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Pulmonary Embolism Severity Index and Simplified Pulmonary Embolism Severity Index Risk Scores are Useful to Predict Mortality in Patients with COVID-19

Pulmoner Emboli Şiddet İndeksi ve Basitleştirilmiş Pulmoner Emboli Şiddet İndeksi Risk Skorlarının COVID-19 Hastalarındaki Prognostik Değeri

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ABSTRACT

Objectives: The prognostic assessment tools such as pulmonary embolism severity ındex (PESI) and simplified PESI (sPESI) are used to predict the mortality in patients with acute pulmonary embolism. The aim of this study is to assess PESI and sPESI accuracy for the prediction of the prognostic outcomes in coronavirus disease (COVID).

Methods: This retrospective single-center was done as a cohort study. Data on hospital admission obtained from medical records were used to calculate PESI and sPESI. All the consecutive patients were assigned to low risk and high-risk groups using of PESI and sPESI. The primary outcome was hospital mortality. Accuracy of the models was assessed to predict mortality by calculating specificity, predictive values, and sensitivity of the patients at low to high risk. The area under receiver operating characteristic (ROC) was calculated to compare the discriminative power of the models.

Results: The PESI and sPESI had similar sensitivities (82.1% vs. 84.6%), negative predictive values (96.7% vs. 97%) for predicting mortality. The area under the ROC curve for predicting mortality was 0.82 (p<0.001) for PESI and 0.72 (p<0.001) for sPESI. PESI and sPESI had a similar discriminatory to predict hospital mortality.

Conclusion: Hospital mortality could be predicted, and risk stratification can be facilitated in COVID-19 patients based on PESI and sPESI Scores.

Keywords: Coronavirus; coronavirus disease-2019; Pulmonary Embolism Severity Index; risk stratification.

ÖZET

Amaç: Akut pulmoner embolide mortalite tahmininde Pulmoner Emboli Şiddet İndeksi (PESI) ve basitleştirilmiş Pulmoner Emboli Şiddet İndeksi (sPESI) gibi prognostik değerlendirme araçları kullanılmaktadır. Bu çalışmanın amacı, COVID-19 hastalarının prognozunda PESI ve sPESI skorlarının uygunluğunu değerlendirmek ve orijinal ile basitleştirilmiş PESI'lerin prognostik değerliliklerini karşılaştırmaktır.

Yöntem: Retrospektif, tek merkezli kohort çalışması olarak tasarlanan çalışmada PESI ve sPESI'yi hesaplamak için hastane yatışında elde edilen tıbbi veriler kullanıldı. Hastalar PESI ve sPESI kullanılarak düşük risk ve yüksek risk gruplarına ayrıldı. Primer sonlanım noktası hastane mortalitesi olarak belirlendi. Düşük ve yüksek riskli hastalarda skorların spesifite, prediktif değerleri ve sensitiviteleri ölçülerek doğrulukları değerlendirildi. Modellerin ayırt edici güçlerini karşılaştırmak için de ROC eğrisi altındaki alan hesaplandı.

Bulgular: PESI ve sPESI, mortaliteyi öngörmek için benzer duyarlılıklara (%82,1'e %84,6) ve negatif prediktif değerlere (%96,7'ye %97) sahipti. Mortaliteyi öngörmek için ROC eğrisi altında kalan alan PESI için 0,82 (p<0,001) ve sPESI için 0,72 (p<0,001) saptandı. Hastane mortalitesini tahmin etme güçleri PESI ve sPESI için benzer saptandı.

Sonuç: COVID-19 hastalarında PESI ve sPESI skorları ile hastane mortalitesi tahmin edilebilir ve risk sınıflandırması kolaylaştırılabilir.

Anahtar sözcükler: Koronavirüs; COVID-19; Pulmoner Emboli Şiddet İndeksi; risk sınıflandırması.

It was confirmed in December 2019 that groups of the patients were infected with viral pneumonia, which was a novel coronavirus. The infection, which was called coronavirus disease-2019 (COVID-19), was due to the new coronavirus, and this coronavirus was named by the World Health Organization and International Committee on Taxonomy of Viruses as severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2).[1] There is a wide clinical spectrum of SARS-CoV-2 infection, which covers mild illness of the upper respiratory tract, asymptomatic infection, and severe viral pneumonia-causing respiratory failure and even death. It causes multi-organ dysfunction by making both systemic and pulmonary inflammation and leads to critical complications such as respiratory failure, sepsis, heart failure, acute syndrome of respiratory distress, and acute cardiac injury.[2–5] The patients who are prognosed poorly in the early stage and, for this reason, take timely measures for intervention to help patients prevent more deterioration of the disease should be identified, causing to reduce mortality rate at the same time.

