

ORIGINAL  
ARTICLE

 Pınar Yeşim Akyol<sup>1</sup>  
 Zeynep Karakaya<sup>1</sup>  
 Fatih Esad Topal<sup>1</sup>  
 Umur Payza<sup>1</sup>  
 Eylem Kuday Kaykısız<sup>2</sup>

<sup>1</sup>Department of Emergency  
Medicine, İzmir Katip Çelebi  
University Atatürk Training and  
Research Hospital, İzmir, Turkey.  
<sup>2</sup>Department of Emergency  
Medicine, Bitlis State Hospital,  
Bitlis, Turkey

**Corresponding Author:**

Pınar Yeşim Akyol  
Department of Emergency Medicine,  
İzmir Katip Çelebi University Atatürk  
Training and Research Hospital,  
İzmir, Turkey  
Tel: +90 5053572941  
E-mail: yesimakyol@gmail.com

Received: 10.01.2019  
Acceptance: 08.06.2019  
DOI: 10.18521/ktd.511525

**Konuralp Medical Journal**  
e-ISSN1309-3878  
konuralptipdergi@duzce.edu.tr  
konuralptipdergisi@gmail.com  
www.konuralptipdergi.duzce.edu.tr

**Simplified Pulmonary Embolism Severity Index in Predicting Mortality in Emergency Department****ABSTRACT**

**Objective:** Pulmonary embolism (PE) is one of the major causes of mortality, morbidity and hospital admission. We aimed to investigate the association of the Simplified Pulmonary Embolism Severity Index (sPESI) and mortality within 3 months.

**Methods:** A total of 118 patients were included in the study. Patients who died within 3 months after PE diagnosis were defined as Group 1. Other patients were defined as Group 2. The sPESI score was calculated and recorded. The effect of these scoring systems on 3-month mortality rate was investigated.

**Results:** There were 31 patients (26.3%) in Group 1 and 87 patients (73.7%) in Group 2. When the sPESI scores of the patients were examined, there was difference between Group 1 and 2 in terms of 3-month mortality. The sPESI had a sensitivity of 43.3% and a specificity of 79.4% for predicting 3-month mortality.

**Conclusions:** It is important to categorize patients diagnosed with PE in the emergency department according to their risk profiles in terms of their treatment needs.

**Keywords:** Pulmonary Embolisms; Emergency Department; Mortality

**Acil Serviste Basitleştirilmiş Pulmoner Emboli Ciddiyet İndeksi'nin Mortaliteyi Öngörmesinin Değerlendirilmesi****ÖZET**

**Amaç:** Pulmoner emboli (PE) mortalite, morbidite ve hastane yatışının en önemli nedenlerinden biridir. Bu çalışmada pulmoner embolide Basitleştirilmiş Pulmoner Emboli Ölçeği İndeksi (sPESI) ile hastaların 3 aylık mortalite ilişkisini araştırmayı amaçladık.

**Gereç ve Yöntem:** Çalışmaya toplam 118 hasta dahil edildi. PE tanısından 3 ay sonra ölen hastalar Grup 1 olarak tanımlandı. Diğer hastalar Grup 2 olarak tanımlandı. sPESI skoru hesaplandı ve kaydedildi. Bu skorlama sistemlerinin 3 aylık mortalite üzerine etkisi araştırıldı.

**Bulgular:** Grup 1'de 31 hasta (% 26.3) ve Grup 2'de 87 hasta (% 73.7) vardı. Hastaların sPESI skorları incelendiğinde Grup 1 ve 2 arasında 3 aylık mortalite açısından fark vardı. 3 aylık mortaliteyi öngörmeye sPESI% 43.3 duyarlılık ve% 79.4 özgüllük göstermiştir.

**Sonuç:** Acil serviste PE tanısı alan hastalarını risk profillerine göre ayırmak tedavi ihtiyaçlarını belirlemek açısından önemlidir.

**Anahtar Kelimeler:** Pulmoner Emboli, Basitleştirilmiş Pulmoner Emboli Ciddiyet İndeksi, Acil Servis, Mortalite

## INTRODUCTION

Pulmonary embolism (PE) is one of the major causes of mortality, morbidity, and hospital admission. The current guidelines emphasize the importance of early risk classification in PE patients (1). This classification would be useful in determining which patients are at increased risk of premature death and thus in determining which patients need aggressive intensive care (2,3). Moreover, it would help to determine which patients have a low risk of early complications such as death, venous thromboembolism, and major bleeding and can be treated in outpatient wards (4,5).

