3.54±7.44	**0.021**
SEDIM-1 (mm/h)	51.80±34.80	29.96±27.26	0.128
SEDIM -5 (mm/h)	58.84±41.82	36.84±28.28	0.088
D-dimer-1 (ng/mL)	7965±9743	138994±16912	0.276
D-dimer-5 (ng/mL)	2980±1896	3412±5139	0.838
Fibrinogen-1 (mg/dL)	504±208	403±214	0.181
Fibrinogen-5 (mg/dL)	541±162	454±204	0.208
Troponin 1-1	0.61±1.14	0.41±0.48	0.289
Troponin 1-5	0.07±0.09	0.04±0.06	0.161

The numbers 1 and 5 next to the laboratory parameters indicate the values on day 1. and day 5. Bold characters indicate statistical significance. *Student's t-test.
CRP: C-reactive protein, SD: Standard deviation, SEDIM: Sedimentation

DISCUSSION

In our study, high PESI scores, low levels of hemoglobin, total protein, and albumin as checked on day 1 and day 5, high RDW levels, high ALP, and WBC, CRP and total bilirubin checked on day 5 remaining high were determined to be associated with mortality.

The incidence of pulmonary embolism is typically equal in both sexes[4,5]. The mortality rate of PTE in non-treated cases is approximately 30%; however, in treated cases, the rate of mortality can decrease to below 8%[6,7]. Mortality typically has a linear relationship with malignancy, chronic cardiopulmonary comorbidities and advanced age[7,8].

74% of the cases enrolled into our study were female and the incidence of PTE was found to be higher in females in this study, in contrary to the literature. Additionally, in female patients, the rate of mortality was higher although the difference was not found to be statistically significant (24.32% and 7.69%, respectively). In a study carried out by Obradović et al.[9], which had a large population, it was reported that the mortality rate of pulmonary embolism was higher in females. The average age of the patients in our study was 71.27±13.26 years. Although all our cases were treated, the mortality rate observed (20%) was higher than the rate in the literature. The average age of non-survivors was higher than survivors.

While the average body temperatures of non-survivors and survivors in our study were similar, average systolic blood pressure and diastolic blood pressure levels were lower and RR values were higher. Additionally, high heartbeat per minute at arrival was correlated with mortality. The literature review did not review any studies mentioning the relevance of average heartbeat at arrival and mortality.

In many studies carried out, it has been shown that sPESI is as efficient as PESI in predicting mortality[10-12]. In our study,

although the difference was not statistically significant, average PESI score of non-survivors weas higher, and average sPESI score was significantly higher in non-survivors. Our study also supports that sPESI score is as efficient as PESI score in determining mortality. For that reason, this score should definitely be taken into consideration in patients diagnosed with pulmonary embolism, as it is a determining factor in mortality.

When measuring ABGs, hypoxia, hypocarbia and respiratory alkalosis are expected in PTE patients. However, it can be detected as normal in 35% of the patients[13]. In the study carried out by Kohyama et al.[14] on 207 normotensive patients diagnosed with PTE, it was shown that hypoxia was positively correlated with the weight of the patient, although it was also common in the diseases for the differential diagnosis of PTE and was not always present in patients with PTE. Our study did not reveal any significant differences between average ABG values and mortality; we believe that this may be due to the fact that the sample size was small.

RDW, which is a parameter checked during routine blood tests, is a recently defined marker indicating the heterogenicity of red blood cells (anisocytosis). The increase in RDW in some cases and some studies stating that it is correlated with mortality is probably due to the fact that it increases in inflammatory conditions[15,16]. In the study on 136 acute PTE patients, published by Zorlu et al.[17] in 2012, RDW >14.6% was found to be significant in indicating mortality with a precision of 95.2% and specificity of 53%. In the retrospective study of Zhang et al.[18], which included 1,539 PTE patients, patients were divided into two groups according to the values determined with ROC analysis: RDW >14.8% and ≤14.8%. In the multivariate model, RDW was found to be significant in indicating mortality as an independent variable. The increase in RDW was explained more in relation to the inflammatory response mechanism against oxidative stress. In line with the literature, in our

study, low levels of average hemoglobin on days 1 and 5 were regarded to be significantly correlated with 180-day mortality. Additionally, the average WBC on day 5 was higher in non-survivors and was correlated with 180-day mortality. Similarly, in our study, average RDW on days 1 and 5 was higher in non-survivors and this was found to be correlated with 180-day mortality, and this is also in line with the literature.

ALT and AST increases with hepatocellular damage, and bilirubin in cases of cholestasis as well as hepatocellular damage. Level of albumin and prothrombin activity are the tests that reflect the synthesis capacity of the liver[19]. The morbidity and mortality in hypoalbuminemic patients are higher than in patients with normal levels of serum albumin[20]. The increase in bilirubin is dependent on the breakdown of erythrocytes in the infarct area. Unless there is a severe problem with the liver, ALT and AST levels do not increase significantly in cases of pulmonary embolism. However, if hypoxemia is severe, these enzymes may increase depending on liver damage[21,22]. In our study, average levels of ALT and AST were determined to be lower in non-survivors both on days 1 and 5. Despite the fact that the level of serum bilirubin was higher in non-survivors, this was not found to be correlated with mortality.

Albumin is the negative acute phase reactant. Serum levels decrease in many acute infective and inflammatory diseases. Low levels of albumin are correlated with poor prognosis and increased mortality in some diseases. The literature review has revealed studies emphasizing that low levels of serum total protein and albumin in critical diseases are correlated with mortality[23]. In line with the literature, our study also showed a significant decrease in average levels of serum total protein and albumin on days 1 and 5 in non-survivors.

High CRP is reported to be correlated with venous thromboembolism risk[24]. Our review of the literature revealed a few studies emphasizing the correlation of high CRP with prognosis of PTE. In the study conducted by Abul et al.[25] on 56 patients diagnosed with acute PTE, 36-month follow-up after discharge revealed higher mortality levels in patients with high levels of CRP and troponin T. Cardiac enzymes are known to be specific and sensitive markers indicating myocardium damage, released from the myocardium due to the overload on the right ventricle, reflecting left ventricle dysfunction. The mortality levels of patients, whose troponin levels were determined to be high in several meta-analyses, were significantly higher than patients with normal troponin levels[26]. Although the average level of CRP was higher in non-survivors on day 1, it was not significantly correlated with mortality; however, the high levels of CRP on day 5 were correlated with mortality, in line with the literature. Additionally, in contrary to the literature, no significant correlation was detected between average level of serum troponin T on days 1 and 5 and mortality.

Study Limitations

There are some limitations of this study that should be mentioned. The first limitation is that the data are based on hospital records since it is a retrospective study; and the second limitation may be that patients do not have longer follow-up. Another limitation is that the study may not reflect the general population due to the low number of patients included in the study.

CONCLUSION

In conclusion, PTE is a disease with high mortality and morbidity despite the advances in diagnosis and treatment. Routine, easily applicable physical examination and laboratory findings may help in predicting mortality.

Ethics

Ethics Committee Approval: The study were approved by the Bezmialem Vakıf University Non-Invasive Ethics Committee (decision number: 03/20, date: 05.02.2020).

Informed Consent: Consent form was filled out by all participants.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: H.Ç., G.İ.D., Concept: H.Ç., Design: G.İ.D., Data Collection or Processing: H.Ç., G.İ.D., Analysis or Interpretation: H.Ç., Literature Search: G.İ.D., Writing: H.Ç.

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

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

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