The pulmonary embolism severity index (PESI) is a clinical prognostic model that is well validated and is highly reliable for patients suffering from acute pulmonary embolism (PE).[6,7] Eleven easily available clinical variables are used to calculate a point score and stratify the patients into five classes of risk (I–V) related to a high mortality rate.[6] A version of PESI, which was simplified, has been recently developed due to the difficulties of calculating PESI in crowded emergency departments. There are six out of 11 original PESI variables in the simplified PESI (sPESI), which is measured by assigning one point to each prognostic variable. Patients scoring 0 in the sPESI risk score are classified as patients with low risk and those ≥1 as the patients with higher risk.[8] The aim of this study was to assess and compare the prognostic value of PESI and s-PESI models for hospital mortality of patients with COVID-19.

Methods

This single-center retrospective study was conducted in the İstanbul Medeniyet University Prof. Dr. Süleyman Yalçın City Hospital between March 25, 2020, and May 30, 2020, after the approved by the Ethics Committee (approval number: 2020/0237, date: May 13, 2020). A case was defined as a patient with positive results of the reverse transcription polymerase chain reaction (RT-PCR) test for SARS-CoV-2. Their baseline demographic characteristics, comorbidities, symptoms, vital signs, and the initial laboratory results were investigated from electronic medical records.

The PESI and sPESI for each patient, as described in the literature was calculated using the clinical data which was obtained from the medical records formed during hospital admission.[6,7] The patients were included in one of the five original version risk classes. Those who were included in the first and second risk classes were regarded as the patients with low risk, while those in the third to fifth risk classes were those with higher risk. The patients with sPESI score 0 points were regarded as those with low risk, and those with ≥1 point was regarded as higher risk ones. It was assumed that the prognostic variables' missing values were normal, which was a strategy used for PESI original derivation.[6–8] Hospital mortality was the primary outcome of the study.

Statistical Analysis

The distribution of variables was measured with the Kolmogorov Smirnov test. The t-test was performed to test the normal distribution of continuous data. The Mann-Whitney U-test for nonnormal distribution was used to test the continuous data of nonnormal distribution. Fisher's exact test or the Chi-square test was used to compare the categorical variables (when one cell had the expected value of below <5). Median for the continuous variable of nonnormal distribution, percentages for categorical data, and mean SD for the continuous variable of normal distribution were regarded as the descriptive data. The risk factors related to death at the hospital were explored using the multivariate and univariate logistic regression models. If differences between the groups in variables were not significant or if they had collinearity with PESI scores, variables were not included in the univariable analysis since the total number of deaths was 39 in our study and overfitting should be avoided in the model. The sPESI and PESI scores were used to compare the patients who were classified as those with low to a higher risk to estimate the mortality rate at the hospital in each risk group. The accuracy of PESI and sPESI was assessed to predict mortality at the hospital, and the specificity, sensitivity, and negative and positive predictive values of the patients with low to higher risk were calculated. They were compared in terms of prognostic accuracy by receiver operating characteristic (ROC) curves and examining the area under the curve (AUC) for each of them.

Number Cruncher Statistical System Statistical Software (Utah, USA) program was used for significance statistical analysis. $P<0.05$ was statistically significant.