The Pulmonary Embolism Severity Index (PESI), a clinical model with high reliability and validity, has been developed for risk classification in PE patients (6), (7), (8). The PESI consists of 11 different diagnostic components. Patients are divided into 5 groups according to the PESI score, and 30-day mortality rate ranges from 1.1% to 24% (9). PE patients in Group 1 and 2 are at low risk according to the PESI score and are seen as

potential candidates for outpatient treatment (10). However, it can be difficult to administer the 11 items of the PESI to patients in emergency departments (ED) in daily practice.

The Simplified Pulmonary Embolism Severity Index (sPESI) has been developed to classify the risks in PE patients. The sPESI contains 6 variables (age >80 years, history of cancer, chronic cardiopulmonary disease, pulse rate  $\geq 110$  beats/min, systolic blood pressure <100 mmHg and arterial oxyhemoglobin saturation <90%). While a score of 0 indicates low risk, a score of 1 or higher is considered high risk (11). In previous studies, it was concluded that the sPESI was as effective as the PESI in predicting 30-day mortality (12). The PESI and sPESI scores are shown in Table 1

The aim of our study was to evaluate the demographic data of PE patients, to investigate the association of the sPESI with mortality at 3 month. The msPESI score we created is shown in Table-1 along with the PESI and sPESI scores.

**Table 1.** Pulmonary embolism severity indexes and simplified pulmonary embolism severity indexes.

Predictors	PESI	Simplified PESI
Demographic characteristics	Age	+1 per year
	Age>80 years	--
	Male sex	+10
Comorbid illness	Cancer(active or history of)	+30
	Heart failure (systolic or diastolic)	+10
	Chronic lung disease (includes asthma)	+10
Clinical findings	Pulse>110/min beats per min	+20
	Systolic blood pressure<100 mmHg	+30
	Respiratory rate>30 breaths per min	+20
	Temperature<36 C	+20
	Altered mental status	+60
	Arterial oxygen saturation<%90	+20

## MATERIAL AND METHODS

This retrospective study included the patients who were admitted to the ED between 01.01.2011-31.12.2014, and who were diagnosed with acute PE. After the approval of the Ethics Committee, this study was conducted in a tertiary care university hospital. Patients who were admitted to the ED between the two dates stated above and who were diagnosed with PE by pulmonary CT angiography were retrospectively screened from the hospital information system. Patients who had an active infection, who had a hematologic malignancy, who had an acute liver or kidney failure, who were pregnant, who were under

the age of 18 years, and who had a chronic PE were excluded from the study. Patients who died within 3 months after the PE diagnosis were defined as Group 1. Other patients who did not die within 3 months after the PE diagnosis were defined as Group 2. Patients' age, gender, chronic diseases, admission vital signs, neutrophil and lymphocyte counts, haemoglobin, hematocrit, and D-dimer levels and pulmonary angiography reports were recorded retrospectively from the hospital data system. Patients who died within the last 3 months were identified by contacting their relatives via telephone, and the cause of death was questioned.

Then, patients who died due to the reasons such as traffic accident and fall were excluded from the study. The sPESI scores of the patients were calculated and recorded.

**Statistical Analysis:** Statistical analysis was performed with the SPSS 17.0 Statistical Package for Windows (SPSS Inc, Chicago, IL, USA). The median and standard deviation of the continuous variables were given, and the categorical variables were defined as percentages. Data were tested for normal distribution using the Kolmogorov-Smirnov test. Categorical variables were compared with the Pearson Chi-Square Test. The Student t-test was used to compare the continuous variables, and the Mann-Whitney U-test was used to compare non-continuous variables. The Receiver Operating Characteristics (ROC) curve was used to demonstrate the sensitivity and specificity of the sPESI. A value of  $p < 0.05$  was statistically significant.

**RESULTS**

The number of the patients diagnosed with PE during the study period was 174. However, 34 of these patients were excluded from the study because of the inability to access their files due to referral to other center or other reasons and because their files were incomplete. 5 of these patients were

excluded from the study due to liver dysfunction. 3 of these patients were excluded from the study due to hematological malignancy and 14 patients were excluded from the study due to active infection. A total of 118 patients were included in the study. Of the 118 patients, 59.3% (n=70) were female and 40.7% (n=48) were male. The mean age of the female and male patients was  $71.66 \pm 13.55$  (range: 25-90) and  $61.42 \pm 15.82$  years (range: 25-96) respectively. The mean age of the female patients was statistically higher than the mean age of the male patients ( $p < 0.05$ ).

The frequency and type of malignancy were examined in the patients. Accordingly, the frequency of malignancy was found to be 32.9%. The most commonly detected cancer types were breast cancer (5.9%), pancreatic cancer (1.7%), malignant melanoma (1.7%), and colon cancer (1.7%). The most common referral symptom was dyspnea with a rate of 60.2%. This was followed by chest pain (11%), syncope (4.2%), and hemoptysis (3.4%). There were 31 (26.3%) patients in Group 1 and 87 (73.7%) patients in Group 2.

When the sPESI scores of the patients were examined, there was statistically significant difference between Group 1 and 2 in terms of 3-month mortality ( $p = 0.004$ ) (Table 2).

**Table 2. Association of Positivity of sPESI and mortality for 3 months**

Mortality for 3 months	sPESI				Total		P
	negative		positive		n	%	
	n	%	n	%			
Group 1	1	4,0	30	32,3	31	26,3	
Group 2	24	96,0	63	67,7	87	73,7	<b>0,004</b>
Total	25	21,2	93	78,8	118	100	

The number of sPESI components of the patients in Group 1 was higher than that of the patients in Group 2 ( $p = 0.021$ ) and this difference

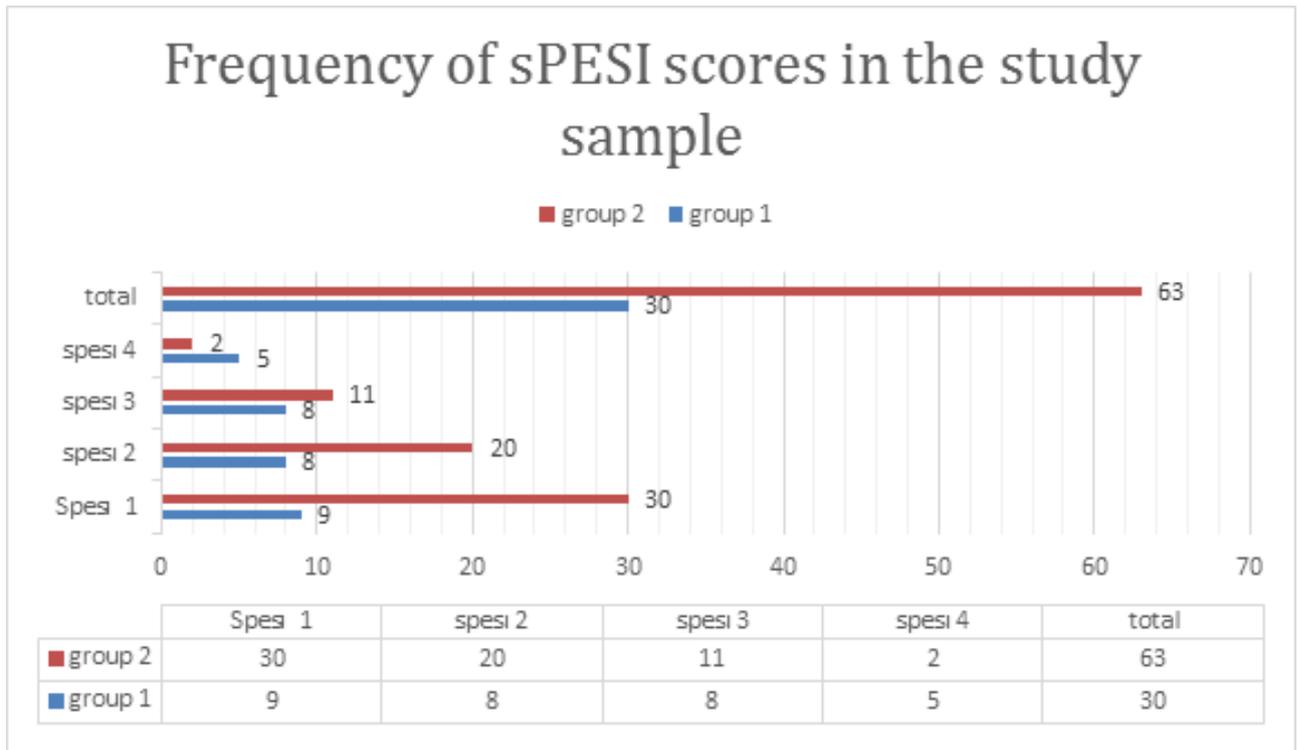
was statistically significant (Table 3). The frequency of the sPESI score of the patients in Groups 1 and 2 is shown in Figure 1.