Table 1. Demographic, clinical and laboratory findings of patients with COVID-19

	Total (n=258) (%)	Survivors (n=246) (%)	Nonsurvivors (n=39) (%)	p
Age years	57.4±18.1	55.2±17.5	71.6±14.7	**0.000**
Gender (male)	147 (51.6)	127 (51.6)	20 (51.3)	**0.000**
Comorbidity				
Hypertension	119 (41.8)	94 (38.2)	25 (64.1)	**0.002**
Diabetes	69 (24.2)	52 (21.1)	17 (43.6)	**0.002**
Coronary heart disease	44 (15.4)	33 (13.4)	11 (28.2)	**0.018**
Chronic kidney disease	25 (8.8)	14 (5.7)	11 (28.2)	**0.000**
Cerebrovascular diseases	10 (3.5)	6 (2.4)	4 (10.3)	**0.034**
Malignancy	8 (2.8)	3 (1.2)	5 (12.8)	**0.002**
Chronic pulmonary disease	29 (10.2)	22 (8.9)	7 (17.9)	0.084
Symptoms				
Altered mental status	7 (2.5)	0 (0)	7 (17.9)	**0.000**
Cough	172 (60.4)	153 (62.2)	19 (48.7)	0.110
Fever	236 (82.8)	206 (83.7)	30 (76.9)	0.295
Dyspnea	103 (36.1)	83 (33.7)	20 (51.3)	**0.034**
Sputum	32 (11.2)	28 (11.4)	4 (10.3)	0.836
Anosmia	16 (5.6)	12 (4.9)	4 (10.3)	0.175
Diarrhea	18 (6.3)	16 (6.5)	2 (5.1)	0.743
Anorexia	42 (14.7)	36 (14.6)	6 (15.4)	0.902
Headache	18 (6.3)	17 (6.9)	1 (2.6)	0.300
Vital signs				
Heart rate, beats/min	87.6 (78.5–95)	86 (79–94)	90 (76–110)	0.272
Systolic blood pressure, mmHg	121 (110–130)	120 (110–130)	121 (110–137)	0.491
Diastolic blood pressure, mmHg	72.8 (70–80)	73.2 (70–80)	70.8 (60–77)	0.116
Respiration rate, breaths/min	22 (20–24)	21 (20–24)	31 (22–39)	**0.000**
Temperature, °C	36.9 (36.5–37.6)	36.8 (36.5–37.5)	37.2 (36.6–38.2)	0.308
Blood oxygen saturation, %	94.5 (92–97)	94.5 (93–97)	90 (80–94)	**0.000**
Laboratory findings				
White blood cell count, $\times 10^9$ per L	6.4 (4.9–9.1)	6.1 (4.7–7.9)	13.6 (10.7–18.2)	**0.000**
Hemoglobin concentration, (mg/dl)	13.4 (12.2–14.2)	13.5 (12.4–14.3)	11.0 (9.6–13.7)	**0.000**
Platelet count, $\times 10^9$ per L	184.5 (148–244)	184 (152–239)	201 (125–330)	0.754
Monocyte count, $\times 10^9$ per L	0.4 (0.27–0.52)	0.4 (0.3–0.6)	0.3 (0.2–0.6)	0.226
Lymphocyte count, $\times 10^9$ per L	1.1 (0.91–1.6)	1.2 (0.9–1.7)	0.6 (0.3–0.9)	**0.000**
Neutrophil count, $\times 10^9$ per L	4.6 (3.1–6.8)	4.2 (3.0–5.6)	10.8 (7.6–14.8)	**0.000**
Albumin, g/l	40 (36–43)	41 (37–44)	33 (28–37)	**0.000**
C-reactive protein, mg/dl	4.8 (1.0–9.2)	4.2 (1.2–8.6)	13.5 (11.6–20.4)	**0.000**
Creatinine mg/Dl	0.9 (0.7–1.0)	1.0 (0.7–1.0)	2.2 (0.8–2.5)	**0.000**
D-Dimer, mg/L	1.2 (0.75–2.7)	0.9 (0.5–1.5)	3.2 (1.5–7.4)	**0.000**
ICU admission	54 (18.9)	24 (9.7)	30 (76)	**0.000**
PESI Score	67 (52–87)	64.5 (51–78)	115 (95–160)	**0.000**
PESI risk classes				
I	139 (48.7)	136 (56.5)	3 (7.7)	
II	72 (25.3)	68 (27.6)	4 (10.3)	
III	32 (11.2)	25 (10.1)	7 (18)	**0.000**
IV	21 (7.4)	13 (5.3)	8 (20.5)	
V	21 (7.4)	4 (1.6)	17 (43.5)	
Low (I, II)	211 (74)	204 (82.9)	7 (17.9)	**0.000**
High (III-V)	74 (26)	42 (17.1)	32 (82.1)	
sPESI risk classes				
Low	183 (64.2)	177 (72)	6 (15.4)	**0.000**
High	102 (35.8)	69 (28)	33 (84.6)	

Data are Mean±SD, n/N (%), where N is the total number of patients with available data. COVID-19: Coronavirus disease 2019; ICU: Intensive care unit; PES: Pulmonary Embolism Severity Index; sPESI: Simplified Pulmonary Embolism Severity Index.

Results

Two hundred and eighty five patients with COVID-19 who were diagnosed via detection of SARS-CoV-2 with RT-PCR were included in this study. Among them, 39 died in the hospital, and 246 were discharged. The hospital mortality was 13.7% (39.285). In total, the mean age was 57.5±18.1 years, and 147 patients (51.6%) were male. Comorbidity was present in 150 (53%) patients, and the most common comorbidity was hypertension (119 [41.8%] patients), before diabetes (69 [24.2%] patients), and finally, coronary heart disease (44 [15.4%]) patients. Only seven patients had an altered mental status. 236 patients (82.8%) had a fever as the most common clinical finding before cough (in 60.4%), and dyspnea (in 36.1%). There was a lower prevalence of other signs and symptoms. Overall, 54 patients (18.9%) were admitted to intensive care units (ICUs) upon hospital admission (Table 1). The deceased patients were significantly older (p<0.001) and reported more dyspnea than the survival patients did (p<0.05). Cardiovascular disease, hypertension, diabetes, chronic kidney disease, cerebrovascular disease, and malignancy were much more frequent among deceased patients than among survival patients (all p<0.05). There was a higher respiratory rate in the deceased group compared with the survival group (p<0.001). The nonsurvival group had lower blood oxygen saturation than survivor had (p<0.001).

The laboratory findings on admission white blood cell counts and neutrophil counts, D-dimer level, and C-reactive protein were higher, whereas lymphocyte counts, hemoglobin concentration, and albumin level were lower in the nonsurvival group than those in the survival group (all p<0.001) (Table 2). The nonsurvival group gained significantly higher PESI score than the survivor did (p<0.001) (Table 1).

Univariate logistic analysis showed significant association between mortality and age, hypertension, diabetes, coronary heart disease, chronic pulmonary disease, chronic kidney disease, cerebrovascular disease, white blood cell counts, hemoglobin concentration, lymphocyte counts, neutrophil counts, albumin, creatinine, C-reactive protein, D-dimer, ICU admission, PESI risk classes, PESI score, sPESI risk classes.

Multivariate logistic analysis showed that cerebrovascular disease (OR, 27.75; 95% CI: 1.75–439.43; p=0.018), cardiovascular disease (OR, 3.90; 95% CI: 1.93–829; p=0.002), ICU admission (OR, 217.98; 95% CI: 27.19–1748; p=0.000) and high PESI classes (OR, 2.31; 95% CI: 1.47–3.62; p=0.000) were independent risk factors for hospital mortality (Table 2). According to the first PESI scores obtained from the data once the patients were admitted were as follows: Patient numbers were 139 (48.8%) in PESI class-I, 72 (25.2%) in PESI class-II, 32 (11.2%) in PESI class-III, 21 (7.4%) in PESI class-IV and 21 (7.4%) in PESI class-V, respectively. When PESI was grouped as low risk (I-II) and high risk (III-V), 211 patients were in the low-risk group for mortality and 74 patients (26%) were in the high-risk group.