**Table 3. Comparison of the number of sPESI components between groups.**

Mortality for 3 months	The number of sPESI components				P
	n	%	average±SS	Min.-Max.	
Group 1	30	32,3	2,3±1,09	1-6	
Group 2	63	67,7	1,76±0,86	1-6	<b>0,021</b>
Total	93	100	1,94±0,96	1-6	

When the groups were compared in terms of Hb, Hct, MPV, PDW, WBC, platelet, neutrophil, lymphocyte and D-dimer values, there was a statistically significant difference between the groups in terms of Hb, Hct and D-dimer values ( $p < 0.05$ ). However, there was no statistically

significant difference between the groups in terms of other variables ( $p > 0.05$ ). While there was a weak positive correlation between D-dimer value and mortality ( $p = 0.007$ ), there was a weak negative correlation between Hb and Hct values and mortality ( $p < 0.05$ ) (Table 4).



**Figure 1.** Frequency of sPESI scores in study population.

**Table 4.** Comparison of laboratory values in terms of mortality for 3 months.

	Mortality for 3 months						p
	Group 2			Group 1			
	n	avarage±SS	Min.-Max.	N	avarage±SS	Min.-Max.	
Mpv	87	9,77±7,45	6-76,7	31	8,7±1,68	5,75-12,2	0,166
Pdw	87	17,18±1,42	15,2-23,2	31	17,55±1,69	15,7-23,7	0,216
Plt	87	259,1±127,93	45-852	31	251,29±127,85	16-601	0,587
Rdw	87	16,11±2,54	12,5-24,2	31	16,61±2,37	12,8-22,3	0,147
<b>Hb</b>	<b>87</b>	<b>12,7±2,03</b>	<b>7,6-19,4</b>	<b>31</b>	<b>11,57±1,83</b>	<b>8,45-14,7</b>	<b>0,011</b>
<b>Htc</b>	<b>87</b>	<b>37,74±5,91</b>	<b>20,4-55,7</b>	<b>31</b>	<b>34,73±5,77</b>	<b>23,7-45</b>	<b>0,032</b>
Wbc	87	10,84±4,95	3,11-39,09	31	12,91±5,75	4,1-22,6	0,089
Neutrophile	87	7,98±4,42	2,2-36,27	31	9,95±4,99	3,17-19,7	0,069
Lymphocyte	87	2±1,32	0,45-9,85	31	2,05±1,75	0,29-7,81	0,223
<b>Ddimer</b>	<b>71</b>	<b>4203,89±5828,87</b>	<b>12-36000</b>	<b>19</b>	<b>10151,58±11174,34</b>	<b>961-36708</b>	<b>0,008</b>

The distribution of the sensitivity and specificity ratios of sPESI components in predicting 3-month mortality was analyzed by the ROC Curve Analysis. The AUC value was found to be 0.022 when the cut-off value was considered > 2. The

sPESI was statistically significant for predicting 3 month-mortality. The sPESI had a sensitivity of 43.3% and a specificity of 79.4% for predicting 3-month mortality (Table 5).