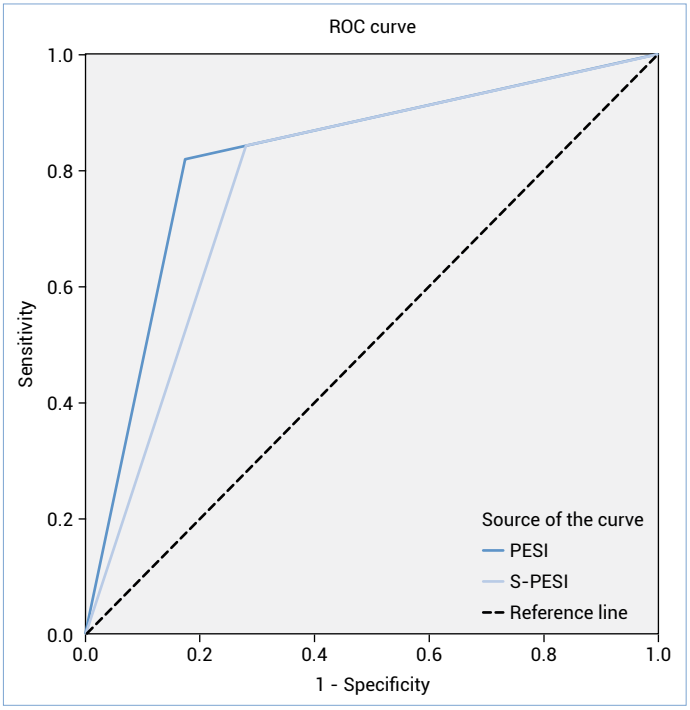

Figure 1. Receiver operating characteristic curve of pulmonary embolism severity index (PESI) and simplified PESI models in predicting in-hospital mortality.

According to the sPESI, 183 patients (64.2%) were those with low risk and 102 patients (35.8%) had high mortality risk within 30 days (Table 1). The patients with low risk had hospital mortality of 3.3% (95% CI: 0.88–5.71) based on PESI compared with 3.3% (95% CI: 0.71–5.88) for patients with low risk based on the sPESI (Table 3). There were similar sensitivities (82.1% vs. 84.6%) and negative predictive values (96.7% vs. 97%) in PESI and sPESI. Due to the specific design of both prognostic models to identify patients at low risk i.e. to eliminate short-term mortality, there were low positive predictive values of both scores (Table 4). In the evaluation of PESI model to predict mortality by using the ROC curve, AUC was 0.82 (p<0.001 and 95% CI: 0.77–0.86). In the evaluation of sPESI model to predict mortality using the ROC curve, AUC was 0.78 (p<0.001 and 95% CI: 0.73–0.83) (Table 5). Figure 1 shows that PESI and sPESI predicted 30-day mortality with similar discriminatory power (p=0.118).

Table 2. Factors associated with mortality in patients with COVID-19

	Univariate model			Multivariate model		
	OR	% 95 CI	p	OR	% 95 CI	p
Age	1.06	1.04–1.08	**0.000**			
Hypertension	2.89	1.43–5.83	**0.003**			
Diabetes	2.88	1.43–5.82	**0.003**			
Cardiovascular disease	2.54	1.15–5.58	**0.021**	3.90	1.93–829.00	**0.002**
Cerebrovascular diseases	4.57	1.23–17.01	**0.023**	27.75	1.75–439.40	**0.018**
Hemoglobin concentration	0.63	0.52–0.75	**0.000**			
Lymphocyte count	0.06	0.02–0.17	**0.000**			
Neutrophil count	1.44	1.30–1.60	**0.000**			
Albumin	0.83	0.77–0.88	**0.000**			
Creatinine	1.02	1.00–1.04	**0.014**			
C–reactive protein	1.5	1.19–1.88	**0.001**			
D-Dimer	1.62	1.25–2.11	**0.000**			
ICU admission	249.21	55.29–1123.31	**0.000**	217.98	27.19–1748	**0.000**
PESI Risk Classes	3.59	2.57–5.02	**0.000**	2.31	1.47–3.62	**0.000**
SPESİ Risk Classes	14.11	5.66–35.16	**0.000**			
PESI Score	1.06	1.04–1.07	**0.000**			

CI: Confidence interval; COVID-19: Coronavirus disease 2019; ICU: Intensive care unit; OR: Odds ratio; PESI: Pulmonary Embolism Severity Index; sPESI: Simplified Pulmonary Embolism Severity Index.

Table 3. Data on prevalence in hospital mortality observed in patients with COVID-19 in the present study, by classification according PESI and sPESI

	Low risk		High risk		
	n/N	% (%95 CI)	n/N	% (%95 CI)	p
PESI	7/210	3.3 (0.88–5.71)	32/76	42.6 (28.2–57.2)	<0.001
sPESI	6/183	3.3 (0.71–5.88)	33/102	32.4 (23.3–41.5)	<0.001

CI: Confidence interval; PESI: Pulmonary Embolism Severity Index; s-PESI: Simplified Pulmonary Embolism Severity Index.

Table 4. Accuracy of the original and simplified PESI to predict 30-day/hospital mortality

	Diagnostic scan				
	Sensitivity % (%95 CI)	Specificity % (%95 CI)	Positive PV % (%95 CI)	Negative PV % (%95 CI)	Accuracy % (%95 CI)
PESI	82.1 (77.5–86.5)	82.5 (78.1–86.9)	42.6 (36.9–48.4)	96.7 (94.6–98.7)	82.5 (94.6–98.8)
sPESI	84.6 (80.4–88.8)	71.9 (66.7–77.2)	32.4 (26.9–37.8)	97.0 (94.6–98.8)	73.7 (68.6–78.8)

CI: Confidence interval; PESI: Pulmonary Embolism Severity Index; sPESI: Simplified Pulmonary Embolism Severity index; PV: Predictive value.

Table 5. AUC of PESI and sPESI scores in predicting in-hospital mortality

Test result variable(s)	Area	Std. Error[a]	p	Asymptotic 95% CI Lower-Upper	p
PESI	0.82	0.033	0.000*	0.77–0.86	**0.118**[a]
sPESI	0.78	0.032	0.000*	0.73–0.83	

CI: Confidence interval; AUC: Area under the curve of the receiver operating characteristic; PESI: Pulmonary Embolism Severity Index; sPESI: Simplified Pulmonary Embolism Severity Index; *: P<0.01; a: Binomial exact test.

Discussion

In this study, we analyzed PESI and sPESI scores to assess the mortality rate of the patients with COVID-19 in the hospital. As far as we know, this was the first study that explored PESI and sPESI scores for patients with COVID-19. Our study PESI and sPESI had excellent sensitivity and negative predictive value. Both of these scores could give clinicians an effective adjunct tool for stratification of risk among those with COVID-19.

COVID-19 is an infection that threatens life due to the SARS-CoV-2 virus.[1] Here, we describe this study as an assessment of the performance of PESI and sPESI scores, which can predict the hospital mortality risk of 285 hospitalized COVID-19 patients at the age of 18 above, based on RT-PCR of positive SARS-CoV-2. COVID-19, with a range of 3–12%, has a higher rate of mortality.[9] One of its characteristics was also a high incidence of the disease among the critical patients, which was approximately 20% of the total number of patients. However, many studies in the literature have reported the clinical characteristics of the defined patients under critical conditions,[10,11] paying much attention to the early-stage patients' general characteristics, not observing the disease development whole course. The patients prognosed poorly in the early stage should be identified, and the timely measures for intervention should be taken to prevent deterioration of the disease among the patients based on the general law for occurrence and development of disease and laboratory and clinical indicators, which can simultaneously reduce the mortality.

COVID-19 patients at risk should be detected, and this decision should be guided using the scores which can be used easily. Many scores used in other diseases based on need have been evaluated to identify patients at risk in COVID-19 patients. Sequential organ failure assessment (SOFA) score can be used to detect septic shock and sepsis as a good diagnostic marker and to reflect the degree and status of dysfunction of different organs.[12] Zhou et al.[13] showed that the potential risk factors such as high SOFA score, D-dimer above 1 μg/L, and older age could be useful for the clinicians to identify early-stage COVID-19 patients prognosed poorly. MEWS and REMS, which are widely used physiological scoring systems developed for the early diagnosis and management of patients at high risk admitted to the emergency department, were evaluated in a retrospective study in terms of mortality predictors in critical COVID-19 patients. Although the REMS was better, both scores had been reported to be acceptable predictive values for in-hospital mortality.[14] The CURB-65, which is a score of severity for community-acquired pneumonia, predicts the mortality following CAP.[15] There was a relationship between the CURB-65 score of COVID-19, which was evaluated among the patients and an unfavorable outcome, which can be promisingly used as the COVID-19 severity score declared.[16]

There has been widely external validation of two clinical models such as PESI and sPESI, which can determine the prognosis among the patients with PE.[6–8] There are objective factors which can be easily identified in both models and can be ascertained once the patient is presented, without needing imaging or laboratory assessments. A comprehensive scoring system with multiple factors among several predicting systems for COVID-19 patients can be used for more precise screening of the infected patients. In this respect, the use of PESI scores in COVID-19 patients can more accurately identify the high-risk patients, as they include physiological parameters as well as age and co-morbidities.