**Table 5.** Distrubition of the sensivity and spesifity rates of sPESI components in predicting mortality for 3 months.

Criterion	Sensitivity	95% CI	Specificity	95% CI
≥1	100	88,4-100,0	0,0	0,0-5,7
>1	70	50,6-85,3	47,6	34,9-60,6
>2	43,3	25,5-62,6	79,4	67,3-88,5
>3	16,7	5,6-34,7	96,8	89,0-99,6
>4	0,0	0,0-11,6	100	94,3-100,0

## DISCUSSION

Acute PE is a potentially fatal condition that has a mortality rate as high as myocardial infarction (13). Its mortality rate can vary between 7-11%. In the International Cooperative Pulmonary Embolism (ICOPER) registry, congestive heart failure, COPD, cancer, and being over 70 years of age have been reported to increase mortality (14). In addition, systolic blood pressure <90 mmHg and the presence of shock or cardiac arrest at admission suggest high-risk PE and require aggressive treatment (13). Therefore, it is important to categorize patients with acute symptomatic PE according to their risk profiles in terms of the determination of the treatment method. Various risk classification systems have been developed for this purpose.

PESI has been developed for risk classification in PE patients, and is one of the most widely accepted prognostic scoring systems (6,7,8). However, it is not always possible to apply this scoring system in EDs in daily practice. The European Society of Cardiology (ESC) model, which is another model used for determining the severity of PE, is based on right ventricular dysfunction and myocardial involvement. The ESC Guideline recommends that right ventricular dysfunction (echocardiography, spiral computed tomography or brain natriuretic peptide (BNP)) and markers of myocardial damage (cardiac troponin T and I) are used in determining the severity of PE. According to this Guideline, based on blood pressure values of patients at admission, patients with hypotension and shock are classified as high risk, and patients with normotension are classified as moderate or low risk according to echocardiography and cardiac marker results. Since both models have some practical limitations, the sPESI was developed by Jimenez D et al. in order to classify the risks in PE patients (11). In validation studies performed for the sPESI, it has been concluded that the sPESI was as effective as the PESI in determining early mortality in PE patients (12), (15), (16), (17). Lankeit et al. compared the ESC model with the sPESI in terms of predicting 30-day mortality, and found that the sPESI had a higher sensitivity especially in PE patients with non-fatal complications (12). Rozjabeck et al. compared the sPESI with the PESI and reported that the sPESI was as effective as the PESI in predicting 30-day mortality (15). There are other studies in the literature that support this result (16, 17). However, studies on the relationship between the sPESI and mortality investigated its relationship with 1-month (short-term) mortality. In our study, we assessed the role of the sPESI in predicting 3-month mortality. The sPESI had a

sensitivity of 43.3%, and a specificity of 79.4% for predicting 3-month mortality. In accordance with the literature, we concluded that mortality was higher at a statistically significant level in patients with positive sPESI.

Controversial results have been obtained in previous studies investigating the relationship between Hb value and PE in PE patients. In a retrospective study of Can et al., it was reported that PE patients had significantly lower hb levels when compared with age and sex-matched healthy controls (18). On the other hand, in a retrospective study by Harringa J.B. et al. conducted on 1294 patients, they did not find an association between Hb level and development of PE (19). However, these studies were performed on development risk of PE rather than mortality rate. In a study of Jimenez et al. (2009) investigating the relationship between anemia and PE prognosis, a statistically significant correlation was found between anemia and mortality in acute PE (20). Similarly, in a study conducted in 2011, it was concluded that anemia was an independent risk factor for mortality in PE (21). In agreement with these studies, there was a weak, statistically significant negative correlation between Hb and Hct values and mortality in our study.

## CONCLUSION

In conclusion, it is important to categorize patients diagnosed with PE in the ED according to their risk profiles and treatment needs. sPESI can be used for predicting 3-month mortality in PE patients. Anemia can affect the prognosis of PE in terms of mortality. There is a need for large prospective multicenter studies that create a new scoring system that combines Hb and Spesi components in the future. If this is supported, we think that it would be more useful in ED in daily practice

This study has some limitations. Firstly, this study was conducted with a small group of patients and was designed as a retrospective, single-center observational study. The fact that patients were excluded from the study because some patient files were missing and the number of patients referred to other centers was high caused a decrease in the number of patients. In addition, the potential effects of the treatments on patient mortality were not discussed because this information is not readily available in our data. It is also unclear whether deaths were associated with primary PE since no autopsy studies were performed after death.

### Disclosure of Conflict of Interest

The authors state that they have no conflict of interest.

**REFERENCES**

1. Torbicki A, Perrier A, Konstantinides SV, et al. Guidelines on the diagnosis and management of acute pulmonary embolism: The Task Force for the Diagnosis and Management of Acute Pulmonary Embolism of the European Society of Cardiology (ESC). *Eur Heart J* 2.
2. Tapson VF. Acute pulmonary embolism. *N Engl J Med* 2008; 358: 1037–1052.
3. Kearon C, Kahn SR, Agnelli G, et al. Antithrombotic therapy for venous thromboembolic disease: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th edition). *Chest* 2008; 133: 454S–545S.
4. Jimenez D, Yusen RD. Prognostic models for selecting patients with acute pulmonary embolism for initial outpatient therapy. *Current Opin Pulm Med* 2008; 14: 414–421.
5. Jimenez D, Yusen RD, Otero R, et al. Prognostic models for selecting patients with acute pulmonary embolism for initial outpatient therapy. *Chest* 2007; 132: 24–30.
6. Aujesky D, Roy PM, Le Manach CP, et al. Validation of a model to predict adverse outcomes in patients with pulmonary embolism. *Eur Heart J* 2006; 27: 476–481.
7. Donze J, Le Gal G, Fine MJ, et al. Prospective validation of the Pulmonary Embolism Severity Index. A clinical prognostic model for pulmonary embolism. *Thromb Haemost* 2008; 100: 943–948.
8. Aujesky D, Perrier A, Roy PM, et al. Validation of a clinical prognostic model to identify low-risk patients with pulmonary embolism. *J Intern Med* 2007; 261: 597–604.
9. Aujesky D, Obrosky DS, Stone RA, et al. Derivation and validation of a prognostic model for pulmonary embolism. *Am J Respir Crit Care Med*. 2005;172:1041–1046.
10. Aujesky D, Roy PM, Verschuren Fet all. Outpatient versus inpatient treatment for patients with acute pulmonary embolism: an international, open-label, randomised, non-inferiority trial. *Lancet*. 2011 Jul 2;378(9785):41-8.
11. Jimenez D, Aujesky D, Moores L et all. Simplification of the pulmonary embolism severity index for prognostication in patients with acute symptomatic pulmonary embolism. *Arch Intern Med* 2010;170-1383-9.
12. Lankeit M, Gómez V, Wagner C et all. A Strategy Combining Imaging and Laboratory Biomarkers in Comparison With a Simplified Clinical Score for Risk Stratification of Patients With Acute Pulmonary Embolism. *Chest*. 2011 Apr 10.1378/chest.11-1355 .
13. Goldhaber SZ, Visani L, De Rosa M. Acute pulmonary embolism clinical outcomes in the International Cooperative Pulmonary Embolism Registry (ICOPER) *Lancet* 1999;353(9162 (apr(24))):1386-9. .
14. Rozjabeck HM, Coleman CI, Weeda ER et all. Effect of vital sign measurement timing on Pulmonary Embolism Severity Index (PESI) and simplified PESI 30-day mortality risk determination. *Thrombosis research* 2016;141:8-10. .
15. Vinson DR, Ballard DW, Mark DG et all. Risk stratifying emergency department patients with acute pulmonay embolism: Does the simplified Pulmonary Embolism Severity Index perform as well as the original? *Thrombosis research* 2016;148:1-8.
16. Venetz C, Jimenez D, Mean M, Aujesky D. A comparison of the original and simplified Pulmonary Embolism Severity Index. *Thromb Haemost* 2011: 106(3):423-8.
17. Can C, Topaçoğlu H, Uçku R. Investigation of relationship between blood hemoglobin level and acute pulmonary embolism in emergency setting. *Intern Med J* 2013; 20(5):584–6
18. Haringa JB, Bracken RL, Nagle SK et all. Anemia is not a risk factor for developing pulmonary embolism. *Am J Emerg Med*. 2017 Jan;35(1):146-149.
19. Jiménez D, Escobar C, Martí Det al. Association of anaemia and mortality in patients with acute pulmonary embolism. *Thromb Haemost* 2009;102(1):153–8.
20. World Health Organization (2008). Worldwide prevalence of anaemia 1993–2005. Geneva: World Health Organization. ISBN 978-92-4-159665-7.
21. Cappellini MD, Motta I. Anemia in Clinical Practice-Definition and Classification: Does Hemoglobin Change With Aging? *Semin Hematol*. 2015 Oct;52(4):261-9.