According to the previous studies, there is poor prognosis among the comorbidity COVID-19 patients. According to some scholars, those with severe disease had more common coexisting illnesses than those who had no severe disease. The main health problems which cause to increase severe COVID-19 susceptibility include diabetes mellitus, chronic obstructive pulmonary disease, hypertension, and cardiovascular disease.[13,17] In a prospective cohort study of COVID-19 among patients with cancer, it was shown that there was a higher risk of severe diseases in those with cancer than that in non-cancerous patients.[18] In this study, age, hypertension, diabetes, cardiovascular disease, chronic lung disease, and cerebrovascular disease were significantly different between the survivor and non-survivor groups. In the multivariate analysis, cerebrovascular disease and cardiovascular disease were independently associated with mortality.

This study found that high-risk patients indicated a poorer prognosis according to PESI and sPESI on admission. According to PESI and sPESI, the mortality rate in COVID-19 patients classified as high-risk was statistically significantly higher than those classified as low-risk according to these scores, respectively. In our analysis, both sPESI and PESI had a statistically significant area under the ROC curve which could predict 30-day mortality. The two scores continued to have similar discriminative power and accuracy measures. There should be suitable medical interventions that are carefully controlled and administered for reduction of their mortality rate.

PESI was developed to identify APE patients with a low-risk of 30-day overall mortality.[6,7] One of the key issues with COVID-19 has been the very high number of patients applying to the health centers or hospitals throughout the pandemic. It is clear that the existing human resources and technical capacity exceed the need, especially for intensive care support.[19] Therefore, accurate identification of low-risk patients is significantly important in real-life clinical practices. While patients predicted to be in low-risk may be discharged early or treated as an outpatient, the ones estimated to be at high-risk may benefit from more intensive surveillance. The burden on the health system may be eased in this way. The patients at low risk should be critically identified correctly in real-life clinical practice. There should be negative predictive value and the highest overall sensitivity in prognostic tools so that the COVID-19 patients at low risk can be identified.[20] PESI and sPESI scores showed that most of the patients were exposed to a low risk of 30-day mortality and 3.3% of them showed poor outcomes. Our study showed low positive predictive values but high negative predictive values in PESI and sPESI. According to the findings of the current study, COVID-19patients at low risk of death can be accurately identified with both PESI prognostic models. Therefore, those with a good prognosis can be selected using PESI and sPESI. We feel that the use of PESI and sPESI scores have significant helpful identification of low-risk patients and helps clinicians to decide out hospital treatment for COVID-19 patients. An international, randomized study concluded that PESI is reliable to guide the doctors' decisions about outpatient treatment of patients with PE. It is argued that outpatient treatment of low-risk patients (class I and II), based on PESI, would improve the quality of care by safely reducing the use of medical resources. Until the effectiveness and safety of outpatient services for low-risk patients based on sPESI can be demonstrated in a prospective study, PESI was proposed as the preferred prognostic model to identify low-risk patients.[21,22] Our study cannot make such a definitive recommendation for PESI and sPESI scores for COVID-19 patients. Our focus was on the hospitalized COVID-19 cases and we could not generalize our results to all COVID19 patients, particularly those suffering from the mild disease. Besides, COVID-19 is epidemiologically, etiologically, and pathologically different from an acute PE. The severity of COVID-19 as a systemic disease might be due to "cytokine storm syndrome" which is activated by the virus, exacerbating the inflammatory responses.[23] The PESI scores might not capture several risk factors such as D-dimers, Interleukin-6, and also the COVID-19 myocardial involvement.[13,24,25] A randomized trial should be conducted to evaluate the safety and effectiveness of a strategy for outpatient treatment of the infected patients at low risk based on PESI scores.

Limitations

A potential limitation of the current study is that it is a retrospective, single-center study. The relative sample size was limited. However, there was selective bias in the infected patients admitted to the COVID-19 ward. The use of PESI and sPESI in COVID-19 patients should be validated prospectively in multi-center studies.

Conclusion

There were acceptable predictive values in both PESI and sPESI scores to predict the mortality of patients with COVID-19 in hospital. These scores could give clinicians an effective adjunct tool for stratification of risk among these patients since it has high negative predictive value.

Disclosures

Ethics Committee Approval: The İstanbul Medeniyet University Clinical Research Ethics Committee granted approval for this study (date: 13.05.2020, number: 2020/0237).

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